Instituto Murciano de Investigación y Desarrollo Agrario y Alimentario

Report on water desalination status in the Mediterranean countries

ir a ÍNDICE

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REPORT ON WATER DESALINATION STATUS IN THE MEDITERRANEAN COUNTRIES

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ir a ÍNDICE

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ir a ÍNDICE

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ir a ÍNDICE

I N D E X

ir a ÍNDICE

ABBREVIATIONS

AD	Anno Domini, in the year of our Lord Jesus Christ.
BC	Before Christ
Cm^2	Square centimetre
ED	Desalting process by electro-dialysis
EDI	Desalting process by electro-deionisation
ESCWA	Economical and Social Commission for Western Asia. United Nations
FAO	Food and Agricultural Organization of the United Nations
GWI	Global Water Intelligence
ha	Hectare
hm^3	Cubic hectometre
HD	Humidification-dehumidification processes
IDA	International Desalination Association
IME	Institute Méditerranéen de l´Eau
Kwh_e	Kilowatt-hour electric
Kwh_t	Kilowatt-hour thermal
Kwh/m^3	Kilowatt-hour per cubic meter
M^3	Cubic meter
MCV	Desalting process by mechanical compression system
MED	Desalting process by multi-effect distillation
m^3/d	Cubic meter per day
MCM/d	Million cubic meter per day
MSF	Desalting process by multi-stage flash system
NF	Nanofiltration
PR	Performance ratio, express the quantity of desalinated water produced with 2.300 kJ.
psi	Pound per square inch
RO	Desalting process by reverse osmosis
SWRO	Seawater reverse osmosis process
TDS	Total dissolved solids
USA	United States of America
US$	United States Dollar
VC	Desalting process by vapour compression system

ir a ÍNDICE

P R E F A C E

The Mediterranen Water Forum, during the meeting constituent celebrated in Marrakech (Morocco) the days 19 and 20 of December, 2011, received the discussion on the importance that no-conventional resources of water have in the sustainable development of all countries integrated in this Region.

Among the named non-conventional water rsources, those obtained by desalination of sea water and brackhis waters constitute a source to supply hydric demands generated by the population as direct consumers of water and, as well, during the economic processes involved in the agriculture, industry, tourism, etc, developed on the Mediterranean territories.

Moreover, the Mediterranean Water Forum considered the need to update the knowledge on the actual state of water desalination in this Region referring to uses, technologies, economic basis, energetic implications, legal framework and generated and predictable impact on the environment.

All this because this knowledge was considered necessary as a starting point to carry out national decisions in order to integratedesalinated water resources into the public planning water activities in all countries of the Mediterranean Region and, in consequence, achive an integrated management of water resources.

This objective will find a good supportive tool in the present REPORT ON WATER DESALINATION STATUS IN THE MEDITERRANEAN COUNTRIES 2012. The author tries to give an overview of the current state of water desalination in the Mediterranean Region. It is possible to find in it detailed information about different water desalination processes, qualitative characteristics of desalinated waters, energy requirements, environmental impacts, desalinated water demands, economy of water desalination and future tendencies.

The author has chosen, as a foundation for this study, the countries with territories in the edges or in the vicinity of the Mediterranean Sea, as is the case of Jordan, although not all its desalination activities are being developed in this region. He has considered that extending the field of study will provide a complete reference that allows us to know how the countries are involved in water desalination development.

Being this report an initial point to achive the purposes of The Mediterranean Water Forum, its improvement would be desirable during the Forum's progress. Thus, an instrument for public opinion could come up, showing the real prospect of the increasing availability of hydric resources, by means of water desalination. A possibility, simultaneous promising and complex, which rational development might be able to turn into an effective instrument to attack the poverty in our region helping to raise the standard of living of its inhabitants.

Adrián Martínez Cutillas

Director

Instituto Murciano de Investigación y Desarrollo Agrario y Alimentario

CHAPTER I

WATER, A WORLD-WIDE CONCERN

Water is an inorganic substance whose functions, within biological processes, cannot be done by any other substance. Therefore, it is irreplaceable and its characteristics have made it something essential in our society and have turned into a valuable possession since the early stages of humanity. Water is definitely essential in order to support every single form of life in our planet.

There is an immense disparity of water distribution on a world-wide scale, not only in time, but also in space. This fact has shown that water is not an unlimited resource. Therefore, the popular belief about the "eternity of water" may be removed from our communal way of thinking. In actual fact, water scarcity is an issue increasingly discussed at the level of international organizations, individual countries and slowly but surely in citizens' minds.

Water is nowadays placed under quantitative pressure and it is also an objective for qualitative alterations, clearly affecting its different uses sustainability. Considering water quality as a management criterion for hydric resources, is related to urban development expansion, industrial activities and irrigated lands intended for agricultural purposes. Indeed, the permanent increase of water used by the activities mentioned above, being essential for social and economic development, has caused international widespread water pollution. This fact occurs with such an intensity that has placed its sustainability in serious jeopardy, not only in the present but also for future generations. There is a continuous increase of entities claiming for a rationalized water use, considering that human progress needs to include social, economic and environmental criteria to be carried out.

Humankind faces the challenge to secure that millions of people surpass the poverty situation in which they are living at this moment in time. This purpose requires an enormous developmental effort that could endanger the environment. In order to avoid any negative effect it seems unavoidable, at a global level, the use of performance guidelines to guarantee the sustainable use of all natural resources. However, amidst conservation-development discussions, there is a reality that can not be avoided: the need to obtain the quantity of fresh water required by the entire world-wide population development. Water

ir a ÍNDICE

demands run in parallel with societies' progress. This is why countries involved in developing policies have to face the problem of water shortage. It has been demonstrated that in countries under arid and semi-arid climates, water deficit is related to socio-economic development, in such a way that the former can represent a serious obstacle for the latter.

According to the current status of hydrologic knowledge, it seems that integrated water resources management (IWRM), including non-conventional water resources, could be a useful basis to solve the problem of water availability minimizing the conflict with environmental requirements. Under this water management principle, it is possible to approach territorial distribution of hydraulic resources, on the basis of justice and solidarity.

Among the few possibilities of increasing water availability are: re-use of reclaimed wastewater and water desalination. Both were subjected to seriously discussions during the World Water Forum 6 celebrated las March (2012) in Marseille. The first one is a provider of agricultural water demand; the latter is a sure supplier of water needs in extreme scarcity situations.

Water desalination refers technologies to produce fresh water by means of processes that apply energy to saline watery solutions. It is not possible to forget environmental, energetic and economic concerns that the world-wide experience in water desalination provokes. It is undeniable that it allows having fresh water obtained from hydric resources whose original salinity makes them inadequate for urban, industrial and agricultural supplying. Desalination nowadays, mainly of sea water, has been accredited as a significant option to approach the problem of water shortage in some extreme cases.

CHAPTER II

WATER DESALINATION

1. INTRODUCTION TO WATER DESALINATION

Use of seawater as a fresh water source is an old dream of human beings, especially of those living in the arid zones of our planet. This idea has fascinated many generations and also has caused frustration due to the several technological, economic and environmental obstacles that are to be surpassed in order to achieve it. Samuel Taylor Coleridge, lyrical poet and philosopher, expressed this type of frustration with the following dramatic words:

Water, water, everywhere,
and all the boards did shrink;
water, water, everywhere,
nor any drop to drink[1].

Sinc early times, history provides data on techniques and methods that have been tried to desalt sea water. In IV BC, Aristotle described a method to produce potable water by sea water evaporation. Saint Basilius (329-379 AD), a Greek religious leader, wrote: "the sailors boil the water of the sea, collect sponge steam to wring them and to satiate their thirst". In VIIIcentury, an Iraqi chemist[2] wrote about distillation theory. Thousand of years later, the British government made use of this Arab study. They patented in 1869 the physical process described in it and later built the first ever distillation tower bassed in such an invention. In 1675 it was registered a patent of water desalination. In 1872, C. Wilson, a Swedish engineer, built a desalting plant in Chile, solar still, on a plot of 4,757 m^2 with a capacity to produce 22.5 m^3/day[3].

In the New World also, Thomas Jefferson, scientist and statesman, showed the first sea water distillation tower, installed on a ship, to help the revolutionary sailors that were fighting during the war of emancipation from England. The first desalination plant in mainland

[1]Coleridge, S.T. (1772 – 1834). The Rhyme of the Ancient Mariner.Part Second. Strophe 9.

[2]Probably, Djabir Ibn Hayyan [721-815]

[3]Zarza Moya, E (1997) Desalinización de Agua de Mar mediante Energías Renovables. Actas del I y II Seminario del Agua. Coord. Pascual Molina. ISBN 84-8108-128-0. Pp. 199-226. La Rioja. Spain

was built by a North-American company, Griscom-Russel, in 1930[4].

According with 22^{nd} DesalData IDA Worldwide Desalting Plant Inventary, in 2009, there were 14.451 constructed plants over the world with a production capacity of 59,9 million cubic meters per day distributed among more than 120 countries. However, the real capacity to produce desalinated water must be smaller because this figure includes the production capacity of many plants considered off line.United Nations (ESCWA, 2001) informed that at the beginning of the XXI century, the worldwide production of desalinated water moves around 26 million cubic meters per day distributed among more than 120 countries. This production capacity has almost doubled up in the last decade. It is estimated that the global desalination market for the coming next 20 years will exceed 70 billions US Dollars. For the period 2000-2005 was foresed an increase of capacity of desalinated water production of 5.3 million cubic meters per day (mcm/d)[5].

2. WATER DESALINATION PROCESSES

It is possible to make one primary classification among the desalination methods attending to the nature of the substance extracted from the saline dissolution object of study: water or dissolved salts.

Distillation, frozen-melting, reverse osmosis and extraction with dissolvent are considered methods that separate or extract water from saline solutions.

Among thermal distillation processes applied to water desalination can be mentioned:

a) Multi-effect distillation (MED). In this process feed water passes through evaporators placed in series. In each effect the pressure is smaller than the precedent; this fact allows the water to be boiled without having to put in any additional heat. This is the oldest method for water desalination. References and patents have existed since the XIX century. Now, it is in competence with multi-stage flash systems (MSF). According to Gasson, C. and Allison P.[6], advantages for MED desalination process are:

- uses less energy than MSF process
- requires no/minimum feed water pre-treatment

[4]García, C. (2006) Agua dulce, agua salada. Boletín del Agua, No 27. Instituto de Promoción para la Gestión del Agua. Lima. Perú.

[5]ESCWA (2001) Water Desalination Technologies in the ESCWA Countries.United Nations. New York. P. 4.

[6]Gasson, C., Allison, P. (2007) Desalination Water Markets, 2007. Global Water Intelligence. Media Analytics Ltd., Oxford. UK. P. 4

- very low TDS in produced water

- requires less cooling water than MSF

- lower capital cost than MSF

- lower top temperature operation than MSF

Its weak points are:

- more complex to operate than MSF

- smaller unit sizes than MSF

- may not be cost-competitive with RO processes

- only practical for seawater applications

MED occupies an important sector in the market of seawater desalination, especially when there is waste heat available.

b) Multi-stage flash system (MSF). This is a method to distil sea water by flushing a portion of water into steam in multiple stages taking advantage of the fact that water boils at successively lower temperatures when pressure decreases. This process operates through a stream of heated seawater (feed water) that flows through the bottom of a vessel containing up to 40 chambers, stages. Each one has a slightly lower pressure than its precedent. Hot water entering from one stage to the other under lower pressure boils vaporizing seawater. Afterwards, the vapour circulates on a condenser to produce pure water. MSF technology has become essential for water desalination industry in Gulf Countries. Gasson, C. and Allison, P.[7], consider that the main reasons for its attraction are:

- simplicity of operations

- reliability

- long, successful track record

- requirement of no/minimum feed water pre-treatment

- very low TDS in water produced

- very large unit sizes (to > 90.000 m^3/day))

- possibility to employ on-line tube cleaning

[7]Gasson, C., Allison, P. (2007) Desalination Water Markets, 2007. Global Water Intelligence. Media Analytics Ltd., Oxford. UK. P.2.

Its weak points are:

- only cost-effective if low cost (or free) steam source available

- electrical requirements higher than MED processes

- high cooling water requirements

- only practical for seawater applications

MSF desalination is not considered competitive with RO or MED processes at unit sizes below 32.000 m^3/day.

c) Vapour compression system (VC). In this system, saline water is evaporated to be afterwards compressed in order to use the energy produced in the compression to evaporate new saline water. It is also known as mechanical vapour compression system (MCV).

d) Humidification-dehumidification processes (HD). These processes are based in the fact that if a flux of air passes over a mass of saline water, air can get a quantity of water as vapour. After this vapour's condensation, almost salt-free fresh water is obtained. currently, studies on HD processes are limited, mainly, to laboratory works[8].

e) Byfreezing processes heat is extracted from the saline feed water until part of it becomes crystallized into pure water-ice granules, which are then separated from the residual brine, and melted into fresh product water. Some of the heat extracted in the freezing cycle may be recovered and utilized in the melting stage. It does involve three basic steps: partial freezing of feed water in which ice crystals of fresh water form ice-brine slurry, separating the ice crystals from the brine, and melting the ice. Freezing has some inherent advantages over distillation, for example less energy is required and there is a minimum of corrosion and scale formation problems because of the low temperatures involved. Freezing processes have the potential to concentrate waste streams to higher concentration than other processes, and the energy requirements are comparable to reverse osmosis. While the feasibility of freeze desalination has been demonstrated, further research and development remains until technology will be widely available[9].

f) Reverse osmosis (RO). In the XX Century, the emergence of technologies based on the osmotic potentials revolutionises the field of sea water and brackish water desalination. In this case, as it happens

[8]Bourouni et all (2000) Water desalination by humidification and dehumidification of air: State of art. Desalination 137 (2001) 167-176.

[9]Mielke, J.E (1999) Desalination R&D: The New Federal Program. National Library for the Environment.National Council for the Science and the Environmente. Washington. USA.

with all technological developments, there aremany prior basic works that were carried out by researchers during previous centuries. It can be mentioned, among the main specialists in this discipline, Abbot Jean-Antoine Nollet [1700-1770] that observed the osmosis phenomenon in 1748, using natural semipermeable membranes. A century later, in 1867, Moritz Traube [1826-1894] referred experiments made with semipermeable membranes obtained artificially[10]. The first quantitative measures on osmotic phenomena were made in 1877 by Wilhem Pfeffer [1845-1920] who built an osmometer using artificial membranes obtained by precipitation of copper ferrocyanide on porous porcelain. These types of artificial membranes were used during a long period of time to investigate many solutions' osmotic pressures.

According with courrent knowledge, the first theoretical explanations on the osmotic phenomenon were given in 1887 by Jakobus Hendricus Van´t Hoff [1852-1911], who followed Pfeffer's works and formulated the theory of the diluted solutions[11]. When thermodynamics became a scientific discipline, it was applied to understand osmotic phenomena. Josiah Willard Gibbs [1839-1903] applying thermodynamics theory provided a scientific base to understand the osmotic phenomena. His contribution to this knowledge was published along 1876-1878 in a series of collective papers entitled *On the Equilibrium of Heterogeneous Substances.*

At the end of 1920, already the main theories on osmosis were formulated. Osmosis, since then, with the exception of biological processes, was relegated to be a mere curiosity; only useful in order to prove the usefulness of thermodynamic reasoning[12].

The first attempt to use reverse osmosis to desalt water was carried out between 1953 and 1959 by C.E. Reid and J.E. Breton in the University of Florida. Both discovered several synthetic membranes with high rejection of salts, but they left their project because of the low desalted water volumes produced. The interest on reverse osmosis returned again in 1959 when Sidney Loeb and Srinivasa Sourirajan prepared semipermeable membranes made with cellulose acetate capable of rejecting great quantity of salts. Although C.E. Reid has been recognized as the creator of the inverse osmosis, the first great advance took place after the works of Loeb and Sourirajan[13].

During 1962, in Los Angeles University (UCLA) (California), it was constructed the first pilot plant with capacity to produce 2 m^3/day of

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[10] Traube, M. (1867) Physiologie und wissenschafttliche Medicin, Arch. An. Physiol. 87.

[11] Van´t Hoff, J.H. (1887). The role of osmotic pressure in the analogy between solution and gases.Zeitschrift fur physicalische Chemie. Vol 1, pp. 481-508 (1887)

[12] Fariñas et al. (1983).desalination por ósmosis inversa. Ingeniería Química. Junio. 1983. Spain.

[13] Fariñas, M. (1999) Ósmosis inversa. Fundamentos, tecnologías y aplicaciones. Serie Electrotecnologías. McGraw Hill/Interamericana de España, S.A.U. Madrid.

desalinated water. In 1965, another plant was built to produce 20 m^3/day of desalted water, processing brackish water containing 2.500 ppm salinity of total solids dissolved. In June, 4th 1965, water produced in this plant was incorporated to the potable water network of Coalinga city (California). It was the first plant in the world providing potable water by reverse osmosis.

The commercial era for reverse osmosis began in the late 1960s when some companies like Havens Industries, from San Diego (California), American Radiato & Standard Sanitary Corporation, from New Bruns Wich (New Jersey), Universal Water Corporation, from Del Mar (California), Aerojet-General Corporation, from Azusa (California), Gulf General Atomic Inc., from San Diego (California) designed different types of modules and pilot plants whose capacity varied between 1,25 m^3/day (Hevens Industries) and 200 m^3/day (Aerojet)[14]. Initially, they used Loeb-Sourirajan cellulose acetate membranes in a spiral wound configuration developed through fundings by the U.S. Department of Interior, Office of Saline Water. in addition, at the end of the 60's, Du Pont de Nemours commercialized hollow fibre membranes; in 1971, this company introduced Permasep® B-9 containing millions of asymmetric aromatic polyamide (aramide) hollow fibres[15].

From those early stages to our days, desalination by reverse osmosis has progressed outstandingly in materials and energy uses; this evolution justifies its predominant use nowadays.

Gasson, C. and Allison, P.[16] refers as advantages of RO processes:

- can be used effectively on seawater and brackish water
- uses less energy than thermal processes
- requires lower capital cost than thermal processes
- requires less feed water than thermal processes

Among its inconvenients are:

- has extremely dependence on pre-treatment'seffectiveness
- presents lower purity of water product
- is more complex to operate than thermal processes

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[14] Fariñas et al. 1983. desalination por ósmosis inversa. Ingeniería Química. Junio. 1983. Spain.

[15] Amjad, Z. 1993. Reverse Osmosis. Membrana Technology, Water Chemistry, and Industrial Applications. Van Nostrand Reinhold. New York. Pp 1.

[16] Gasson, C., Allison, P. (2007) Desalination Water Markets, 2007. Global Water Intelligence. Media Analytics Ltd., Oxford. UK. P.5.

These authors' comments imply that reverse osmosis is a mature core technology, turning it in the first choice for water desalination outside the Gulf countries. Its main areas of technological development are energy recovering, energy efficiency, membranes and fouling and scaling issues. They note that pre-treatment technology is still in need for development, which is remarkably interesting because the right performance of RO plants and its durability depend in a great measure of how clean water entering into the membranes is.

Boron concentration in water product is the main challenge for membranes' manufacturers because its ion flows easily through them. It has been pointed out that high boron content in the Gulf seawater explains why the use of RO processes are not too much extended in those regions.

g) Nanofiltration (NF) is like reverse osmosis, a process to separate salts dissolved in water. It does operate mainly on divalent ions, as calcium and magnesium, pesticides and organic molecules. Its limit of remotion is in the substances with a molecular weight superior to 1000 daltons[17]. (Dalton is a molecular mass measure unit. Dalton unit is equal to 1/12 the mass of the most abundant isotope of carbon, carbon 12). The size of its porous ranges between 1 and 10 nm. Usually it works under pressure of 40 – 250 psi (2.75 – 17.24 bar). It is used to soften the water mainly domestic water supply purposes and to remove pesticides and other organic substances.

h) Methods of desalination based on the **extraction withdissolvent** split pure water through the interface liquid-liquid of a system formed by saline water and an organic compound immiscible on it, in which pure water is partially miscible.

Electrodialysis and ionic change are examples of methods for extracting dissolved salts from a saline solution.

i) Electrodialysis (ED) consists of an electrochemical separation process in which electrically charged membranes and an electrical potential difference are used to separate ionic species from an aqueous solution and other uncharged components. This is done providing all necessary elements for this process in which concentrate and dilute solutions are separated by membranes into two streams. Electrodialysis is widely used for brackish water desalination. In some regions of the world it is the main process for producing potable water.

Water desalination cost using this method is directly proportional to the used feed water salinity. In consequence, it is more adequate for brackish water.

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[17] Schaefer, A (Edit) (2005) Nanofiltration: principles and applications. Elsevier Science LTD. Great Britain. ISBN 9781856174053.

j) Electro deionization (EDI) is a water treatment technology that uses mixed-bed ion change plus an electrical potential to remove unwanted dissolved solids[18]; it can be considered to be part of the ion change methods.

3. WATER DESALINATION AT GLOBAL LEVEL

TABLE 1 presents a summary of worldwide desalination capacity including relative data of processes applied in 1998. According with this information, MSF was the water desalination method mostly used in the world. The second one was RO that, nevertheless, was equipping many more desalting plants.

However, H. El-Dessouki and H. Ettouny (2001) confirmed the predominance of MSF method in the top petrol producer countries to obtain desalinated water. TABLE 2 contains the information provided by these authors. It is immediately concluded that the production of desalinated water by MSF method was concentrated in Arabia Saudi plus the countries of the Arabic Gulf that, as a whole, produced 8,715.68 millions of m^3/day by this method. That is to say that 87 % of MSF world production of desalinated water is located in those countries where, at the same time, maintain a high petrol production.

It is remarkable the similarity of information provided by the two above mentioned sources. Both are taking into account that one table is referred to the whole world and the other one is restricted to the desalinated water main producer countries. In addition, they equally put on evidence that CV is not a method used excessively.

In order to reach a more accurate perception of water desalination nowadays, it would be interesting to compare the production of 26 million cubic meters per day at the beginning of XXI century, with the information provided by Gasson, C. and Allison, P.[19] (2007) considering a whole water desalination market of more than 45.5 millions cubic meters per day. Now, as it was stated before, the global capacity of desalinated water could be near 70 millions of cubic meter per day. Attending to water feed origin, contracts in desalination market are referred to seawater (62,87 %), brackish water (19,85 %), river water (7,53 %), wastewater (5,05 %), pure water (4,47 %), and brine (0,22 %).

4. CHEMICAL AND PHYSICAL CONSIDERATIONS ON WATER QUALITY

In general terms, it is possible to distinguish three water fluxes within the desalting process: feed water, water product and brine. In RO processes water product is also called permeate.

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[18] Semi (2007) International standards: Compliation of terms.

[19] Gasson, C., Allison, P. (2007) Desalination Water Markets, 2007. Global Water Intelligence. Media Analytics Ltd., Oxford. UK. P.1.

Feed water is the saline solution intended to desalt; feed water is seawater or brackish water. It can also be pure water and brine. In actual fact, the present-day desalting plants are mainly actuating on seawater or brackish water as feed water. Chemical composition is in both cases important to design the corresponding plants, but this importance is extreme when RO systems are applied.

The term "salinity" is used to describe the concentration of inorganic dissolved salts. Taking into account this parameter, IDA[20] uses the following classification regarding feed water salts concentration:

Seawater: 50.000 – 15.000 mg/l
Brackish water: 15.000 – 1.500 mg/l
River water: 3.000 – 500 mg/l
Pure water: less than 500 mg/l

Courrently it is possible to find another category called brine. We can consider as brine a feed water which salt concentration is higher that 50.000 mg/l.

Seawater is the largest feed water source, due to its availability and geographical proximity to areas suffering water scarcity. Seawater composition can be studied considering the suspended and dissolved materials that contain. The term "salinity" is used to describe the concentration of inorganic salts dissolved. For world's open oceans it is admitted an average of 35 g per litre of dissolved salts; so, seawater is made out of 96.5 % pure water and 3.5 % salts. These salts are constituted by: major, minor and trace components.

As major components are considered: Chloride (Cl^-) which average presence is 55,04 % of the total weight of salts; sodium (Na^+) with 30,61 %; sulphate ($SO_4^=$) with 7,68 %; magnesium (Mg^{++}) with 3,69 %; calcium (Ca++) with 1,16 %; and potassium with 1,10 %. Chloride and sodium make 86,65 % of the total weight of dissolved salts. The group of major constituents represents 99,28 % of weight of total dissolved salts.

Between minors components are $HCO_3^=$, Br^-, H3BO3, Sr^{++} and F^-. The addition of major and minor components mentioned represents 99,99 % of the weight of total dissolved salts in seawater.

Seawater chemical composition varies according to the ocean or sea considered. In the Mediterranean Sea water salinity reaches 37 g/l of dissolved salts.

Reverse osmosis membranes are not entirely semipermeable and they permit the flow of the same quantities of saline ions that constitute

[20] IDA 2006 The 19th IDA Worldwide Desalting Plant Inventory. Media Analytics.

the saline concentration of the water product or permeate. In a first approach, it is possible to consider that the permeate quantity of a determined ion is in inverse relation to its size; the quantity of chloride and sodium ions that membranes allow to go by is superior to that of the sulfateions, bicarbonate and calcium. For this reason, the proportion of the diverse ions in the permeated water does not coincide with the existing ones in feed water before osmotization. TABLE 3 shows seawater composition (Atlantic Ocean) and the desalinated water obtained from it. TABLE 4 contents data on ions concentration in both feed water and brine referred to a RO process[21] developed in the Canary Islands.

In spite of its minor salinity brackish water, it has a more variable chemical composition than seawater. Therefore, to design a desalination project mainly based on RO processes, it is essential to have a detailed study on the salinity variation along the time. It could be said that this study is the whole project's mile stone.

Boron is nowadays one of the most important RO desalination processes quality problems. Many regulations order the limits of boron concentration for different purposes, mainly urban and agricultural supply. It is then, a challenge for membranes manufacturers to accomplish with these regulations.

In an aquous solution, when the pH is less that 8, boron is under boric acid form (H_3BO_3), that dissociated forming borate ion under its tetraedric confinguration [$B(OH)_4^-$].

Usually, the average of boron concentration in seawater ranges between 4,8to 5,5 mg/l[22]. After desalination by RO this concentration declines till 0,8 – 1,5 ppm[23]. So, after seawater desalination, in same cases it is necessary to do a specific treatment in order to remove this element to reach the concentration required by the final user. The more frequent option is to aplly a second RO or an ionic exchange process.

Boron is a necessary nutrient for the plants but only in small quiantities, so it became toxic when the essential limit is surpassed. It is assumed that a boron concentration in water irrigatior surpassing 0,5 ppm could causes toxiticy in a very wide group of crops, including the more characteristiques of the Mediterranean agriculture.

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[21] Source: UNED/MAP (2003) Seawater desalination in the Mediterranean. Assessment and Guideline. MAP Technical Reports Series No. 139. Athens. P. 46.

[22] Martínez Vicente, D. Cánovas Cuenca, J. 2005. Uso agrícola de aguas desaladas de origen marino. Problemática general del boro. Instituto Murciano de Investigadción y Desarrollo Agrario y Alimentario. Murcia.

[23] Chillón Arias, M.F. (2009). Reduccón de boro en aguas procedentes de la desalación. Tesis doctoral. Departamento de Ingeniería Química. Universidad de Alicante. Alicanta. P. 3.

In plants, symptoms of toxicity comprising boron leaf burn, chlorosis and necrosis. But some sensitive species show no apparent symptoms. Citrus, avocado, loquat and many other species show marginal and apical burns in mature leaves, accompanied by chlorosis of tissue between the veins. Boron damage to the leaves of the walnut is also characterized by marginal burns and necrotic areas between the veins. Several fruit trees, including apple and pear, are sensitive to boron but do not accumulate high concentrations in their leaves and place in these typical symptoms. Cotton, grapes, potatoes and beans show marginal scorching and rolling.

Given the reduction in yields caused by the toxicity of boron in irrigation water, Ayers and Westcot classified the crops as very sensitives (< 0,5 ppm), sensitives (0,5 – 1,0 ppm), moderately sensitives (1,0 – 2,0 ppm), moderately tolerants (2,0 – 4,0 ppm), tolerants (4,0 to 6,0 ppm) and very tolerants (6,0 – 15,0 ppm)[24]. Lemon trees are very sensitives to boron toxicity; among sensitives crops are the trees of avocado, oranges, grapefruts, apricots, peaches, cherries, plums, grapevines and walnut. Garly, wheat, barley, sunflower and artichoke are mentioned into the group of sensitives crops to this toxicity.

In 2010, the World Health Organization (WHO) issued the actual guideline of boron concentration in drinking water which value is 2,4 ppm[25]. In many cases, boron requirements are higher for irrigation water that for drinking water.

Suspended components are particles which size is bigger than 0,45 microns. In RO systems, fouling of membranes caused by this component has a strong effect decreasing its productivity. To avoid this damage is necessary to filter feed water properly. Also, fouling can be produced by microbial films across membrane surface; this can be prevent by backwashing and chemical treatments.

There is an index used to foresee the potential risk that a determined type of water has to fouling RO membranes. This is Silt Density Index (SDI). Its value is determined by estimating the decrease of water flux across a membrane, with a constant pressure of 30 psi[26]. The device for its measurement consists of a pressure regulator followed by a filter of 0.45 microns. At the initial moment, it will be measured the time (t_1) that 500 ml of tested water need to pass across the membrane. After 15 minutes of continuous water fluxing, it will be measured again the time (t_2) necessary to pass another 500 ml of water. After that, SDI value will be calculated as follows:

$$SDI = 100\ (1 - t_1/t_2)/\ T$$

[24] Ayers, R.S.; Westcot, D.W. (1987). La calidad del Agua en la agricultura. Estudio FAO Riego y Drenaje, nº 29, revisión 1. FAO.Roma.

[25] WHO (2011) Guidelines for for drinking water quality.Chapter 8.P. 178. Four edition.

[26] 1 psi = 0,068947 bar.

Where:

t_1 = Necessary time to pass across the membrane 500 ml of tested water measured at the starting point.

t_2 = Necessary time to pass across the membrane 500 ml of tested water, alter continuous flux during 15 minutes.

T = Time between both measurements (15 minutes).

Practically, it is admitted that, for a correct operation, feed water needs to have a SDI value less than 2.5 before entering the membranes.

Quality of desalinated water is also an object of attention due to the needs for adjusting water composition to the specifications required by every precise use. Sometimes, specifications are set by law, as it is in the case of urban supplies. In other occasions, like in industrial or in agrarian applications of desalinated waters, the limitations of its use come from scientific and technical considerations. In some cases it is necessary to correct pH value, SAR relation and the presence of boron. These corrections can be considered as post-treatment activities.

Brines management is one of the major problems to be solved during the productive periods of every desalting plant. Its nature of residue and the high salinity of these rejections demand special care when operating the crucial disposal with a minimum effect on the environment. At the end, all salts removed from feed water are concentrated in brines, entailing a high risk for natural resources. This is why the law prescribes a necessary procedure for the declaration of environmental impact, in order to proceed with the authorization of desalting plants' constructions, as it occurs in Spain.

5. WATER DESALINATION THERMODYNAMICS (RO SYSTEMS)

Reverse osmosis processes thermodynamics can give a clear idea on theoretical requirements of energy for water desalting.

Initially, it can be highlighted that reverse osmosis is a thermodynamic reversible process; this means that the energy needed for desalting water is equal to that necessary to dissolve salt into pure water. Furthermore, this quantity of energy is independent to the applied technology. These hypotheses allow calculating the minimal energy needed for desalting a saline solution.

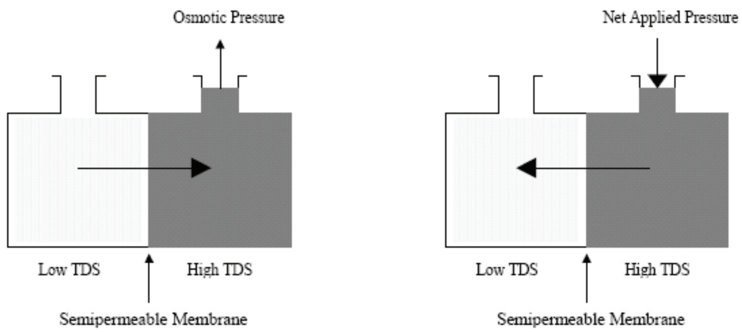

Figure 1

Reverse osmosis (RO) is a process by means of which water flows across a semipermeable membrane that blocks saline ions bypass. The external pressure applied on the saline solution determines the speed and direction of the flow across the membrane. Figure 1[27] illustrates fluxes dynamics in RO processes.

Schematically, it represents the fluxes between two aqueous with different salinities across a semipermeable membrane.

Figure 2 illustrates the phenomena of reverse osmosis that occurs when energy applied to the most concentrated solution (B), forcing pure water to pass across the semipermeable membrane to the lower saline solution (A) side.

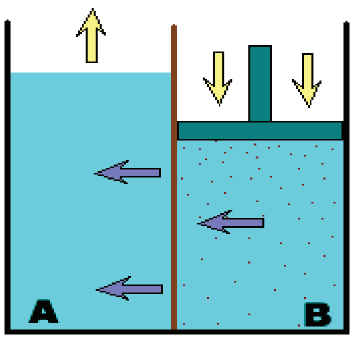

Figure 2

Theoretically, semipermeable membrane blocks saline ions bypass and allows pure water bypass.

[27]ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P.55.

Energy, W, necessary for the separation is equal to the value of the force applied on the saline solution, F, multiplied by the distance, x, moved by the water.

$$\mathbf{W = F.x}$$

The value of applied force (F) is equal to solution's osmotic pressure (π) multiplied by the surface where it was applied (S).

$$\mathbf{F = \pi.S}$$

The value of osmotic pressure (π) depends directly on saline concentration in the aqueous solution. It can be calculated by means of Van´t Hoff equation, whose formula is:

$$\mathbf{\pi = cRT}$$

Where:

π = osmotic pressure expressed in bars.

c = Concentration of saline ions expressed in moles per litre.

R = constant of perfect gases which value is 0,082 [bar.l/mol.ºK]

T = absolute temperature expressed in ºK[28].

This simple formula allows to infer that osmotic pressure of a saline solution is directly proportional to the quantity of saline ions per unit of volume and, also, to the existing temperature. When the value of any of these parameters is increased, osmotic pressure increases.

It is admitted that quantity of dissolved salts (TSD) in seawater varies not only in space, but also in time. For this reason it is necessary to talk about concentration intervals to describe seawater saline concentration. Apart of this, it is usual to admit that this salinity ranges in the interval between 33-40 grams per litre. For this study we are going to consider the highest of these values.

A maximum simplification, but very useful, would be to consider that the total salinity of seawater is due, only, to the sodium chloride. Under this hypothesis, the calculus of its osmotic pressure needs to be completed using the following data:

a) Atomic weight of Cl^- y Na^* ions are, respectively, 35,5 g and 23 g.

[28]Absolute temperature. –Temperature measured from absolute zero that, in centigrade degrees, is equal to T = - 273.1 ºC. This is the origin of scale of Kelvin degrees. The absolute zero is the temperature from which is expected to stop any atomic and molecular movement.

b) In the referred saline solution, there are 24,27 g of Cl^- and 15,73 g of Na^+, equivalent in both cases to 0,683 moles per litre. In consequence, the value of c is 1,367 moles per litre.

c) The considered temperature is 293,1 °K, equivalent to 20 °C.

Applying all these data to Van´t Hoff equation, the value of osmotic pressure in that saline solution is:

$$\mathbf{\Pi} = 1{,}367\ [mol/l] \times 0{,}082\ [bar.l/mol.°K] \times 293{,}1\ [°K] = \mathbf{32{,}87\ bars}$$[29]

This value is equivalent to 32,87 kg/cm². From a theoretical point of view, this value could interpreted as representing the amount of energy needed to expel pure water out of the initial solution or, considering the reversibility of the thermodynamic process, to expel saline ions out of the initial solution.

Considering a space with 1 litre volume, defined by a section of 1 cm² and a height of 10 meters, the action of a force of 32,87 kg acting along these ten meters would be sufficient as to expel saline ions from a solution of those characteristics occupying a 1 litre volume space. The necessary energy will be:

$$W = F.x = 32{,}87\ [kg] \times 10\ [m/l] = 328{,}7\ kg\ m/l$$

Bearing in mind the necessary conversion of units, this value would be of, approximately, 0,000894 kwh/l or 0,894 kwh/m³. This value represents a theoretical requirement of energy to desalting a cubic meter of seawater whose saline concentration is caused by 40 g/l of sodium chloride.

This theoretical value is around 0,7 kwh/m³ in the case of seawater with medium salinity.

Comparing this value with the real energetic consumptions by desalinization processes, it is possible to find a real huge difference between practice and theory that could be used as a spur for the improvement of the current processes and for the research in new ways for desalting water with lower energetic costs.

6. PRACTICAL ENERGY REQUIREMENTS FOR WATER DESALINATION

It is not wrong to state the existence of a direct relation between desalinated water production and energy consumption. But, in this

[29] Bar: Pressure exercised by a weigh of one kilo on one square centimetre. Atmosphere: pressure exercised by a column of mercury of 760 mm of height on a square centimetre. Equivalence: 1 atmosphere = 1,033 bar.

case, at a high level of abstraction, it´s possible to consider that water is quasi equal to energy. So, it is possible to say that desalinated water production cost depends on the cost of energy used in the desalting processes.

Energy use is usually expressed as kwh per cubic meter of desalinated water produced.

Morris, R. and Baltas P[30], cited by Ribeiro, J., offered some figures of energy consumption by different water desalination processes. TABLE 5 contains this information. They inform that brackish water energy consumption ranges between 0,5 to 2,5 kwh/m^3.

Medina San Juan studied the variation of energetic requirements for sea water desalination as related to different processes used. MSF energy requirements during 1970-1980 decreased from 22 kwh/m^3 to 18 kwh/m^3. Perhaps, the most significant variation has occurred in the energetic needs of reverse osmosis. In the period 1985-1988 energetic consumptions of CV's processes lowered from 15 kwh/m^3 to 13 kwh/m^3.

According to this author, the most significant variation has taken place in the energetic use of reverse osmosis processes. In the period 1990-2001 the energetic needs of the process decreased from 8,5 kwh/m^3 to 3,7 kwh/m^3. This fact evidences a great research and development effort led in the last few years to reduce reverse osmosis water desalination energetic costs. Main progress in this technology refers to energy recovery from brines generated in the process, development of more productive membranes and improvements in plants design.

TABLE 6 shows the result of the above mentioned study.

RO, compared to other methods used nowadays, is currently the one that requires less external energy.

7. ENERGY RECOVERY TECHNOLOGIES

Energy consumption is the major element among the different components affecting desalination processes final cost. Thus, it is necessary to decrease this consumption in order to reach lower desalination costs.

It is in relation with RO system where there is more progress on saving energy, mainly reusing it from the brine flux and reintroducing it again into the system. Pelton impulse turbines and hydraulic

[30]Morris, R. and Baltas, P. (2001) Estimated energy consumption by desalination precess. International Journal of Islands Affairs. Year 10, no 1 29-34.

turbochargers have been installed in most reverse osmosis desalination plants all over the world. Both systems recover the remanent brine pressure aiming to apply it to feed water, by using different devices. These results imply important energy savings. The efficiency of the Pelton turbines and the turbochargers is 85-88% and 76-79%, respectively.

Nowadays, the newest energy recovery technologies available in the market are the so-called hyperbaric or isobaric systems. Those systems are able to achieve efficiencies of about 95%. The improvement on energy saving is evident. There are different builders of this type of systems and the outstanding ones are (Loidi, J.L., 2003)[31]: two-way independent isobaric chambers, one-way isobaric chambers (Kinetic® system), and "revolver" chambers (Pressure exchanger®, Energy Recovery Inc.). Those systems are constantly being improved in order to be applicable to bigger plants. Those efficient systems allow to obtain a reduction of the specific energy consumption of 0.3-0.4 kWh/m^3, as opposed to a design using Pelton impulse turbines.

However, feed water quality may not be constant. TDS variations affect directly to the water desalting needed pressure. So, it is indispensable to adjust pumps working pressure to the necessities in each moment. The best energy control known are the variable frequency drive pumps, which work using only as much energy as it is needed. The drawback of this technology is its higher investment cost that has to be compared to the energy saving acquired in each case.

8. USE OF ALTERNATIVE ENERGIES IN WATER DESALINATION

Use of renewable energies for seawater desalinization is technically a viable possibility. There are investigation projects combining different technologies (eolic-reverse osmosis, photovoltaic-reverse osmosis and photovoltaic-thermal distillation) that have demonstrated this viability. In many cases they are prototypes desalting small water quantities, located in remote or isolated zones, far away from any electrical network, where the cost is a secondary factor opposite to the urgent need of water.

In areas connected to the electrical network, in general, seawater desalination using renewable energies have not motivated great interest. From an economic point of view, seawater desalinization using eolic energy it is, nowadays, the more viable integration of processes. Nevertheless, if it works isolated from the network, it is foreseen that the desalting plant will not use more than 25 % of its capacity, due to wind instability and, consequently the energy resource. So, if we have a

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[31] LOIDI ARREGUI, J.L. 2003 "Sistemas actuales de recuperación de energía en la ósmosis inversa." Seminario sobre Avances en la desalination para usos agrícolas. University of Murcia, Spain.

smaller production with the same investment amortization, the desalinated water cost will be higher. On the contrary, if a desalting plant is connected to the electrical network when there is no sufficient wind power, the cost of desalinated water would turn out to be competitive with that obtained using exclusively conventional electricity. Plus, it has the advantage of reducing the CO_2 emissions to the atmosphere.

There are many factors that make the use of renewable energies interesting for the desalination of seawater. It is frequent in water scarcity zones the existence of a good photovoltaic or wind energypotential. In many Mediterranean islands where water skimps and has to be stored in cisterns, the wind is a frequent meteorological factor that, with adequate technologies, can be used to generate electricity. In many areas of the Mediterranean Region there is also insolation that can be used as an energy source. In Spain, the east of Almería is a good example of this.

It is a real fact that in the coastal zones water demand increases in hot periods due mainly to agricultural and touristic needs. These periods coincide with the ones of major insolation.

Since many years ago, Public Administrations and private institutions try to look for the best utilization of energies offered continuously in nature. Among the lines of use of these energies is the one that tries to apply in the increase of the availability of water resources by means of desalination water. The main system intended to reach is:

Solar stills. Among the most primary forms of solar radiation utilization are these applied in solar stills. They are systems that benefit the so-called greenhouse effect. This is the consequence of solar energy accumulation into a greenhouse because glass or plastic materials let solar rays go through them, but do not permit radiation to get out from its interior due the major wave length. Basically, its main elements are a water reservoir and a cover structure.

Salty water is stored in a reservoir that can be constructed in a natural concavity or built artificially. The cover made of transparent material (glass or plastic) is placed on the reservoir in such a way that the temperature in the interior can reach above 60 °C. This favours water evaporation from the reservoir. Then, once water has been transformed into steam, rises up, without salts, till the inside part of the cover where condensed slips to collectors that transport it to storage deposits.

Solar stills are not hugely used for desalting water due to its low water production by unit of used surface, which forces to use a great surface to obtain significant water quantities. Its production can range between 1 and 4 litres of desalinated water by square meter of reservoir surface[32].

Moreover, there are other problems affecting the viability and suitability of those systems like:

a) Losses of steam and condensed water.

b) Productivity decrease throughout the time due to senescence or staining of cover materials.

c) Capital costs.

From an energetic point of view, the performance ratio (PR) of a solar still is about 0,53. This means that it is needed 4.350 kJ to obtain 1 kg of desalinated water[33].

Solar collectors. Solar collectors are devices that transform solar radiation into thermal energy by means of circulation of a fluid that is warming up when circulates through them. Heat needs to be stored before it is used. They can be applied in the MED and MSF water desalination systems.

Geothermic applications. Geothermal energy resources can be found in three forms: thermal, hydraulic and methane gas. This energy can be applied to produce electricity that is sent to local grids or to power thermal desalination plantsdirectly.

Ocean energy. Ocean energy can be obtained by tidal energy, wave energy, and ocean thermal energy conversion methods. Tidal power is the most developed technology in this category, and takes advantage of the hydraulic head difference between low tide and high tide which is typically between 1,22 and 1,83 meters (4-6 ft)[34]. Nevertheless, for the purpose of this Report, it is important to say that in the Mediterranean Sea there are small tides that generate a mean variation of about 0,40 meters, but atmospheric conditions often hide the rise and fall in sea level. Headwinds or, more often, higher-than-normal atmospheric pressure attenuates the effect of these tides, sometimes making them virtually impossible to see. However, for example, the Gulf of Gabes off the coast of Tunisia has a range of nearly two meters. In other areas, such as the Adriatic and south of Sicily,

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[32] Zarza Moya, E (1997) Desalinización de Agua de Mar mediante Energías Renovables. Actas del I y II Seminario del Agua. Coord. Pascual Molina. ISBN 84-8108-128-0. Pp. 199-226. La Rioja. Spain. P. 209.

[33] Zarza Moya, E (1997) Desalinización de Agua de Mar mediante Energías Renovables. Actas del I y II Seminario del Agua. Coord. Pascual Molina. ISBN 84-8108-128-0. Pp. 199-226. La Rioja. Spain. P. 210

[34] Younos et Tulou, 2005. “Energy needs, Consumption and Sources.” Universities Council on Water Resources.Journal of Contemporary Water Research & Education.Issue 132, pages 27.38.

tides are very small in the vicinity of amphidromic points where the tidal range is zero. The Atlantic affects tides in the Strait of Gibraltar, but its influence soon declines further east[35].

Photovoltaic and eolic systems.

Photovoltaic plates transform the solar radiation photonic energy into electric energy.Aerogenerators transform the mechanic energy of the wind into electric energy. In both cases, the energy produced is accumulated or sent directly to the power net.

These systems are specially indicated to supply energy for desalting plants working with RO or ED processes.

In 2000, it was published[36] that, at a worldwide scope, the production of desalinated water by means of renewable energies was 5.829 m^3/day of which 2.503 m^3/day were obtained using wind energy and 1.065 m^3/day by photovoltaic systems. Considering worldwide production of desalinated water the average of that produced by renewable energies is insignificant.

9. COSTS OF WATER DESALINATION

In the final cost of desalinated water there are two groups of elements: capital costs and conservation and maintenance costs. According to ESCWA Study (2001)[37], the components of these groups are:

Capital costs

Into the group of capital costs it must be considered direct and indirect capital cost.

Direct capital costs group is integrated by:

a) Land costs. Land costs may vary considerably; there may be no sum or nominal sums charged by the municipality and/or sums that depend on location and other site attributes. Government-owned plants are normally constructed on public land, entailing no charges. Plants constructed under build-own-operate-transfer (BOOT) contracts with Governments or municipalities may also be built on very highly reduced or free land.

b) *Well supply*. Recent estimates indicate that costs for well

[35]Legos, 1999. “Mediterranean tides are more than meets the eye.” Aviso website, "Ocean, Altimetry and Climate" group. Tolouse, France.

[36]Wangnick, K 2000 IDA Worldwide Desalting Plants Inventory: report No. 16.

[37]ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York.

construction are around US$ 650 per metre of depth. Average well capacities is estimated in around 500 m^3/d.

c) *Process equipment*. This is one of the higher-cost items, though amounts naturally depend on process type and capacity. The cost of process equipment may be under US$1.000 for a laboratory-scale RO unit operating on low-salinity tap water; however, equipment costs for a 100.000 m^3/d RO system could total as much as US$50 millions. Equipment costs for MSF and MED processes are higher than those for RO processes and currently average around US$40 millions for units with a capacity of 27.000 m^3/day. The items comprising process equipment include instrumentation and control equipment, pipelines and valves, electric wiring, pumps, process cleaning systems, and pre- and post-treatment equipment.

d) *Auxiliary equipment*. Cost items under this heading normally include open intakes or wells, transmission piping, storage tanks, generators and transformers, pumps, pipelines and valves. Cost reductions are possible if local materials and other local inputs are used. Care would have to be taken to ensure compatibility with operational conditions, overall design criteria and planning schedules.

e) *Building cost*. Building costs vary widely, ranging from US$100 to US$1.000/m^2 of surface area. Actual costs are site specific and depend on the type of construction opted for. This item normally includes facilities such as the control room, laboratory, offices, and mechanical, electrical and electronics workshops.

f) *Membrane modules cost*. In the RO plants the cost of membrane modules depends on plant capacity and ranges between US$500 and US$1.000 per module, with production rates of 50-100 m^3/day.

Indirect capital costs group is integrated by:

a) *Freight and insurance*. These costs amount to around 5 per cent of total direct costs. Freight and insurance costs may cover only imported items; however, it may be necessary to ensure the delivery and commissioning of locally produced items.

b) *Construction overhead*. This is estimated at around 15 per cent of direct material and labour costs, and then adjusted for plant size. Construction overhead costs include labour, fringe benefits, field supervision, temporary facilities (canteen, common room, recreational facilities, rest rooms and so on), construction equipment, tools, miscellaneous items, and contractors' profits.

c) Owner's costs. Owner's costs essentially comprise engineering and legal fees. This cost is worked out at around 10 per cent of direct material and labour costs adjusted for plant size.

d) *Contingencies*. Project contingency is estimated at around 10 per cent of total direct costs.

Direct and indirect costs of the capital are paid by means of annual quotas which total sum is named amortization or fixed charges. Each one partial amortization quote (a) of an every cost of capital (C_i) must be calculated as function of a period of time (period of amortization), expressed as number of year (t), and, moreover, an estimated rate of interest for the money market (r). The following formula allows to calculate the quota of amortization for a period t and an interest r of the money market.

$$a_i = C_i\,[r(1+r)^t/(1+r)^t-1]$$

The period of amortization is not the same for every part of a desalination plant. Medina San Juan[38] suggested 30 years for civil works in the case of seawater and 20 years for brackish water. For the equipment suggested 15 and 10 years respectively.

So, the fixed charges (A) will be:

$$A = \Sigma\, a_i$$

H. El-Dessouki and H. Ettouny compiled important information about the capital costs of desalting plants, under different processes, published by several authors. TABLE 7 presents a list of capital cost proceeding from this study.

Medina San Juan[39], also has studied the capital costs of desalting plants operating with reverse osmosis. It is prominent that this author, in his analysis, differenciates between plants desalting seawater and those working with brackish water. TABLE 8 shows information of his study.

Precedent information founds an economy of scale that, depending on plant size, operates on capital cost. According to ESCWA Study[40], capital and operating unit costs decline significantly with increasing plant capacity. Upper capacity limits are around 11.000 m^3/day for brackish water and 19.000 m^3/day for seawater. It states that beyond these limits, only minor cost reductions are attainable with increasing plant size. It is essential to note that the rate of cost

38 Medina San Juan, J.A. 2001. La desalacion del siglo XXI. Una aproximación a los costes reales de la desalación de aguas salobres y de mar en la agricultura. II Congreso Nacional de AEDyR. Alicante. Spain.

39 Medina San Juan, J.A. 2001. La desalación del siglo XXI. Una aproximación a los costes reales de la desalación de aguas salobres y de mar en la agricultura. II Congreso Nacional de AEDyR. Alicante. Spain.

40 ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P. 78.

reduction with increasing plant size is more significant for thermal processes than for RO or ED. In brackish water desalination, capital costs for RO and ED facilities are about equal.

Operation and maintenance costs

In this group are included the following costs:

a) Energy. The cost of energy supplied to desalination plants varies widely. ESCWA study (2001) described an interval of US$0.04 and US$0.09 per kWh, depending on a number of factors, in which ranged the price considering that lower values are more commonly encountered in the GCC countries and the United States[41].

TABLE 9 provides indications of energy costs for a variety of plants seawater reported by various authors.

Continuing with his habitual differentiation between seawater and brackish water, Medina San Juan (2001)[42] offered the information on energetic costs that shows the TABLE 10.

Cánovas Cuenca, J. and Martínez Vicente, D[43]. (2005) considered, for SWRO plants of desalination, an energetic cost of 0,16 euros per cubic meter.

b) Labour. Reasonably, ESCWA Study considers this cost as site-specific item, as well, depending on the character (public or private) of the plant ownership. So, it is subjected, in a double way, to local conditions. It has been remarked an actual tendency to contract out operational and maintenance duties with specialized companies that normally tend to reduce full-time staff. Normally, this reduced staff should be integrated by one Plant Managing Director and an small team of experienced engineers and technicians. It was signalled that one disadvantage of this tendency, particularly when the contractor is a foreign firm, could be the lack of experience on local aspects of plant management.

That Study[44] considers that labour costs constitute 15-30 per cent of operation and maintenance cost depending on the type, size and

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[41] ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P. 78.

[42] Medina San Juan, J.A. 2001. La desalination del siglo XXI. Una aproximación a los costes reales de la desalination de aguas salobres y de mar en la agricultura. II Congreso Nacional de AEDyR. Alicante. Spain.

[43] Cánovas Cuenca, J. and Martínez Vicente, D. (2005). Sea water reverse osmosis costs in Spain: Perspectives and Challenges. International Conference on Water, Land and Food Security in Arid and Semi-arid Regions.Mediterranean Agronomic Institute.Valenzano. Bari. Italy.

[44] ESCWA.2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P. 80.

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location of the plant and the operator's skills.

c) Membrane replacement. This concept represents between 5 and 20 per cent of the operation and maintenance cost[45]. Cánovas Cuenca and Martínez Vicente[46] estimated for the same concept a range of 2,5-5,8 %.

d) Filter cartridge replacement. Cánovas Cuenca and Martínez Vicente[47] considered that the value of this concept ranges around 0.1 per cent of the operational and maintenance costs.

e) Chemicals. ESCWA considers that cost of chemicals used in feed treatment and cleaning operations, including sulphuric acid, caustic soda, antiscaling agents and chlorine, is generally higher for membrane processes than for thermal processes. The cost of chemicals may exceed 20 per cent of total operating costs for RO plants, while comparable costs for MSF facilities may be around half this amount. Experience seems to indicate that the cost of chemicals is largely a function of the operator's skill and commitment to cost reduction. Strategies for reducing chemical costs can only be developed through efforts to achieve process optimization, with emphasis on site and plant design[48]. TABLE 11 shows data on chemical costs for various desalination processes.

Cánovas Cuenca and Martínez Vicente considered chemical cost ranging 4,7-8,4 % of the operational and maintenance costs.

f) Discharge taxes. In some countries, like in Spain, there are existing taxes that lien the discharge of brines in the sea which value could represent more than 5 % of the operational and maintenance costs.

Total cost

In this paragraph data is enclosed for total cost of desalinated water from sea water for different technologies. TABLE 12 includes information on estimated cost for a multistage flash plant with a capacity of 100.000 m^3/day. This information referred to 1994 and provides a final cost of 1,55 US$/$m^3$ of desalinated water.

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[45]ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P. 79.

[46]Cánovas Cuenca, J. and Martínez Vicente, D. (2005).Sea water reverse osmosis costs in Spain: Perspectives and Challenges. International Conference on Water, Land and Food Security in Arid and Semi-arid Regions.Mediterranean Agronomic Institute. Valenzano. Bari. Italy. P.4.

[47] Cánovas Cuenca, J. and Martínez Vicente, D. (2005). Sea water reverse osmosis costs in Spain: Perspectives and Challenges. International Conference on Water, Land and Food Security in Arid and Semi-arid Regions.Mediterranean Agronomic Institute.Valenzano. Bari. Italy. P.4.

[48]ESCWA.2001. Water Desalination Technologies in the Escwa Member Countries. United Nations.New York. P. 80.

TABLE 13 informs on estimated cost for a multiple effect distillation plant with a 100.000 m^3/day capacity. Its information is referred to year 1994 and provide a final cost of 1,32 US$ per cubic meter of desalinated water.

TABLE 14 provides information on estimated cost for a reverse osmosis plant with 100.000 m^3/day capacity. This is referred, as well, to year 1994 and concludes with a cost of 1,24 US$ per cubic meter of desalinated water.

Cánovas Cuenca and Martínez Vicente (2005)[49] provided information on cost of water produced in a seawater reverse osmosis plant with 100.000 m^3/day capacity. To determine the capital cost they considered a ratio of 600 euros per cubic meter and day of water production. They concluded that the total cost ranged between 0,39 and 0,44 euros per cubic meter of desalinated water. This information is included in TABLE 15.

In all references consulted fixed charges and electrical consumption appear as principal components for desalinated water final cost.

FAO[50] Committee on Agriculture, indicated as final cost of desalinated water:

a) For large plants seawater distillation: 1 to 1,5 US$ per cubic meter.

b) For RO applied to seawater: more than 1,5 US$ per cubic meter for small plants; 1 to 1,5 US$ per cubic meter for medium plants; and less than 1 US$ per cubic meter for large plants.

c) For RO applied to brackish water, less than 0,5 US$ per cubic meter.

One of the many problems faced by policy and decision makers, end-users, consultants, contractors etc. when evaluating alternative water treatment and resource options, is defining, with some accuracy, all of the capital and operating costs associated with a treatment plant.

The credibility of a planning estimate usually depends a great deal on the cost reports received from various operating facilities. However, capacity requirements, water characteristics, and local

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[49] Cánovas Cuenca, J. and Martínez Vicente, D. (2005).Sea water reverse osmosis costs in Spain: Perspectives and Challenges. International Conference on Water, Land and Food Security in Arid and Semi-arid Regions.Mediterranean Agronomic Institute.Valenzano.Bari. Italy. P.4.

[50] FAO. 2005. Water Desalination for Agricultural Applications. FAO Committee on Agriculture.Nineteenth Session. Rome. April. 2005.

conditions such as water intake, brine disposal options, land cost, electricity price, and labour rates for the contemplated facility rarely match conditions for the plant under study. These inconsistencies also make comparisons between alternative technologies (e.g. between reverse osmosis and multistage flash distillation) difficult and evaluations of research projects onerous.

To make a planning cost evaluation meaningful, it is desirable to have a defined formatavailable. Such a format is today non-existent or highly fragmented. To create a comparative and planning standard means that cost estimates must include the same items and variable factors such as electricity, chemicals, labour, maintenance, equipment, building costs, overheads, interest rates, amortization period, land costs, insurance, contingencies and profit. In the same way, estimates can be adjusted and analyzed on a common basis. One way of insuring that these criteria are met is to develop a computer model for processing capital and operating and maintenance costs.

The U.S. Bureau of Reclamation with the assistance of I. Moch & Associates and Boulder Research Enterprises has developed a computer cost estimating program, named WTCost©. This program can calculate the costs of most desalination technologies[51], and has proven, from field reports, to be friendly and accurate.

By combining all water treatment technologies into one CD ROM program, a user can evaluate any treatment system using a standard desalination cost format. Thus, direct comparisons can be made, enabling a customer to define what are the least costly process and technology alternatives for a project tender. Furthermore, this procedure will also enable researchers to evaluate their studies for commercial viability at any point in time. Before this enhanced supplier neutral computer model is issued, experts will assess the consistency and accuracy of all subsystems against recent awards.

The model provides estimates for the following desalination technologies[52]: Brackish water reverse osmosis (BWRO), seawater reverse osmosis (SWRO), mechanical vapour compression (MVC), multiple effect distillation (MED), multi-stage distillation (MSF), nanofiltration (NF), and electrodialysis reversal (EDR). The model provides a set of default values for all input parameters, but default parameters can be overridden when more accurate information becomes available.

WTCost© model provides estimates of capital costs and indirect costs. Capital costs include start-up costs for desalination technologies,

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[51] Moch, I. "Capital and Operating Costs CDROM for All Commercial Desalination Processes". International Desalination Association World Congress, 2005.SP05-180.

[52]Younos, T. "The Economics of Desalination".Universities Council on Water Resources.Journal of Contemporary Water Research & Education. Issue 132, pages 39-45. December 2005.

various pre-treatment and post-treatment options, and concentrate disposal options (surface water discharge, disposal to sewer system, land application, evaporation ponds, deep well injection, and zero discharge (using concentrators)).

Other capital costs include feed water intake infrastructure (seawater and brackish surface water, seawater and brackish well water), feed water pipeline, general site development, auxiliary equipment, and buildings. The model gives estimates of indirect depreciating and non-depreciating capital costs. Depreciating costs include freight and insurance, interest during construction, construction overhead, owner's expenses, and contingency. Non depreciating costs (costs that do not lose value or expense) include land and working capital costs (ready cash on hand to cover the day-to-day expense of operating the facilities).

WTCost© also estimates annual costs, that vary directly with the quantity of water produced and are indexed to the price levels at the date of estimate. Annual cost estimations are provided for labour (for staff requirements and plant size), chemical costs (for type of desalination technology), energy (cost of electricity in US$/kWh), type of desalination technology including plants co-located with power plants, replacement parts and maintenance materials, membrane replacement cost, insurance (assuming 5% of total capital costs), annual cost of capital, and plant factor (the percent of time the units will operate during the year at the percent design capacity).

10. WATER DESALINATION AND ENVIRONMENT

When talking about the impact of water desalination activities on the environment it could be useful to distinguish between the effects caused by the inputs applied on water desalination and those of the outputs generated by the processes.

Desalination activities have as first input a natural resource of great importance for the environment as it is water. So, since the beginning of its theoretical consideration have to be present the environmental considerations. Feed water intake, if it is seawater or brackish or from other origin, has to be done, in any case, after an strict study regarding environmental impact.

All desalination processes uses energy from different origins to produce desalinated water. This is another cause of environmental affection.

Focussing on electricity obtained from petrol, the generation of one kwh_e in a thermic power station has associate, as average, emissions to the atmosphere of 0,58 kg of CO_2.[53]It is immediate to conclude, as an example, that one cubic meter of desalinated water obtained from seawater using RO systems provokes the emission of around 2 kg of CO_2. This is only the case in one water desalination system among the less demanding in energy; in the case of thermal processes, also considering that to produce 1 kwh_e it is needed 2,54 kwh_t, this figure could be much higher. Only under the first hypothesis, a production of 500,000 m^3/day of desalinated water obtained by processing seawater could increase CO_2 emissions in 1.000 tons per day or, as equivalent, 365.000 tons per year.

Also in this chapter, it is necessary to consider the impact on the environment that has its origin in electricity distribution. Sometimes, the construction of a desalting plant provokes the installation of an electrical line to supply energy. As a consequence of this, it is necessary to consider carefully the desalting activity bearing in mind the environmental impact originated by the line of energy supply.

After these considerations, it is evident that water desalination can have a close relation with the fulfilment of the Kyoto Protocol commitments.

In 1997, a group of Governments agreed to incorporate an addition to the United Nations Framework Convention on Climatic Change Convention (UNFCCC); this addition named Kyoto Protocol, develops and provides specific content generic prescriptions of the UNFCCC that relies on more energetic measures with juridical effects as obligations. The Kioto Protocol, adopted in 1997, but came into force in February of 2005, establishes, for the first time, aims of reducing gases emission with greenhouse effect for the main developed countries which economies are in transition. The main agreement aims to reduce gas emissions contributing to the greenhouse effect, from the industrialized countries, during the period 2008-2012 at least 5 % below the levels of 1990. Among its signatories, there is the European Union[54]. Moreover, it is precise to say that among the countries that ratified UNFCC Convention are many of those Mediterranean ones considered in this report.

This clearly shows that water desalination, as it is referred to energy consumption, has an important impact on the environment and it determines that its authorization is not only a competence of the countries but also, as related with CO_2 emissions, concerns to the international community.

The main outputs generated during water desalinization

[53] In Italia per il mix di centrali elettriche presenti un kWhe produce circa 0.56 kg di CO_2. 220 La duocentoventi Azzurra.

[54]EU-15.

processes are: brines, chemicals additives residues used to prevent fouling, scale, corrosion and noises. In this group it could be also included the effect of civil works and visual impact produced by the desalting plants on the landscape. Focusing on RO plant, the outputs can be described as follows.

Brine. It is characterized by its high salinity, depending on the source of the feed water that varies between 8.000 mg/l (for some brackish waters) and 69.000 mg/l (for seawater). These values are usually twice as much the salinity of the feed water. Brines represent about 98,5% of the total disposal produced by a RO plant.

Brine disposal can be dealt with using different methods, which have to be evaluated depending on the volume of brine, its quality, the location of the plant, environmental aspects and laws, etc. The different methods are:

- Surface water disposal (river, sea, lake…), directly at the coastline.
- Submerged disposal, by means of pipes that transport the brine far into the sea.
- Disposal to front or end of wastewater treatment plant.
- Mixing with the water disposal of a power plant.
- Land application.
- Deep well injection.
- Evaporation ponds.
- Zero liquid discharge.
- Brine concentrators.

There is no global solution to the problem of brine disposal, because every disposal method has drawbacks. Surface or submerged disposals, for example, have to be designed properly in order to respect live organisms by means of a rapid dilution of the brine in the receiving water. In the case of the disposal to fresh waters it is important to avoid that a continuous discharge provokes an excessive increase of salinity. On the other hand, submerged pipes have to be installed far away from Posidonia oceanica (Fanerogamae) fields because these environmentally important plants are very sensitive, besides to the increase of salinity, to changes provoked by the removal of sand, like decreasing illumination and burying.

The disposal of wastewater treatment plants depends on the final use of the treated water, since conventional wastewater treatments do not remove salts from water. So, if brine with high TDS is added, then the TDS of the obtained water could be excessively high for some uses (irrigation, environmental flows).

The cooperation between desalination facilities with power plants has demonstrated to have some benefits from the techno-economical and the environmental points of view. The benefits of the latter are a consequence of mixing the concentrate of the desalination plant with the water disposal of a power plant. This can have two main advantages that can help to obtain a smaller environmental impact: the reduction of the temperature of the water poured out by the power plant, and the dilution of the brine produced by the desalination plant.

Relating to land application and deep well injection, both solutions could be very hazardous to ground waters, so they should only be applied under very specific conditions. Moreover, regulatory constraints should be present in order to prevent these practices.

Other solutions for brine disposal are evaporation ponds, zero liquid discharge systems and brine concentrators. Although those solutions use different technologies, they have in common that its major objective is to concentrate brine and that they can obtain a final outcome of dry salt. On the contrary to the latter methods, evaporation ponds need to use large land areas and the evaporated water cannot be recovered.

Brines disposal in coastal water and inland has different implications but always is subjected to very deep environmental effect. It could be said that at the present there are no solutions to this problem that are a hundred per cent respectful with the environment.

Regarding inland desalting plants, the question to answer is where the brines have to be released. In many cases the solution adopted is that brine is transported through pipes to the coast and afterwards discharged into the sea. Another solution can be adopted, for example storage in natural or artificial depots located near desalting plants or injecting it down in deep aquifers. In both cases, the judgement of sustainability has the risk to be negative for these operations.

Coastal brines discharge has an impact on marine ecosystems not entirely studied and solved at this moment in time. To carry out this discharge there are, at least, two possibilities: direct discharge on surface and discharge in deep by submarine outfalls. Perhaps, the more conservative one is the discharge below 30-40 meters deep, where the activity of Fanerogamae as Posidonia sp. is rare. But, as an argument against this solution, it can be said that, at the present time, brine dynamics is not well-known, having a density very superior to sea water, when it is discharged on marine beds where water is usually especially quiet. It is also unknown the effect of brine salinity on the fauna living at these depths.

Superficial brine discharge allows a rapid dilution, although its impact on existing fauna and flora over there can be problematic.

Among the possible environmental impacts, brine disposal is the most difficult to solve. Younos (2005)[55] wrote "cost-effective and environmentally-sensitive concentrate management can be significant obstacles in the widespread use of desalination technologies". The composition of brine produced in a desalination plant depends on the technology used in each case, even though it is characterized by its high TDS. The concentration in salts of brine depends on the plant's technology and on the recovery ratio. Besides this high salinity, brine can contain some chemical products that are added to feed water, such as pre-treatments. Other environmentally dangerous characteristics of brine are its high density and, in evaporative systems, its high temperature.

In order to improve environmental management of brine produced by desalination plants, it is necessary to take into account the newest tools, like interactive simulation and decision support software. According to Doneker, R.L.[56], those systems can be used by scientists to improve prediction techniques, by regulators to assess and manage risk, and finally by consultants, engineers, and the public to analyze impacts and optimize outfall design. The systems developed can have immediate and widespread application to several thousand desalination concentrate discharges worldwide. Techniques developed improve scientific prediction of mixing zones by supporting researchers in calibration and validation of hydrodynamic models. Regulators can obtain enhanced scientific methods to analyze water quality impacts of mixing zones. The public benefits from the design and management advice the system displays to correct avoidable and undesirable mixing behaviour. Since the same integrated software analysis tools will be used by all of these groups, communication among them about mixing phenomena, risk assessment, regulatory requirements, and design optimization will be improved.

Doneker informs about the development of the software CORMIX desktop computer information systems, in the Portland State University. This software helps to address the hydrodynamic, ecological, and regulatory issues associated with the fate and transport of desalination facility concentrate discharged into surface waters. The information systems improve the ecological impact assessment, regulatory management, and scientific prediction of concentrate behaviour within the mixing zone, a limited region where the initial mixing of a discharge occurs. The CorSpy and CorVue computer visualization techniques developed in this project are tools which enhance communication of environmental impacts associated within the hydrodynamic mixing zone to scientists, engineers, regulators,

[55] Younos, T. (2005)."Environmental issues of Desalination" Universities Council on Water Resources. Journal of Contemporary Water Research & Education.Issue 132, pages 11-18, December 2005.

[56] Doneker, R.L., "Systems development for environmental impact assessment of concentrate disposal. CorVue and CorSpy Interactive Visualization Tools for CORMIX Mixing Zone Analysis". Desalination and Water Purification Research and Development Program Final Report No. 98, U.S. Department of the Interior, Bureau of Reclamation, July 2003.

industry, and the public. This report describes state-of-the-art systems for hydrodynamic process simulation, environmental impact visualization, regulatory risk assessment, and infrastructure design.

The CorVue computer visualization tool displays mixing zone processes and the behaviour of concentrate plumes on benthic regions and shoreline boundaries. Visualization tools address concentrate plume boundary interaction, near-field dynamic attachments, instabilities, density currents, upstream buoyant spreading, and formation of density-stratified terminal layers. Interactive graphic tools display the effect of flow stability and boundary interaction on mixing behaviour. New techniques address regulatory mixing zones which may be specified as lengths, areas, or volumes around the discharge point. Tools display concentration profiles for near-field and far-field mixing processes. Visualizations include positively and negatively buoyant flow classifications for single port discharges (CORMIX1), multiport diffuser discharges (CORMIX2), and surface discharge sources (CORMIX3).

Filter washing water. This type of water doesn't contain any chemicals, although it contains sand, organic matter and colloids of different source. This is a discontinuous flow, normally made once a day, during 15-20 minutes, and it is 1.3% of the total disposal.

Membrane cleaning chemicals. These are used to clean the RO membranes. The cleaning operations vary depending on various issues (feed water quality, pre-treatments...). It is normally accepted an average of one cleaning frequency once a year, so it represents a 0.2% of the total disposal

Chemical reactive for feed water and product water conditioning. These are used to adequate the water to the quality required for the RO membranes and the final produced water use, respectively.

Previous reflections demonstrate that water desalination environmental impact is not a minor question and it must be studied previously. Thus, in order to prevent its negative effects, every project should include correction measures. These procedures are to be followed with the aim of turning water desalination into a sustainable activity.

11. WATER DEASALINATION AND LAW

Water is a good that has always been an object of the Law, especially for societies settled in arid zones with low hydric resources availability. Nowadays, water demands satisfaction is one of the public powers' main tasks in modern societies. This is reinforced by a strong public opinion movement pushing to introduce the right to potable water availability as one more in the list of human rights. The juridical regulation of water and its uses constitutes an activity whose relevance increase into a society in the measure of its shortage. Water desalination activities are not exempt from this normative development. Ultimately, these activities deal with hydric resources, natural resources, with a concrete status into every society's juridical institutions. In some countries, like in Spain, there has been a discussion on the nature of public or deprived desalinated water. Initially, it was accepted that desalinated water coming from seawater was a private good; later the legal definition has been changed in order to consider it to be a public good. This change affects largely to the regime of concessions and authorizations on its use.

Water desalination is an activity involving an environmental impact. This impact must be considered through its study, as a requirement for the execution of the corresponding projects. In the UE there is a frame regulation of procedure on environmental impact declaration. Each State Member has been developed its internal law. The purpose is to prevent as much as possible the undesirable effects of those activities on the natural resources and the environment considered as a dynamic entity.

Water desalination constitutes as well an industrial activity usually under administrative authorization and produce a matter of first necessity, fresh water, which distribution must be subjected to the equity principles, at least into the group of people having the right to use it. For all of these reasons, it is necessary to add the obligations and rights that are generated by the exercise of desalination activities by third persons that are foreign to the water consumption as constructors, suppliers, workers, etc.

This previous exposition allows to consider desalting activities as submitted to the juridical order with force in every moment and that this submittion has, conceptually, an equal importance or, maybe major, technologies used in water production.

12. WATER DESALINATION TRENDS

In 2001, ESCWA Study[57] exposed a lot of considerations on the status of water desalination technologies and their future perspectives that, in general lines, still remain nowadays. It is emphasized on bottlenecks existing in both, thermal and membrane processes. For the first group, MSF and MED, it was signalled the need of attention in the areas of research, development and engineering. In this sense, also remarked the investment needs for building plants, energy requirements and material corrosion. For vapour compression processes, it stood out high energy consumption and small capacity

[57]ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P. 87.

units as main mechanical challenges. The size of available compressors limits capacity of units and its increase since the actual dimensions will not a viable future option.

In order to reduce energy costs and achieve optimized designs, there are three main performances: cogeneration plants, co-located plants and hybrid plants.

Cogeneration plants consist on a combination of a power and a desalination plant, both getting some benefits out of in. Power plant sends its waste steam to the desalination plant, taking advantage of its energy that, questions saved, would go to disposal; thus, a decrease of final costs is achieved, due to the fact that boilers are installed only once, and to the waste steam energy use.

Co-located plants performance consists on a seawater reverse osmosis desalination plant and a power plant, sharing the same plot of land. In this case, the power plant cooling water is sent to the desalination plant as feed water, so that the desalination plant can remarkably lessen its investment and operation costs. Moreover, the brine of the desalination plant is mixed up with the disposal of the power plant, diluting it and reducing its environmental impact.

In hybrid plants, two desalination systems are combined such as reverse osmosis and thermal technology. This allows the whole system to obtain an optimized design that can reduce energy costs.

RO processes have more promising future perspectives. Nevertheless, there are some constraints that require certain efforts to be spent on research and development. Look for longer membranes lifetime, lower energy consumption, bigger water productivity of membranes, brine energy recovery and greater cost was considered as main lines of development.

ED technologies appear as being well developed for brackish water processes. Its request to seawater is nowadays, in general terms, an objective not too realistic.

TABLE 16 contents a summary of bottlenecks in desalination processes provide by the referred ESCWA Study adapting information coming from other source.

A useful indicator for future water desalination technologies can be given by the study of trends in the desalination market. Gasson, C. and Allison, P. (2007)[58]) consider that market share of thermal desalination versus membrane desalination has a close relation with

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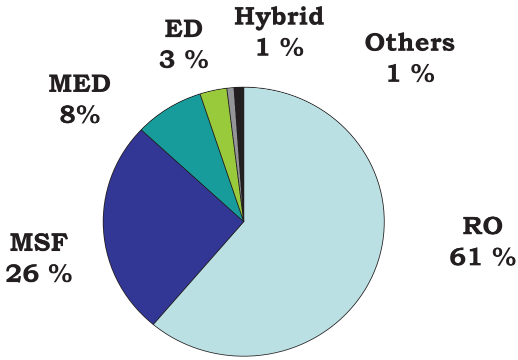
[58] Gasjson, C., Allison, P. (2007) Desalination Water Markets, 2007. Global Water Intelligence. Media Analytics Ltd., Oxford. UK. P. 9.

cyclical growth of the Gulf desalination market. They describe three cycles: the first peaking in the early 1980s following the 1979 oil price spike, the second peaking in the early 1990s in the wake of the first Gulf war and the third, continuing today as oil prices remain over 50 US$ per barrel.

GRAPHIC 1 represents the share of desalination global market by different technologies inferred from the data of plants contracted since 2000[59].

GRAPHIC 1
Market share by desalting processes contracted since 2000



It reveals the actual market predominance of RO processes and, also, a low dependence on the Gulf situation.

According to the precedent comments, it is possible to infer that, during the coming years, RO systems will continue their development growing in the market share of desalination technologies. So, the future of water desalination is, in great measure, associated to improve reverse osmosis processes. Meanwhile, other new desalination principles become applied generating new technologies to produce desalinated water with significant advantages over those applied nowadays.

In words of Lior, N.[60], it is felt generally that sufficient knowledge, hardware, and experience exist to operate commercial desalination plants safely and reasonably reliably, but improvements in automation strategies that would allow online operation optimization would result

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[59] Adapted from Gasson, C., Allison, P. (2007) Desalination Water Markets, 2007. Global Water Intelligence. Media Analytics Ltd., Oxford. UK. P. 9.

[60] Lior, N. et al. "An update on the State of Instrumentation, Measurements, Control and Automation in Water Desalination".International Desalination Association World Congress, 2005.SP05-111.

in savings in the consumption of energy and materials, in replacement components, and in labour and maintenance. It is also recognized, according to this author, that many advanced control methodologies perhaps usable in other fields, may not be justifiable or applicable to MSF and RO water desalination processes.

The main areas in which cost reduction could be affordable are: energy consumption, materials consumed by the plant, labour and its required dexterities, and environmental costs. IMCA (Instrumentation, Measurements, Control and Automation) strategies could help this optimization of the processes, stabilising the operation of the plant at operating points and handling efficiently the different constraints on the process variables.

Lior wrote as well: "while the most important goal in the past was to achieve the highest possible availability of the plants, nowadays the best performance of the plants becomes increasingly important. For that purpose it is no longer sufficient to operate the plants according to the operating manuals of the process manufacturer or to follow the experience of the operators. It now becomes necessary to use supplementary calculations to determine the optimal set points of the individual control loops based on a rigorous process model which allows an improvement of the efficiency under all modes of operation. That model may be used in online mode for the optimization of the plant under all modes of operation and changing boundary conditions (e.g. summer/winter mode, changing salinity or temperature of the sea water). As it is built using physical laws, it may also be used off-line to determine in advance the anticipated behaviour of a plant by using the actually designed geometrical and material data including additional heuristic knowledge, e.g. to determine the brine level. This helps to examine the construction of the plant and to calculate and evaluate different alternatives. Dynamic simulations allow examination the transient behaviour of the plant and assurance of smooth and safe operation during load changes".

Actually, research and development of membrane technology runs along two main paths: nano-engineering and biomimetic.In the first field, the use of a new material, nanoporous graphene as thin layer in a RO membrane, opens promising expectations to increase productivity of these membranes and, as well, to reduce drastically energy consumption of desalinated processes[61]. Natural proteins known as aquaporins are at the base of a new line of research of selective membranes technology.

[61]Cohen-Tanugi, D. and Grossman, J.C. (2012) Water Desalination across Nanoporous Graphene.Department of Material Science and Engineering. Massachusetts. Cambridge, Massachusetts. USA. ACS Publications (dx.doi.org/10.1021/nl3012853). *Nano Lett*. XXXX, XXX, XXX-XXX.

TABLES MENTIONED IN THIS CHAPTER

ir a ÍNDICE

ir a ÍNDICE

TABLE 1

Summary of worldwide desalination capacity (1998)[62]

Desalinating process	Capacity (10^6 m^3/day)	%	Nº of plants
MSF	10,02	44, 4	1.244
RO	8,83	39,1	7.851
MED	0,92	4,1	682
ED	1,27	5,6	1.470
VC	0,97	4,3	903
Others	0,56	2,5	283
TOTAL	**22,57**	**100**	**12.433**

TABLE 2

Use of desalination methods in selected countries[63]

Country	Total Capacity 1,000 m^3/day	% relative to world	RO (%)	MSF (%)	MED (%)	MCV (%)	ED (%)
Saudi Arabia	5.429	21,1	32,3	64,2	0,3	1,4	1,8
United States	4.328	21,0	74,4	1,3	4,4	6,4	13,5
United Arab Emirates	2.891	11,2	5,5	86,7	7,7	0,03	0,1
Kuwait	1.615	6,2	3,3	96,4	0,1	----	0,2
Japan	945	3,7	84,3	3,9	2,3	----	7,4
Libya	701	2,7	15,9	65,7	10,7	-----	7,7
Qatar	573	2,2	1,8	94,3	3,9	------	-----
Spain	1.234	4,8	84,2	4,5	3,5	2,8	5,0
Italy	581	2,2	21,5	43,6	12,3	6,4	16,2
Bahrain	473	1,8	26,9	62,7	9,7	-----	0,7
Oman	378	1,2	7,6	87,3	1,1	3,7	0,2
World top producers	19.148	73,9	38,8	50,0	3,8	2,3	5,1

[62] Martínez Beltran, J; Koo-Oshima (Edit) (2006). Water desalination for Agrícultural applications.Proceeding of the FAO Expert Consultation for Agricultural Applications. 26-27 April, 2004. Rome. Land and Water Discusión papper 5.FAO. Rome.

[63] H. El-Dessouki and H. Ettouny (2001) “Study on water desalination technologies”, prepared for ESCWA in January 2001.

TABLE 3

Chemical composition of seawater (feed water) and its permeate in a RO process

	Seawater		Permeate		%
Ion	mg/l	%	mg/l	%	
Cl-	19.354	55,2	208	56,6	98,9
SO4=	2.712	7,7	11	3,0	99,6
CO3H-	142	0,4	8	2,2	94,4
Na+	10.770	30,7	128	34,8	98,8
Ca ++	412	1,2	2	0,5	99,5
Mg++	1.290	3,7	6	1,6	99,5
K+	399	1,1	4	1,1	99,0
B	4.5	0,01	1,3	0,35	71,1
Total	35.084	100,00	368,3	100,00	

TABLE 4

Chemical composition of brine in relation to its feed seawater

Ions	Seawater (mg/l)	Brine (mg/l)	Ratio (brine/seawater)
Ca^{++}	962	1.583	1,64
Mg^{++}	1.021	1.909	1,87
Na+	11.781	19.346	1,64
K^+	514	830	1,61
NH_4^+	0,004	0,005	1,25
HCO_3^-	195	256	1,31
$SO_4^=$	3.162	5.548	1,75
Cl^-	21.312	43.362	2,03
F^-	1,5	1,9	1,26
NO_3^-	2,6	4	1,54
Total hardness in $CaCO_3$	6.600	11.800	1,78
Total salinity (TDS)	38.951	63.840	1,64
Electrical conductivity	46.200 µmho/cm	75.300 µmho/cm	1,63

ir a ÍNDICE

TABLE 5

Estimated energy consumption by desalination process

Feed water	Process	Energy of steam (Kwh_{el}/m^3)	Equivalent Electricity consumption (kwh_{el}/m^3)
Seawater	MSF	7,5 – 11,0	10,0 – 14,5
Seawater	MED	4,0 – 7,0	6,0 – 9,0
Seawater	CV	-----	7,0 – 15,0
Seawater	SWRO	-----	4,0 – 8,0
Brackish	BWRO	-----	0,5 – 2,5
Brackish	ED	-----	0,7 – 2,5

TABLE 6

Variation of energetic cost in desalting plants according to the process applied (sea water)[64]

Year	Desalting method	Energetic needs (Kwh/m^3)
1970	MSF	22,0
1980	MSF	18,0
1985	VC	15,0
1988	VC	13,0
1990	RO	8,5
1994	RO	6,2
1996	RO	5,3
1998	RO	4,8
1999	RO	4,5
2000	RO	4,0
2001	RO	3, 7

64 Medina San Juan, J.A. Desalación y sus costes.

TABLE 7

Capital cost for different water desalting plants (US $)

Reference	Process	Cost (US $)	Cost (US $/m³/d)	Capacity (m³/d)
Matz and Fisher (1981)	RO	$9{,}40 \times 10^5$	924,0	1.000
Leitner (1992)	RO	$49{,}00 \times 10^6$	1.313,1	37.850
Wade (1993)	RO	$53{,}00 \times 10^6$	1.665,6	32.000
Leitner (1999)	RO	$98{,}00 \times 10^6$	1.035,0	94.625
Matz and Fisher (1981)	MVC	8.940×10^5	894,0	1.000
Veza (1995)	MVC	1.586×10^6	1.322,0	1.200
Leitner (1992)	MSF	$60{,}500 \times 10^6$	1.598,0	37.850
Wade (1993)	MSF	$72{,}600 \times 10^6$	2.269,0	32.000
Morin (1993)	MSF	$76{,}817 \times 10^6$	1.690,0	45.460
Leitner (1992)	MED	$70{,}400 \times 10^6$	1.860,0	37.850
Wade (1993)	MED	$67{,}200 \times 10^6$	2.100,0	32.000
Morin (1993)	MED	$35{,}050 \times 10^6$	1.562,0	22.730
Morin (1993)	MED-TVC	$34{,}650 \times 10^6$	1.524,0	22.730
Hammond et all (1994)	MED VS	$187{,}100 \times 10^6$	548,0	340.956

Source: H. El-Dessouki and H. Ettouny (2001)[65]

TABLE 8

Capital cost of RO desalting plants according to its production capacity

Plant production (m³/day)	Seawater (Euros)	Brackish water (Euros)
< 500	---	270,46
500 – 1.000	---	228,38
1.000 – 1.500	---	204,34
1.500 – 2.000	---	174,29
> 2.000	---	150,25
> 5.000	961,62	---
5.000 – 10.000	856,44	---
10.000 – 25.000	751,27	---
25.000 – 40.000	661,11	---
40.000 – 60.000	611,53	---
60.000 – 80.000	588,99	---
80.000 – 100.000	525,89	---
> 100.000	506,35	---

65 H. El-Dessouki and H. Ettouny (2001) Study on water desalination technologies. Mentioned in ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P. 78.

TABLE 9

Energy cost for various desalination processes (US $)

Reference	Process	Cost (year)	Cost (m^3)	Capacity (m^3/d)
Matz and Fisher (1981)	RO	1,71 x 10^6	0,52	1.000
Leitner (1992)	RO	4,3 x 10^6	0,35	37.850
Wade (1993)	RO	6,261 x 10^6	0,63	32.000
Zimmerman (1994)	RO	1,971 x 10^6	0,30	20.000
Veza (1995)	MVC	1,680 x 10^5	1,057	500
Zimmerman (1994)	MCV	2,690 x 10^6	0,410	20.000
Matz and Fisher (1981)	MVC	3,420 x 10^6	0,52	2.000
de Gunzbourg and Larger (1998)	MED-ABS	5,21 x 10^6	0,165	9.600
Morin (1993)	MED-TVC	5,658 x 10^6	0,758	22.730
Hammond et all (1994)	MED VS	13,650 x 10^6	0,129	340.956
Leitner (1992)	MED	1,000 x 10^6	0,080	37.850
Morin (1993)	MED	3,919 x 10^6	0,490	22.730
Wade (1993)	MED	1,206 x 10^6	1,147	32.000
Leitner (1992)	MSF	4,300 X 10^6	0,350	37.850
Wade (1993)	MSF	1,154 x 10^6	1,098	32.000
Morin (1993)	MSF	1,245 x 10^6	0,880	45. 461

Source: H. El-Dessouki and H. Ettouny (2001)[66]

TABLE 10

Energetic costs of desalinated water (2001)

Brackish water							
Deep of wells	Captation	Salinity Increase	Transfer	R.O.	Total	Price of kwh	Total cost
m	Kwh/m^3	Kwh/m^3	Kwh/m^3	Kwh/m^3	Kwh/m^3	euros	euros/m^3
50	0,2260	0,2	0,2571	1,1000	1,7832	0,066	0,118
75	0,3390	0,2	0,2571	1,1000	1,8962	0,066	0,125
100	0,4521	0,2	0,2571	1,1000	2,0092	0,066	0,132
125	0,5651	0,2	0,2571	1,1000	2,1222	0,066	0,140
150	0,6781	0,2	0,2571	1,1000	2,3352	0,066	0,154
175	0,7911	0,2	0,2571	1,1000	2,3482	0,066	0,155
Seawater							
			0,4	3	3,4	0,042	0,143

66 H. El-Dessouki and H. Ettouny (2001) Study on water desalination technologies. Mentioned in ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P. 79.

TABLE 11

Chemical cost for various desalination processes

Reference	Process	Cost (US$/m^3)	Capacity (m^3/day)
Matz and Fisher (1981)	RO	0,110	1.000
Daerwish and others (1990)	RO	0,350	100
Leitner (1992)	RO	0,070	37.850
Wade (1993)	RO	0,330	32.000
Zimmerman (1994)	RO	0,070	20.000
Zimmerman (1994)	MVC	0,050	20.000
Daerwish and others (1990)	MVC	0,025	100
Matz and Fisher (1981)	MVC	0,020	1.000
de Gunzbourg and Larger (1998)	MED-ABS	0,080	9.600
Hammond et all (1994)	MED-VST	0,040	340.956
Leitner (1992)	MED	0,024	37.850
Morin (1993)	MED	0,060	22.730
Wade (1993)	MED	0,207	32.000
Leitner (1992)	MSF	0,024	37.850
Wade (1993)	MSF	0,207	32.000
Morin (1993)	MSF	0,058	45.461

Source: H. El-Dessouky and H. Ettouny, "Study on water desalination technologies", prepared for ESCWA in January 2001.

TABLE 12

Estimated cost for a multistage flash plant with a 100.000 m^3/day capacity

Cost item	Cost (US$)	% on annual cost
Capital cost	190.000.000	
Fixed charge	24.301.000	47,8
Energy: extraction steam	13.538.000	
Energy: electrical power	5.543.000	
Energy subtotal	19,180,000	37,6
Chemicals: chlorine	42.000	
Chemicals: antifoam	7.000	
Chemicals: antiscalant	1.387.000	
Chemical: others	1.044.000	
Chemical subtotal	1.044.000	4,9
Labour	1.125.000	2,2
Spare parts	3.800.000	7,5
Total annual cost	50.886.000	
Product water cost (US$/m^3)	1,55	

Source: V. Van der Mast and S. May, "Comparison of desalination processes", a presentation by the Saudi Arabian Bechtel Company (Riyadh, 1994), p. 29. Cited in ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P. 82.

TABLE 13

Estimated cost for a multiple effect distillation plant with a 100.000 m³/day capacity

Cost item	Cost (US$)	% on annual cost
Capital cost	180.000.000	
Fixed charge	23.022.000	44,9
Energy: extraction steam	18.832.000	
Energy: electrical power	2.204.000	
Energy subtotal	21.036.000	41,0
Chemicals: chlorine	42.000	
Chemicals: antifoam	7.000	
Chemicals: antiscalant	1.387.000	
Chemical: others	1.044.000	
Chemical subtotal	22.480.000	4,8
Labour	1.125.000	2,2
Spare parts	3.600.000	7,0
Total annual cost	51.263.000	
Product water cost (US$/m³)	1,32	

Source: V. Van der Mast and S. May, "Comparison of desalination processes", a presentation by the Saudi Arabian Bechtel Company (Riyadh, 1994), p. 29. Cited in ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations. New York. P. 82.

TABLE 14

Estimated cost for a reverse osmosis plant with a capacity of 100.000 m³/day

Cost item	Cost (US$)	% on annual cost
Capital cost	170.000.000	
Fixed charge	21.743.000	53,0
Energy: electrical power	7.133.000	18,0
Chemicals: chlorine	42.000	
Chemicals: coagulant	127.000	
Chemicals: polimer	79.000	
Chemical: sodium bisulphite	222.000	
Chemicals: antiscalant	1.586.000	
Chemicals: sulphuric acid	166.000	
Chemicals: Post-treatment	1.044.000	
Chemical subtotal	3.266.000	8,0
Membranes	4.074.000	10,0
Labour	1.125.000	3,0
Spare parts	3.400.000	8,0
Total annual cost	40.741	
Product water cost (US$/m³)	1,24	

Source: V. Van der Mast and S. May, "Comparison of desalination processes", a presentation by the Saudi Arabian Bechtel Company (Riyadh, 1994), p. 29. Cited in ESCWA. 2001. Water Desalination Technologies in the Escwa Member Countries. United Nations.New York. P. 82.

TABLE 15

Estimated cost for a reverse osmosis plant with a capacity of 100.000 m³/day

Cost item	Cost (euros/m³)	% on annual cost
Fixed charge	0,1652	37,7 – 37,7
Energy: electrical power	0,16	50,0 – 36,5
Chemicals	0,0198 – 0,0395	5,0 – 9,0
Membranes	0,0079 – 0,0157	2,0 – 3,7
Filter cartridge replacement	0,003 – 0,006	7,7 – 13,7
Maintenance	0,0173 – 0,0343	4,4 – 7,8
Staff	0,0171	3,9 – 4,4
Produc water cost (euro/m³)	**0,39 – 0,44**	

TABLE 16
Technical bottlednecks of desalination processes

Process	Bottleneck	R & D efforts	R & D budget
MSF/MED	Corrosion and material improvement	Medium	Medium
MSF	Scaling	Medium	Medium
MSF	Energy consumption	Medium	Medium
VC	Compressor problems (reliability/costs)	Medium	High
VC	Small unit capacity	Low	Low
RO	Pre-treatment (scaling/fouling)	Medium	Low
RO	Membrane system	High	Medium

CHAPTER III

WATER DESALINATION IN THE MEDITERRANEAN REGION

1. WATER RESOURCES

Natural water renewable resources in the Mediterranean basin, including those of Jordan and Balcanic countries, can be approximately up to 1,370 hm^3/year[67]. Water withdrawal (2000) can be estimated in 300 hm^3/year. According to Plan Bleu studies, it is realistic to affirm that the figure 700 hm^3/year is a good appreciation to value of average of renewable resources that might be mobilized all over the region. Its distribution is very much irregular being remarkable the existence of water penury situations in the countries located in the South and the East of the Region. An approximation to the real satisfaction of water needs in the different countries considered in this report can be supported by water renewable resources per capita referred to each one of these.

Water renewable resources per capita are a useful index to describe the satisfaction of water needs in a country or on over a territory. Conventionally it is accepted that the interval between 1.000 and 500 m^3/inhabitant corresponds with water poverty status. When this value is lower than 500 m^3/inhabitant, the situation is of penury.

According to available information[68], in 2000, 49 millions inhabitants of the Mediterranean region were suffering water penury, being certainly prominent the situation in Libya and Jordan. Vision that became more dramatic if instead of the value of the water renewable resources we use that of water withdrawal or, even worse, the volume of water really useful for the population. Algeria, Tunisia, Israel, Cyprus and Malt were, as well, under penury situation.

While the available volume of hydric resources remains constant or diminishes slowly, demands in the whole Region increase due mainly to the increase of domestic and urban needs and, also, to the expansion of irrigated land.

TABLE 17 contains a theoretical inference of water demands, in 2000, for a group of countries considered. The hypotheses of calculation are: 109.5 cubic meters per year per caputfor the domestic and

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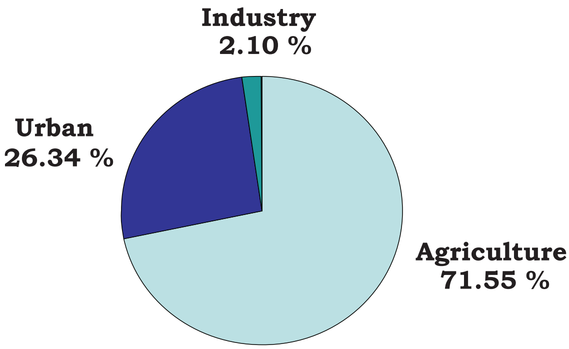
[67] Burak, S. (2002) Politiques de l´Eau des Pays Méditerranéens. Synthèse Régionale des Dossiers Pays (Pays du Sud et de l´Est). Blue Plan.Regional Activity Centre.Sophia Antipolis.

[68] Cánovas, J., del Campo, A. (2006) Study on Irrigation Water Management in the Mediterranean Region. EMWIS.IMIDA. FENACORE (unpublished).

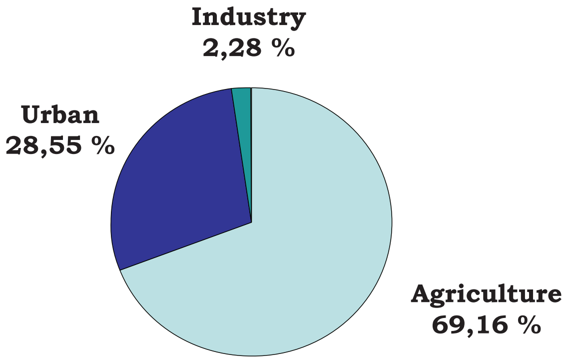
municipal withdrawal and 6,176 cubic meters per hectare and year for agriculture. The industrial demand can be determined as a percentage of urban consume, around 8 %. With the same hypothesis, having in mind estimated growth of population and as well the inferred increase of irrigated lands, were determined water demands for 2025 which information is presented in TABLE 18.

Those figures let to estimate that in 2025 urban demand could increase, in respect to year 2000, 12-13 km^3/year; irrigation 16-17 km^3/year; and, industrial demand 0,9 -1,0 km^3/year. So, the biggest increase is expected from the agricultural sector.

GRAPHIC 2
Distribution of water demands by sectors in the Mediterranean Region (2000)

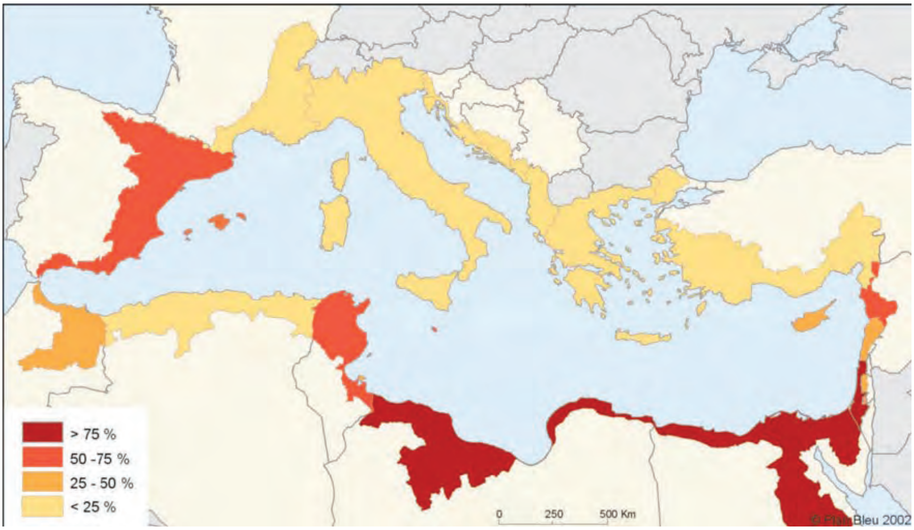


GRAPHIC 3
Distribution of water demands by sector in Mediterranean Region (2025)

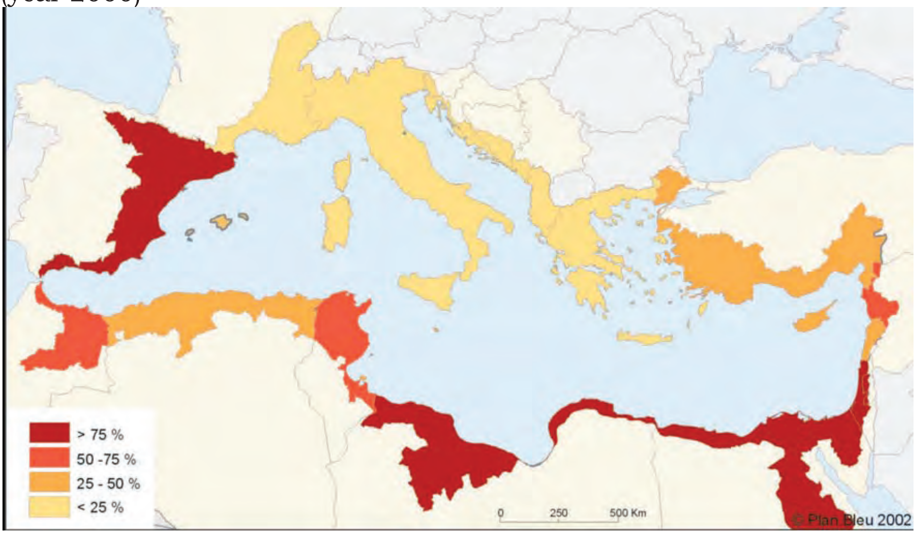


MAP 1

Exploitation indexes of renewable natural water resources



(year 2000)



(year 2025)

Source: Plan Bleu, J. Margat[69]

GRAPHIC 2 represents the distribution of water demands by each consumer sector in 2000. GRAPHIC 3 represents the same distribution referred to 2025. In both cases, irrigation appears as the biggest

[69] Benoit, G., Comeau, A. (Edit) (2005) A Sustantaible Future for the Mediterranean: The Bleu Plan´s Environment and Development Outloock.United Nations. Mediterranean Action Plan. Plan Bleu. Earthscan. London.

consumer of water resources with a demand of around 70 %. Nevertheless, for countries located in the South and East can represent more than 80 %.

MAP 1 represents territorial distribution of exploitation index of natural resources around the Mediterranean Sea in 2000 and in its inference for year 2025.Its temporary variation suggests a worsening of water problem, especially for those countries in the South and East of this Region.

The progressive water demand evolution tendency and the increasing pressure on hydric resources in the Mediterranean Region were considered by CEMAGREF (2000)[70] to define four groups of countries according to the availability of water. These groups are:

1st Egypt, Turkey, Libya. The pressure on the resource and the growth of the demand are strong, even very strong for the pressure on the resource (Libya). In these countries, water demand management is essential but probably insufficient to ensure a balance between offer/demand.

2nd Tunisia, Morocco, Spain, Lebanon. Both, pressure on the resource and increase of water demand, are moderated or pressure is strong with a weaker increase (Tunisia). Water demand management appears as necessary in order to prevent the increase of pressure on the hydric resources that exceed the limit of the exploitation of renewable resources.

3rd Malta, Jordan, Israel, Cyprus. Countries included in this group are those for which the pressure on the hydric resources moves from strong to very strong but whose demand for water is stabilised. Demand management must be continued in order not to turn over towards a rise of demand which cannot be guaranteed by the mobilization of new resources (except non conventional high-cost, like the desalinisation in Cyprus). Indeed, the limit of renewable water resources is reached.

4thItaly, Greece, France, Albania, Croatia, Slovenia. These countries have a relatively low total pressure on resource water and the demand is as much in weak rise, it would be even in reduction in Italy. However, the management of the demand for water can be necessary locally or in a seasonal system (Greece in summer) because of tensions among different uses. In addition, the problem of quality of water and the aquatic environments must be taken into account in the management of water demand.

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70 CEMAGREF (2002) Les outils économiques pour la gestion de la demande en eau en Méditerranée. Forum Advances de la gestion de la demande en eau en Méditerranée. Fiuggi. October, 2002.

From a regional vision, it is expected that water demand evolution in the Region will run parallel with an increase of natural water resources exploitation in countries affected nowadays by water shortage that, on the other side, have the biggest demographic growth. This is the effect that the authors of MAP 1 try to illustrate.

According to this information, it is coherent to conclude that improving water availability in the territories affected by structural hydric deficits is the only way to approach water scarcity successfully. The purpose to increase available water resources can be reached by means of politics tending to promote water saving in all uses, planning the use of natural renewable resources of water according to the needs detected in every territory and redistributing total hydric resources with criteria of justice and solidarity between the regions. Finally, promoting reuse of treated waste water and establishing programs of water desalination. All of that can be given in the context of the integrated water resources management (IWRM).

Desalination can guarantee water availability but near this evidence there are bottlenecks, as it is the price of desalinated water and other disadvantages for what its use must be preceded of realistic considerations taking into account the possibility for consumers to pay for this type of water and also the economic activity affected by its use.

2. WATER DESALINATION IN THE MEDITERRANEAN REGION

To elaborate this paragraph it was taken into account the information provided by The 19th IDA Worldwide Desalting Plant Inventory (2006) with the remarks that follow:

a) It was assumed as water desalting production capacity those that can be provided by existing plants on line plus plants presumed on line plus plants under construction.

b) It was considered the total production capacity of every country having coasts directly on Mediterranean Sea, except Jordan, with independence of the place of the world where desalting plants were located.

Under these conditions is data determined in TABLE 19 on water desalting production capacity in the studied countries of the Region. The total volume of desalinated water that the Region is able to produce is 11.650.047m^3/day nowadays. That can represent between 15 – 27 % of the world operative installed desalting plants. Among top producers are: Spain (40,94 %), Algeria (15 %), Israel (10 %), Libya (6,95 %) and Italy (6 %).

The total capacity of desalinated water production in the Region is served by 8.207.979m^3/day of seawater (70,46 %); 2.282.081m^3/day of brackish water (19,60 %); 718.737m³/day of river water (6,17 %); 273.921m³/day of wastewater (2,35 %); 110.556m³/day of pure water (0,95 %); 8.638m³/day of brine (0,07 %). 47.335 m³/day (0,40 %) are produced by unknown methods. TABLE 20 contains data on desalinated water origin in the countries studied. GRAPHIC 4 represents this distribution.

GRAPHIC 4
Water desalinated distribution according water feed origin in Mediterranean Region

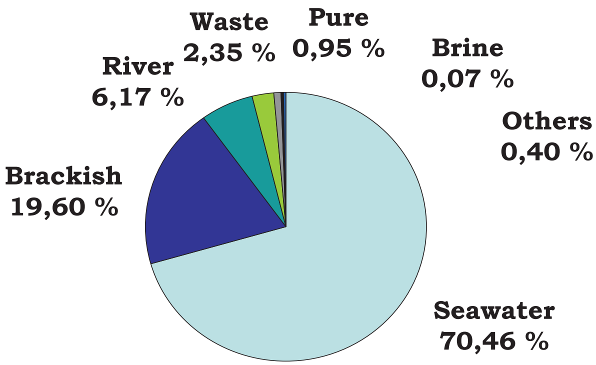
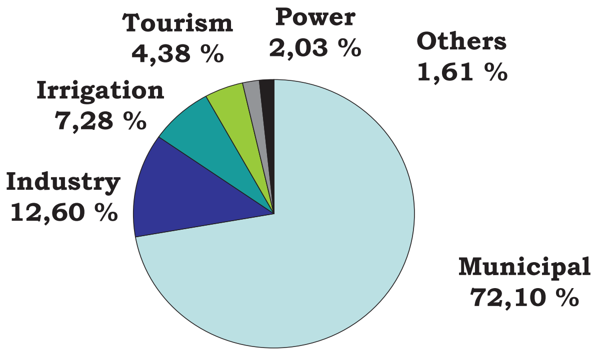


TABLE 21 informs on use of desalinated water in the countries selected in this study. For municipal use is destined a production capacity of 8.398.777m³/day of desalinated water equal to 72,10 % of total production capacity. This is the main use of desalinated water in the region that, in importance, is followed by industrial application with 1.468.353 m³/day of installed capacity of production which share is 12,60 % in total installed capacity. For irrigation is destined a production capacity of 848.069m³/day representing 7,28 % of the total installed capacity. Spain with 811.621m³/day of capacity installed absorbs 95,70 % of all installations dedicated to irrigation. 510.141m³/day (4,38 %) are applied to tourism; and 236.288 m³/day (2,03 %) to power. The GRAPHIC 5 represents the uses distribution of desalinated water in the region.

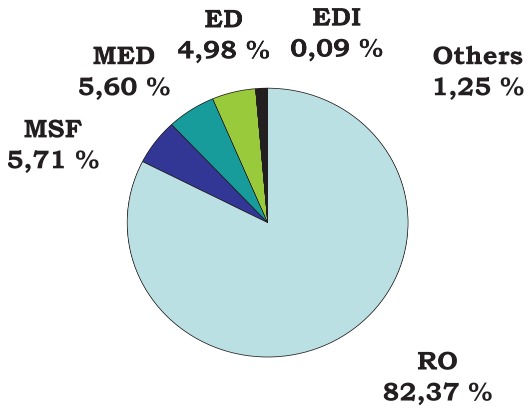
RO methods are predominant among water desalination processes applied in the Mediterranean Region. Table 22 illustrates the intensity with which water desalting methods are used in this region, Confirming this estimation, 9.595.739m³/day is the capacity operated by reverse osmosis being equivalent to 82,37 % of total capacity installed. In decreasing order is followed by MSF methods that share with a capacity of 665.515m³/day (5,71 %); MED with 650.580 m³/day (5,60 %); ED with 580.326m³/day (4,98 %); and EDI with 11.469m³/day (0,09 %). The GRAPHIC 6 represents these data.

ir a ÍNDICE

GRAPHIC 5
Distribution of desalinated water uses in the Mediterranean Region



GRAPHIC 6
Frequency of water desalination methods in the Mediterranean Region



The information existing on water desalination in the Mediterranean Region invites to infer some conclusions as:

a) Considering that seawater desalting requires, as average, 4.5 kwh/m³ and desalting feed water of the other origins, as average, 1.5 kwh/m³, it is easy to calculate that the total energy needed to supply the desalting capacity considered in the Region is of around 15.000

Gwh per year[71], this is equivalent to a continuous power supply of 1.745 Mw. Its relative importance can be remarked taking as reference that installed power capacity in Spain varies around 67.000 Mw.

b) Considering a very conservative use of 109,5 cubic meters per year and person as the average of municipal demands and 6.176 m^3/ha per year for irrigation purposes, it can be stated that near 28 million people in the considered Mediterranean Region satisfy their hydric municipal needs with water produced in the desalination industry. Those people represent, approximately, 4 % of total population in the area studied.

It is also possible to infer that more than 50.000 ha of irrigated land are receiving desalinated water, mainly in Spain.

[71] Equivalences. 1 Kw = 1,000 w. 1 Mw = 1,000,000 w. 1 Gw = 1,000,000,000 w.

TABLES MENTIONED IN THIS CHAPTER

ir a ÍNDICE

TABLE 17

Theoretical demands of water, for main uses, in selected Mediterranean Region countries in 2000

Country	Population x 1000 habitants	Irrigated land has X 1000	Water Demands Km³/year		
			Urban	Agrarian	Industrial
Morocco	29.231	1.313	3.200	8.109	0,256
Algeria	30.463	385	3.335	2.377	0,266
Tunisia	9.563	410	1.047	2.532	0,083
Egypt	67.285	2.650	7.367	16.366	0,589
Israel	6.084	193	0,666	1.191	0,053
Jordan	4.972	154	0,544	0.951	0,043
Lebanon	3.398	101	0,372	0.623	0,029
Syria	16.813	1.280	1.841	7.905	0,147
Turkey	63.234	2.679	6.924	16.545	0,554
Greece	10.975	1.500	1.201	9.264	0,096
Cyprus	786	39	0,086	0.240	0,007
Malta	392	0,763	0,043	0.004	0,003
Italy	57.715	3.110	6.319	19.207	0,505
France	59.278	1.400	6.491	8.646	0,519
Spain	40.717	3.840	4.458	23.710	0,357
Portugal	10.225	750	1.119	4.632	0,089
TOTAL	411.131	19.804.763	45.0188	122.314	3,601

Source: Cánovas, J. and del Campo, A. (2006) Study on Irrigation Water Management in the Mediterranean Region. EMWIS.IMIDA. FENACORE (unpublished).

TABLE 18

Theoretical demands of water, for main uses, in selected Mediterranean Region countries in 2025

Country	Population x 1000 habitants	Irrigated land has X 1000	Water Demands Km³/year		
			Urban	Agrarian	Industrial
Morocco	40.280	1.552	4.410	9.585	0,353
Algeria	42.871	425	4.694	2.624	0,375
Tunisia	12.028	560	1.317	3.458	0,105
Egypt	101.092	3.100	11.069	19.145	0,885
Israel	8.734	193	0.956	1.1919	0,077
Jordan	8.134	395	0.890	2.439	0,071
Lebanon	4.297	85	0.470	0,524	0,037
Syria	28.081	1.780	3.074	10.993	0,245
Turkey	90.565	3.595	9.916	22.202	0,793
Greece	11.173	1.500	1.223	9.264	0,097
Cyprus	1.014	39	0,111	0,241	0,009
Malta	432	0,763	0,047	0,005	0,004
Italy	56.307	3.020	6.165	18.651	0,493
France	63.407	1.400	6.943	8.646	0,555
Spain	44.244	4.020	4.844	24.827	0,387
Portugal	10.924	820	1.196	5.064	0,095
TOTAL	523.583	22.484.763	57.332	138.866	4,586

Source: Cánovas, J. and del Campo, A. (2006) Study on Irrigation Water Management in the Mediterranean Region. EMWIS.IMIDA. FENACORE (unpublished).

TABLE 19

Water desalting production capacity in selected Mediterranean Region countries (2011)

Country	**Production (m³/day)**
Morocco	85.471
Algeria	1.700.046
Tunisia	93.276
Libya	809.875
Egypt	683.277
Israel	1.169.474
Jordan	248.855
Lebanon	29.125
Syria	13.981
Turkey	468.749
Greece	149.250
Cyprus	228.853
Malta	251.151
Italy	698.891
France	233.104
Spain	4.769.582
Portugal	17.087
TOTAL	**11.650.047**

TABLE 20

Origin of desalinated water in selected Mediterranean Region countries (m^3/day) (2011)

Country	Seawater	Brackish	River	Waste	Pure	Brine	Others
Morocco	65.500	19.971					
Algeria	1.544.027	141.599	14.300				120
Tunisia	9.857	83.169					250
Libya	747.906	60.859	160		150		
Egypt	543.109	84.339	13.771	9.430	14.178	1.600	16.850
Israel	933.415	157.796	39.480	15.000	144	400	23.239
Jordan	2.740	244.137	1.200			778	
Lebanon	26.390	2.735					
Syria	280	13.581	120				
Turkey	433.464	31.380	3.602	303			
Greece	83.276	60.524	1.700		3.750		
Cyprus	225.457	3.396					
Malta	247.720	2.931	200		300		
Italy	359.602	193.934	64.352	35.671	42.492		2.840
France	23.024	23.008	165.907	988	19.457		720
Spain	2.956.854	1.149.747	412.361	211.449	29.995	5.860	3.316
Portugal	5.358	8.975	1.584	1.080	90		
TOTAL	**8.207.979**	**2.282.081**	**718.737**	**273.921**	**110.556**	**8.638**	**47.335**

TABLE 21

Use of desalinated water in selected Mediterranean Region countries (m^3/day) (2011)

Country	Urban	Industry	Irrigation	Tourism	Power	Others
Morocco	55.568	27.777		295	1.831	0
Algeria	1.535.718	151.512		3.900	8.348	568
Tunisia	59.564	23.267	3.748	3.520	3.177	0
Libya	548.479	212.538		7.550	32.330	8178
Egypt	221.576	116.407	1.500	317.962	12.252	13580
Israel	1.131.317	23.157	15.000			0
Jordan	241.346	1.200	4.242	967	1.100	0
Lebanon	9.113	342		500	19.170	0
Syria	5.920	3.101			3.000	1960
Turkey	301.299	143.923		2.242	16.285	5000
Greece	71.764	46.375		23.801	6.340	970
Cyprus	194.675	3.534		24.504	5.340	800
Malta	242.876	1.430		1.045	5.800	0
Italy	188.452	406.372	11.958	2.210	73.053	16.846
France	155.572	72.860		1.512	1.600	1560
Spain	3.432.853	226.984	811.621	116.665	43.302	138157
Portugal	2.685	7.574		3.468	3.360	0
TOTAL	**8.398.777**	**1.468.353**	**848.069**	**510.141**	**236.288**	**187.619**

TABLE 22

Process water desalination applied in selected Mediterranean Region countries (m^3/day) (2011)

Country	RO	MED	MSF	ED	EDI	Others/ Unknown
Morocco	66.397	8.108	7.402	1.404		2.160
Algeria	1.531.048	41.911	113.003	13.934		150
Tunisia	80.059	3.760		8.640	817	0
Libya	79.933	330.278	383.982	14.672		210
Egypt	607.561	27.062	22.334	24.570	120	1.630
Israel	1.076.214	17.432		45.917	431	29.480
Jordan	244.537	1.100		818		2.400
Lebanon	14.455	14.670				0
Syria	13.981					0
Turkey	453.889	3.360	1.000			10.500
Greece	111.060	12.640	10.080	15.220		250
Cyprus	199.513	3.060	2.280			24.000
Malta	225.351	5.800	20.000			0
Italy	425.482	87.751	93.134	72.416	3.596	16.512
France	207.477	6.764		356	6.007	12.500
Spain	4.242.793	86.644	12.300	382.379	408	45.058
Portugal	15.989	240			90	768
TOTAL	**9.595.739**	**650.580**	**665.515**	**580.326**	**11.469**	**145.618**

APPENDIX

ir a ÍNDICE

The following description of water desalination status in each country of the Mediterranean Region is based mainly in the information obtained from The IDA Worldwide Desalting Plants Inventory (2011).

MOROCCO

ir a ÍNDICE

ir a ÍNDICE

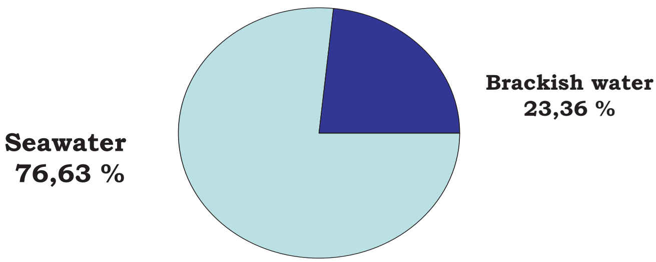
MOROCCO

The actualized IDA Worldwide Desalting Plants Inventory (2011), informs on 40 desalting plants installed in Morocco with a total capacity of 85.471 m^3/day. Among these, 15 desalting plants, with a total capacity of 46.750 m^3/day, are on line (TABLE 23); and 25 plants, with capacity to produce 38.721 m^3/day, are presumably also on line (TABLE 24). So, the presumed water desalination capacity at the end of that year was 85.471 m^3/day. This is equal to 31,19 million cubic meters per year or 0,10 % of renewable water resources in the country.

Total capacity of desalinated water production is served by 65.500 m^3/day (76,63 %) proceeding from seawater and 19.971 m^3/day (23,36 %) from brackish water. GRAPHIC 7 represents this distribution.

GRAPHIC 7

Desalinated water distribution according to feed water origin in MOROCCO

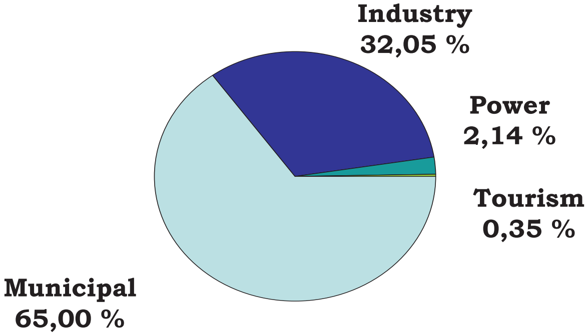


Total desalinated water capacity is applied as follows:

- 55.568 m^3/day (65,00 %) for municipal supply.
- 27.777 m^3/day (32,5 0 %) for industry.
- 1.831 m^3/day (2,14 %) for power.
- 295 m^3/day (0,35 %) for tourism.

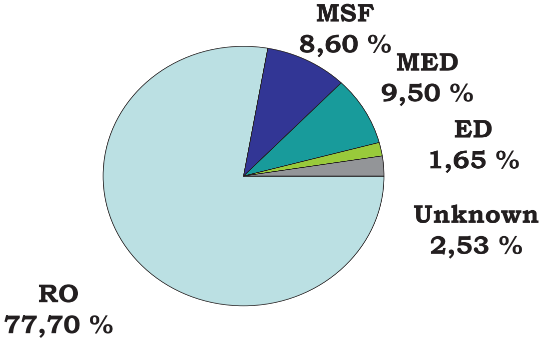
GRAPHIC 8 represents the distribution of desalinated water uses in Morocco.

GRAPHIC 8
Uses distribution of desalinated water in MOROCCO



Reverse osmosis is the principal method employed in Morocco to produce desalinated water. According to the data studied, 66.397 m^3/day (77,70 %) are produced by RO systems; MED systems provide 8.108 m^3/day (9,50 %); MSF, provide 7.402 m^3/day (8,60 %); and, ED provide 1.404 m^3/day (1,65 %). 2.160 m^3/day (2,53 %) are produced by unknown systems. The GRAPHIC 9 represents the distribution of these figures.

GRAPHIC 9
Frecuency of water desalination methods in MOROCCO



It is foreseen that for the year 2015 will be functioning the following plants:

Water Desalting Plant in Agadir, capable of producing 100.000 m^3/day, by SWRO process, to be used in industry. Its entry on line is planned for 2012.

Water Desalting Plant in Al Hoceima, capable of producing 20.000 m^3/day by SWRO process, to be used in municipal supply. Its entry on line is planned for 2015.

Water Desalting Plant in Safi, capable of producing 68.000 m^3/day by SWRO process, to be used in industry. Its entry on line is planned for 2014.

Desalting Plant in Sidi Ifni, capable of producing 34.000 m^3/day by SWRO process, to be used in municipal supply. Its entry on line is planned for 2013.

TABLE 25 provides information about these desalting plants.

The conclusion of those projects will increase Morocco capacity to produce desalinated water over three times more than the actual.

Desalination activity will induce new economies in Morocco with a significant effect on welfare of population.

ir a ÍNDICE

ir a ÍNDICE

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 23

Morocco. Desalting Plants on line (2011)

Denomination /Location	Method	Production (m^3/day)	Raw water	Year	Use
Agadir	RO	1.000	Seawater	2003	Municipal
Akhfennir	RO	860	Seawater	2009	Municipal
Boujdour	RO	800	Seawater	1995	Municipal
Boujdour	RO	2.500	Seawater	2004	Municipal
El Aaiun	RO	4.000	Seawater	2004	Industry
HT/CCPP	RO	3.288	Brackish	2008	Industry
Kenitra	RO	1.512	Brackish		Industry
Laayoune	RO	5.280	Seawater	2005	Municipal
Laayoune	RO	4.000	Seawater	2006	Municipal
Laayoune	RO	13.000	Seawater	2009	Municipal
Morocco	RO	1.500	Brackish	2001	Industry
OI BW 1100	RO	1.100	Brackish	2008	Industry
Ras Boudjour	RO	3.750	Seawater	2001	Municipal
Socoin	Other	2.160	Brackish	2008	Industry
Tan Tan	RO	2.000	Brackish	2001	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**46.750 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 24

Morocco. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production (m^3/day)	Raw water	Year	Use
Boujdour	RO	800	Seawater	1995	Municipal
Casablanca	RO	1.920	Brackish	1990	Industry
Casablanca	RO	1.900	Brackish	1992	Industry
El Aaiun	RO	7.000	Seawater	1995	Municipal
Laayoune	RO	7.000	Seawater	1995	Municipal
Morocco	ED	1.120	Brackish	1992	Industry
Morocco	RO	960	Brackish	1992	Industry
Morocco	RO	912	Brackish	2006	Industry
Phos Boucraa	MED	6.000	Seawater	1990	Municipal
Smara	RO	330	Brackish	1986	Municipal
Tan Tan	MED	360	Seawater	1984	Municipal
Tan Tan	MED	100	Seawater	1989	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**28.402 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 25

Desalting Plants in construction (2011)

Named	Method	Production (m^3/day)	Raw water	Year	Use
Agadir	RO	100.000	Seawater	2012	Industry
Al Hoceima	RO	20.000	Seawater	2015	Municipal
Safi	RO	68.000	Seawater	2014	Industry
Sidi Ifni	RO	34.560	Seawater	2013	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**214.560 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ALGERIA

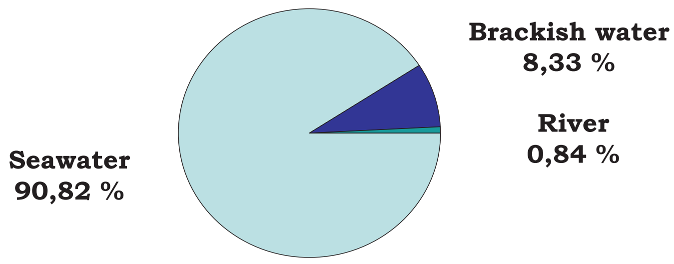
ir a ÍNDICE

ALGERIA

The IDA Worldwide Desalting Plants Inventory (2011), informs about 166 desalting plants installed in Algeria since 1965. Among these, 57 desalting plants, with a total capacity of 1.559.168 m^3/day, are on line (TABLE 26); 75 plants, with capacity to produce 140.878 m^3/day, are presumed on line (TABLE 27);and 19 plants are under construction with a planed capacity of 1.331.476 m^3/day (TABLE 28). So, it is presumable that at the end of 2011 the capacity to produce desalinated water in Algeria was 1.700.046 m^3/day. This means 4,48 % of renewable water resources of the country.

The total capacity of desalinated water production is served by 1.544.027 m^3/day (90,82 %) proceeding from seawater; 141.599 m^3/day (8,33 %) of brackish water; 14.300 m^3/day of river water (0,84 %). The origin of 120 m^3/day was not reported. The GRAPHIC 10 represents this distribution.

GRAPHIC 10
Desalinated water production according to feed water origin in ALGERIA



The total desalinated water capacity is applied as follows:

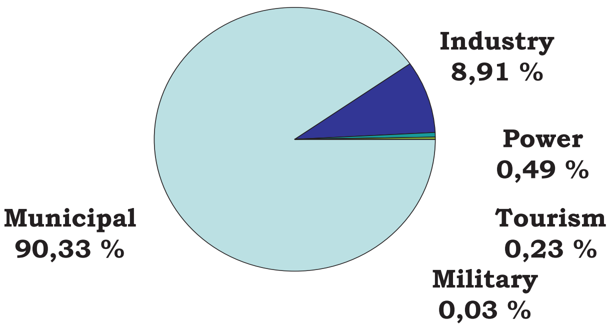
- 1.535.718 m^3/day (90,33 %) to municipal supply.
- 151.512 m^3/day (8,91 %) to industry.
- 8.348 m^3/day (0,49 %) to power.

- 3.900 m^3/day (0,23 %) to tourism.

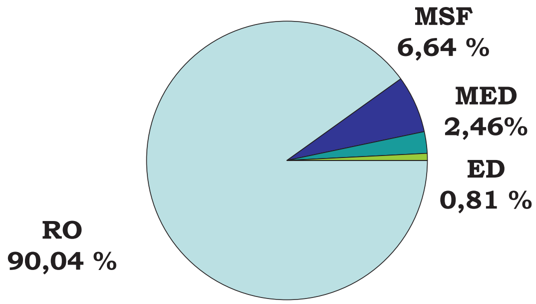
- 568 m^3/day (0, 03 %) to military purposes.

GRAPHIC 11 represents the distribution of desalinated water uses in Algeria.

GRAPHIC 11
Uses distribution of desalinated water in ALGERIA



GRAPHIC 12
Frecuency of water desalination methods in ALGERIA



1.531.048 m^3/day of desalinated water are obtained by RO systems, this represents 90,04 % of total desalinated water production. MSF systems provide 113.003 m^3/day (6,64 %); MED systems provide 41.911 m^3/day (2,46 %) and ED 13.934 m^3/day (0,81 %). Production of 150 m^3/day is not reported. The GRAPHIC 12 represents the distribution of these data.

Actually, there are 19 desalting plants in construction with a total capacity 831.525 m^3/day. TABLE 28 informs about these projects.

ir a ÍNDICE

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

TABLE 26

Desalting Plants on line in Algeria (2011)

Denomination /Location	Method	Production (m^3/day)	Raw water	Year	Use
Ain Benian	RO	1.200	Brackish	2002	Municipal
Algeria	ED	380	Brackish	1996	Industry
Algeria	MED	2.400	Seawater	2000	Industry
Algeria	ED	100	Brackish	2000	Municipal
Algeria	ED	364	Brackish	2000	Municipal
Algeria	RO	2.000	Seawater	2001	Municipal
Algeria	MED	1.920	Seawater	2002	Municipal
Algeria	ED	1.300	Brackish	2003	Tourism
Algeria	ED	600	Brackish	2004	Tourism
Algeria	MED	8.000	Seawater	2004	Municipal
Algeria	RO	300	River	2004	Industry
Algeria	MSF	1.000	Seawater	2005	Municipal
Algeria	RO	1.000	Seawater	2010	Municipal
Almerk	RO	170	Brackish		Industry
Aqua-Cleer IW	RO	576	Brackish	2007	Industry
Arzew	MED	1.100	Seawater	2002	Industry
Arzew GL2Z	MED	1.440	Seawater	2004	Industry
Beni Saf	RO	150.000	Seawater	2009	Municipal
Bethioua	RO	5.000	Seawater	2002	Municipal
Bou Ismail	RO	5.000	Seawater	2003	Municipal
Bou Ismail	RO	5.000	Seawater	2006	Industry
Bredeah	RO	34.600	Brackish	2004	Municipal
Capcaxine	RO	2.400	Seawater	2002	Municipal
Capcaxine	RO	2.400	Seawater	2002	Municipal
Casse	RO	5.000	Seawater	2002	Municipal
Champ de Tir 1	RO	2.500	Seawater	2003	Municipal
Champ de Tir 2	RO	2.500	Seawater	2003	Municipal
Ciba WTP	RO	2.000	Brackish	2009	Tourism
Corso Regaia	RO	10.000	Seawater	2003	Municipal
El Hamma	RO	200.000	Seawater	2005	Municipal
Fontaine 1	RO	2.500	Seawater	2003	Municipal
Fontaine 2	RO	2.500	Seawater	2003	Municipal
Fouka	RO	120.000	Seawater	2010	Municipal
Gazaouet 1	RO	2.500	Seawater	2003	Municipal
Gazaouet 2	RO	2.500	Seawater	2004	Municipal
Hassi R'Mel	RO	1.104	Brackish	2010	Industry
Kahrama	MSF	86.000	Seawater	2006	Municipal
Koudiet	MED	720	Seawater	2010	Power
Mactaa	RO	500.000	Seawater	2011	Municipal
O.I. SW	RO	12.500	Seawater	2003	Municipal

Source: IDA Worldwide Desalting Plant Inventory (2011)

TABLE 26 (Continued)

Desalting Plants on line in Algeria (2011)

Denomination /Location	Method	Production (m^3/day)	Raw water	Year	Use
Oil S 4800	Other	100	Seawater	2008	Industry
Oil S 1200	Other	50	Seawater	2008	Industry
Saida 1	RO	5.650	Seawater	2003	Industry
Saida 2	RO	5.650	Seawater	2003	Municipal
Sete	RO	30.000	Seawater	2004	Municipal
Skikda	RO	2.500	Seawater	2002	Municipal
Skikda	RO	14.000	River	2003	Industry
Skikda	RO	14.000	Brackish	2003	Municipal
Skidda	RO	1.000	Seawater	2003	Municipal
Skikda	RO	1.000	Seawater	2004	Municipal
Skikda	MSF	1.000	Seawater	2005	Industry
Skikda	RO	100.000	Seawater	2009	Municipal
Souk Tleta	RO	200.000	Seawater	2010	Municipal
Terga	RO	500	Brackish	2009	Industry
Terga	MSF	1.920	Seawater	2010	Power
Tigzir	RO	1.200	Seawater	2002	Municipal
Village 15 Cont	RO	24	Brackish	2008	Industry
TOTAL CAPACITY OF WATER PROODUCTION				**1.559.168 m^3/day**	

Source: IDA Worldwide Desalting Plant Inventory (2011)

TABLE 27

Desalting Plants presumed on line in Algeria (2011)

Denomination /Location	Method	Production (m^3/day)	Raw water	Year	Use
Ain Smara	RO	480	Seawater	1979	Municipal
Algeria	ED	265	Brackish	1974	Military
Algeria	ED	303	Brackish	1977	Military
Algeria	ED	227	Brackish	1978	Industry
Algeria	ED	227	Brackish	1978	Industry
Algeria	ED	227	Brackish	1978	Industry
Algeria	ED	400	Brackish	1978	Industry
Algeria	ED	300	Brackish	1979	Industry
Algeria	ED	300	Brackish	1979	Industry
Algeria	ED	379	Brackish	1981	Industry
Algeria	RO	550	Brackish	1983	Power
Algeria	RO	100	Brackish	1984	Industry
Algeria	RO	100	Brackish	1986	Industry
Algeria	ED	1.000	Brackish	1990	Industry
Algeria	ED	200	Brackish	1990	Industry
Algeria	ED	2.300	Brackish	1991	Industry
Algeria	ED	650	Brackish	1994	Industry
Algeria	RO	2.182	Brackish	2007	Industry
Algiers	RO	273	Brackish	1980	Industry
Algiers	RO	600	Seawater	1995	Municipal
Amenas	MED	260	Seawater	1980	Municipal
Annaba	MED	5.000	Brackish	1990	Industry
Arzew	MED	352	Seawater	1978	Industry
Arzew	MSF	961	Seawater	1980	Power
Arzew	MSF	3.264	Seawater	1980	Industry
Arzew	MED	1.200	Seawater	1982	Industry
Arzew	MED	2.880	Seawater	1982	Industry
Arzew	MED	2.000	Seawater	1993	Industry
Arzew	MSF	2.180	Seawater	1986	Municipal
Arzew	MED	1.440	Seawater	1989	Industry
Arzew	MED	1.720	Seawater	1989	Industry
Arzew	ED	1.805	Brackish	1989	Industry
Arzew	MED	500	Seawater	1990	Industry
Arzew	MED	480	Seawater	1993	Industry
Arzew	MSF	5.678	Seawater	1994	Industry
Beahdja	RO	2.500	Seawater	2007	Municipal
Bethioua	MSF	2.000	Seawater	1994	Industry
Bethioua	MSF	3.000	Seawater	1994	Industry
Bou Ismail	RO	200	Brackish	1976	Municipal
Bucheikif	RO	480	Brackish	1980	Municipal

Source: IDA Worldwide Desalting Plant Inventory (2011)

TABLE ALGERIA 27 (Continued)

Desalting Plants presumed on line in Algeria (2011)

Denomination /Location	Method	Production (m^3/day)	Raw water	Year	Use
Capcaxine	RO	2.500	Seawater	2007	Municipal
El Outaya	RO	287	Brackish	1976	Industry
Ghardaia	RO	220	Brackish	1980	Industry
Ghardaia	RO	120	Brackish	1982	Industry
Ghazaouet	MED	2.000	Seawater	1994	Industry
Ghazaouet	RO	320	Brackish	2009	Municipal
Hadjadt	MED	1.497	Brackish	1981	Power
Hassi R'Mel	RO	120		1978	Municipal
Hassi Messaoud	MED	360	Seawater	1979	Municipal
Jijel	RO	500	Seawater	1979	Municipal
Jijel	MSF	2.000	Seawater	1995	Power
Mers El Hadjadi	MSF	2.000	Brackish	1987	Industry
Mers El Hadjadi	MED	500	Seawater	1994	Power
Mostaganem	RO	52.800	Brackish	1980	Industry
Oil Camps	ED	2.407	Brackish	1985	Industry
Oran	RO	492	Brackish	1977	Industry
Oran	RO	2.592	Seawater	2007	Industry
Quenza	RO	3.000	Brackish	1984	Industry
Ras Djinet	MSF	2.000	Brackish	1983	Industry
Reganne	RO	500	Seawater	1985	Industry
Relizane	RO	200	Brackish	1976	Power
Rhourde Nouss	ED	200	Brackish	1985	Industry
Rhourde Nouss	RO	360	Brackish	1990	Industry
Sidi Bel Abbes	RO	184	Brackish	1985	Industry
Sidi Bel Abbes	RO	500	Seawater	2004	Municipal
Sig	RO	480	Brackish	1980	Industry
Skikda	MED	382	Seawater	1974	Industry
Skikda	MED	5.760	Seawater	1993	Industry
Skikda	RO	3.000	Seawater	2007	Municipal
Tenes	RO	250	Brackish	1978	Industry
Tenes	RO	150	Brackish	1980	Industry
Tigzir	RO	2.500	Seawater	2007	Municipal
Tlemcen	RO	384	Seawater	2006	Municipal
Tolga	RO	1.350	Brackish	1991	Industry
TOTAL CAPACITY OF WATER PROODUCTION				**140.878 m^3/day**	

Source: IDA Worldwide Desalting Plant Inventory (2011)

TABLE 28

Desalting Plants under construction in Algeria (2011)

Denomination /Location	Method	Production (m^3/day)	Raw water	Use
Ain Kheir	RO	6.750	River	Municipal
Algeria	RO	120	Brackish	Municipal
Arzew	RO	100	Seawater	Municpal
Arzew, Fertilizr Plant	MED	10.800	Seawater	Industry
Bamendil Khafdji	RO	5.625	River	Municipal
Bamendil Village	RO	2.250	River	Municipal
Boumerdas	RO	17.280	Brackish	Municipal
Cap Djinet	RO	100.000	Seawater	Municipal
El Hadeb	RO	70.500	Brackish	
Gharbouz	RO	2.250	River	Muncipal
Hai Bouzid	RO	3.375	River	Muncipal
Ifri Gara	RO	7.875	River	Municipal
Melhadma	RO	2.250	River	Municipal
Mostaganem	RO	200.000	Seawater	Municipal
Ouargla	RO	100	Brackish	Municipal
Sokra	RO	2.250	River	Municipal
Tenes	RO	200.000	Seawater	Municipal
Tlemcen-Hounaine	RO	200.000	Seawater	Municipal
TOTAL CAPACITY OF WATER PRODUCTION			**831.535 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TUNISIA

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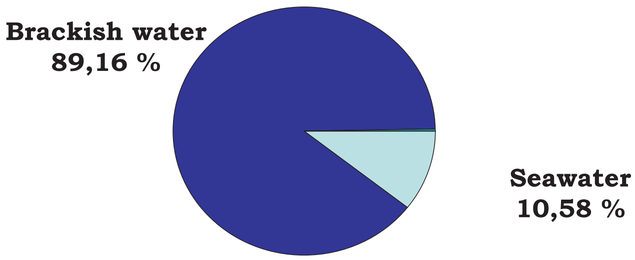
TUNISIA

The IDA Worldwide Desalting Plants Inventory (2011) informs on 56 desalting plants established since 1971. Among these, 32 desalting plants, with a total capacity of 48.244 m^3/day are on line (TABLE 29); and 28 desalting plants with a capacity of 45.032 m^3/daypresumed on line (TABLE 30). So the presumed water desalination capacity in Tunisia at the end of that year was 93.276 m^3/day. This means 0,74 % of its renewable water resources.

Total capacity of desalinated water production is served by 9.857 m^3/day (10,58 %) from seawater and 83.169 m^3/day (89,16 %) by brackish water. The origin of 250 m^3/day was not reported. GRAPHIC 13 represent this distribution.

GRAPHIC 13
Desalinated water production according to feed water origin in TUNISIA

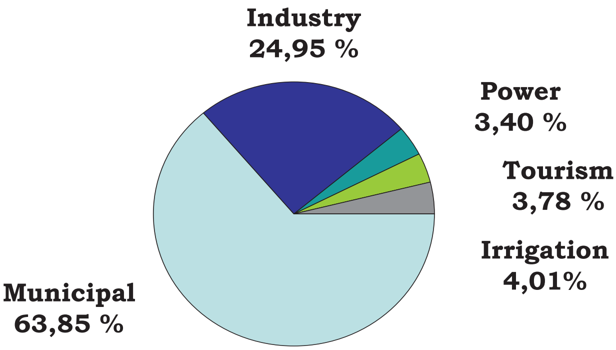


Total desalinated water is applied as follows:

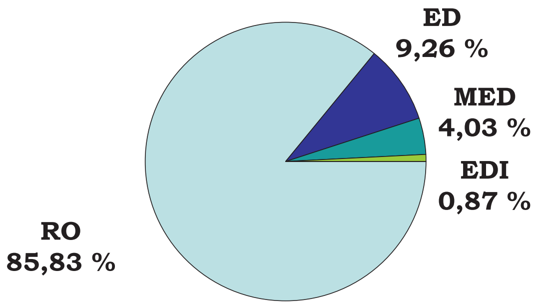
- 59.564 m^3/day (63,85 %) supply municipalities.
- 23.267 m^3/day (24,95 %) is dedicated to industry.
- 3.748 m^3/day (4,01 %) for irrigation.
- 3.520 m^3/day (3,78 %) for tourism.
- 3.177 m^3/day (3,40 %) for power.

GRAPHIC 14 represents the distribution of desalinated water uses in Tunisia.

GRAPHIC 14
Uses distribution of desalinated water in TUNISIA



GRAPHIC 15
Frecuency of water desalination methods in TUNISIA



Reverse osmosis is the principal method employed for water desalination in Tunisia. 80.059 m^3/day (85,83 %) of desalinated water are obtained by RO systems; ED provides 8.640 m^3/day (9,26 %); MED provides 3.760 m^3/day (4,03 %); EDI provides 817 m^3/day (0,87%). GRAPHIC 15 represent the distribution of these figures.

For the coming years, it is planned to build one desalting plant in Sfax, to produce 150.000 m^3/day; Djerba to produce 50.000 m^3/day processing seawater. Other, in Tozeur to produce 12.000 m^3/day from brackish water.

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 29
Tunisia. Desalting Plants on line (2011)

Denomination /Location	Method	Production (m^3/day)	Raw water	Date	Use
Acqua Cleer SW 18K	RO	864	Brackish	2007	Industry
Acqua Cleer SW 18K	RO	864	Brackish	2007	Industry
Acqua Cleer IW 20	RO	480	Seawater	2007	Tourism
Acqua Cleer IW 20	RO	480	Seawater	2007	Tourism
Acqua Cleer IW 12	RO	240	Brackish	2009	Industry
Djerba 1	RO	12.000	Brackish	1999	Municipal
Djerba 2	RO	3.000	Brackish	2002	Municipal
Dutch Brewery	RO	1.200	Brackish	2008	Industry
Dutch Brewery 2	RO	1.200	Brackish	2008	Industry
Koutine	RO	720	Brackish	2001	Industry
OI BW 2000	RO	2.000	Brackish	2008	Industry
OI BW 2000	RO	2.000	Brackish	2008	Industry
OI BW 25	RO	25	Brackish	2008	Industry
O.I. SW 300	RO	300	Seawater	2002	Tourism
O.I. SW 300	RO	300	Seawater	2002	Tourism
OSMO 12 AM	RO	300	Brackish	2009	Industry
Qued Zar – Tataounie	RO	100	Brackish	2005	Industry
Seta Osmo SW 500	RO	500	Seawater	2001	Tourism
Seta Osmo SW 500	RO	500	Seawater	2001	Tourism
Tunis	RO	200	Brackish	2005	Industry
Tunis	RO	1.000	Brackish	2006	Industry
Tunisia	RO	500	Seawater		Industry
Tunisia	EDI	272	Seawater	2000	Power
Tunisia	EDI	545	Seawater	2000	Power
Tunisia	RO	750	Seawater	2001	Power
Tunisia	ED	600	Brackish	1996	Industry
Tunisia	RO	600	Seawater	1999	Tourism
Tunisia	MED	600	Seawater	1998	Industry
Tunisia	RO	552	Brackish	2009	Industry
Tunisia	RO	552	Brackish	2009	Industry
Zarzis	RO	12.000	Brackish	1999	Municipal
Zarzis 2	RO	3.000	Brackish	2002	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**48.244 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 30
Tunisia. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production (m³/day)	Raw water	Date	Use
Ben Bechir	RO	1.104	Brackish	1988	Municipal
Bouargoub	ED	600	Brackish	1992	Industry
Djerba	RO	1.248	Brackish	1993	Irrigation
Djerba	RO	5.000	Brackish	2007	Municipal
Gabes	MED	1.020	Seawater	1980	Industry
Gabes	RO	22.500	Brackish	1995	Municipal
Gabes	MED	480	Seawater	1983	Power
Gabes	MED	600	Seawater	1985	Municipal
Gabes	MED	480	Seawater	1986	Industry
Koutine	RO	360	Brackish	1993	Municipal
La Skirra	MED	200	Seawater	1984	Industry
Mahdia	ED	600	Brackish	1992	Industry
M'Dilla	MED	380	Seawater	1983	Power
Sfax	RO	2.500	Brackish	1990	Irrigation
Sfax	ED	600	Brackish	1992	Industry
Sfax	RO	100	Seawater	1994	Power
Sousse	RO	360	Seawater	2006	Tourism
Tunis	ED	600	Brackish	1991	Industry
Tunis	ED	600	Brackish	1992	Industry
Tunisia	ED	240	Brackish	1994	Power
Tunisia	ED	600	Brackish	1992	Industry
Tunisia	ED	600	Brackish	1992	Industry
Tunisia	ED	600	Brackish	1992	Industry
Tunisia	ED	600	Brackish	1992	Industry
Tunisia	ED	1.800	Brackish	1992	Industry
Tunisia	RO	410	Seawater	1994	Power
Tunisia	ED	600	Brackish	1995	Industry
Tunisia	RO	250	Tap water	2006	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**38.822m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

LIBYA

ir a ÍNDICE

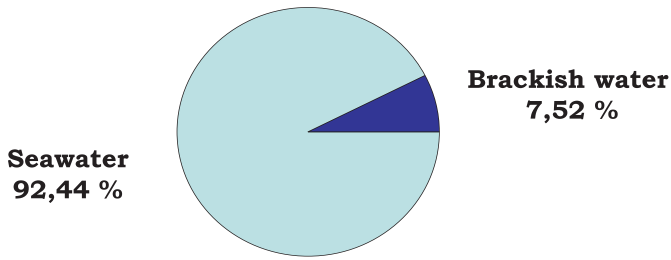
ir a ÍNDICE

LIBYA

The IDA Worldwide Desalting Plants Inventory (2011) informs on 285 desalting plants installed in Libya since 1962. Among these, 68 desalting plants, with a total capacity of 487.827 m^3/day are on line (TABLE 31); 75 desalting plants with a total capacity of 321.248 m^3/day are presumed on line (TABLE 32); and 2 plants with capacity of 80.000 m^3/day are under construction (TABLE 33). It is presumable that in 2011 operative desalination capacity of Libya was 809.075 m^3/day. This represented 22.26 % of all total renewable resources in this country.

The total capacity of desalinated water production was served by 747.906 m^3/day (92,44 %) proceeding from seawater; 60.859 m^3/day (7,52 %) from brackish; 160 m^3/day (0,02 %) from river water; and 150 m^3/day (0,018 %) from water with tap quality. The GRAPHIC 16 represents this distribution.

GRAPHIC 16
Desalinated water production according to feed water origin in LIBYA



Total desalinated water capacity is applied as follows:

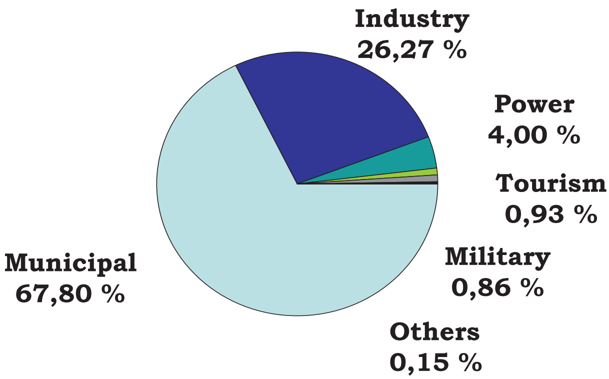
- 548.479 m^3/day (67,80 %) to supply municipalities.
- 212.588 m^3/day (26,27 %) to industry.
- 32.330m^3/day (4,00 %) to power.
- 7.550 m^3/day (0,93 %) to tourism.
- 6.962 m^3/day (0,86 %) to military supply.

- 640 m³/day (0,08 %) to discharge.

- 576 m³/day (0,07 %) to demonstration.

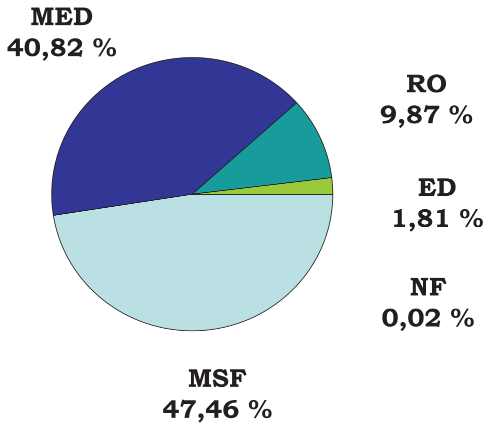
The GRAPHIC 17 represents this distribution.

GRAPHIC 17
Uses distribution of desalinated water in LIBYA



MSF processes provide 383.982 m^3/day (47,46 %); 330.278 m^3/day (40,82 %) are produced with MED systems; 79.933 m^3/day (9,87 %) by RO systems; 14.672 m^3/day (1,81 %) by ED; and 210 m^3/day (0,02 %) by NF. GRAPHIC 18 represents the frequency of desalination methods in Libya.

GRAPHIC 18
Frecuency of water desalination methods in LIBYA



TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 31

Libya. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw Water	Year	Use
2X SHR 90	RO	20.000	Seawater	2009	Industry
Abutaraba, East of Benghazi	MED	40.000	Seawater	2006	Municipal
Al Assah	RO	600	Brackish	2002	Municipal
Al Khalij PP	MED	7.200	Seawater	2010	Industry
Azzawiya	MED	2.000	Seawater	1993	Industry
Azzawiya	MED	1.000	Seawater	2004	Industry
Bar El Bahr	RO	300	Seawater	2007	Tourism
Bengazi	RO	250	Brackish	1972	Power
Benghazi	RO	500	Brackish	1991	Tourism
Benghazi	RO	500	Brackish	1996	Industry
Banghazi	RO	2.000	Seawater	2000	Municipal
Benghazi	RO	360	Brackish	2003	Municipal
Benghazi	MED	4.800	Seawater	2005	Power
Benghazi	MED	5.000	Seawater	2006	Power
Bomba	MSF	30.000	Seawater	1988	Municipal
Buatifel	ED	300	Brackish	1997	Discharge
Dat El Emad	RO	1.000	Seawater	2008	Municipal
Derna	MED	4.700	Seawater	1996	Industry
Derna	MED	40.000	Seawater	2009	Municipal
Desalination Skid	RO	36	Brackish	2008	Municipal
Hid 6 AM	RO	150	Tap water	2008	Industry
Jagboub	RO	1.500	Brackish	2005	Municipal
Jalo Rd	ED	200	Brackish	1997	Municipal
Kaam IND.	RO	750	Brackish	2009	Industry
Libya	RO	1.360	Brackish	2002	Industry
Libya	MED	1.200	Seawater	2001	Municipal
Libya	RO	200	Brackish	2003	Tourism
Libya	RO	300	Brackish	2003	Tourism
Libya	RO	450	Seawater	2003	Industry
Libya	RO	480	Brackish	2003	Industry
Libya	RO	197	Brachish	2008	Municipal
Libyan S CO	RO	3.000	Brackish	2010	Industry
Libyan S CO	RO	3.000	Brackish	2010	Industry
Meljtta	MSF	15.840	Seawater	2003	Power
Mutllatat CO	RO	1.632	Brackish	2008	Municipal
Oil Field	NF	210	Brackish	2002	Discharge

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 31 (Continued)

Libya. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw Water	Year	Use
Osmo 10 AM	RO	240	Brackish	2007	Industry
Osmo 12 AM	RO	500	Brackish		Industry
Osmo 60 AM	RO	2.000	Brackish		Tourism
Osmo 40 AN	RO	1.500	Brackish		Tourism
Ras Lanuf	MSF	8.400	Seawater	1993	Municipal
Ras Tajura	ED	1.870	Brackish	1996	Industry
Shahhat	MSF	13.500	Seawater		Municipal
Soussa	MED	10.000	Seawater	1997	Municipal
Soussa	MED	26.000	Seawater	2010	Industry
Subrata	RO	1.000	Brackish	2000	Municipal
Subrata	RO	500	Brackish	2001	Municipal
Surman City	RO	500	Brackish	2001	Municipal
Tobruk	MED	750	Seawater	1995	Industry
Tobruk	RO	500	Seawater	2000	Tourism
Tobruk II	MED	40.000	Seawater	2000	Municipal
Trípoli	RO	650	Seawater	1995	Municipal
Trípoli	RO	376	Seawater		Industry
Trípoli	RO	1.000	Seawater	1995	Municipal
Trípoli	RO	2.500	Seawater	1995	Municipal
Trípoli	MED	10.000	Seawater	1997	Industry
Trípoli	MED	1.200	Seawater	2002	Power
Trípoli	RO	288	Brackish	2009	Industry
Trípoli	RO	120	Brackish	2009	Industry
Trípoli	RO	48	Brackish	2009	Industry
Trípoli Project	RO	240	Brackish	2008	Industry
Wafa	RO	2.000	Seawater	2002	Industry
Wafa	MSF	16.000	Seawater	2003	Industry
Zanzur	RO	130	Brackish	1996	Discharge
Zawia	MED	5.000	Seawater	2005	Power
Zawia	MED	80.000	Seawater	2010	Municipal
Zliten	MSF	30.000	Seawater	1998	Municipal
Zuara	MED	40.000	Seawater	2005	Municipal
TOTAL PRODUCTION				**487.827 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 32

Libya. Desalting Plants presumed on line (2006)

Denomination/ Location	Method	Production M³/day	Raw Water	Year	Use
Abu Kamma	MSF	2.880	Seawater	1982	Industry
Abu Kamma	MED	120	Seawater	1982	Industry
Azzawiya	MED	2.000	Seawater	1993	Industry
Benghazi	RO	288	Brackish	1994	Demonst.
Bishr	RO	300	Seawater	1986	Municipal
Brega	MSF	500	Seawater	1980	Industry
Hamaba	RO	200	Seawater	1987	Municipal
Homs	MED	240	Seawater	1982	Power
Homs	MSF	52.800	Seawater	1980	Municipal
Libya	ED	852	Brackish	1979	Military
Libya	ED	852	Brackish	1979	Military
Libya	ED	852	Brackish	1979	Military
Libya	ED	852	Brackish	1979	Military
Libya	ED	852	Brackish	1979	Military
Libya	ED	852	Brackish	1979	Military
Libya	MED	480	Seawater	1980	Industry
Libya	ED	151	Brackish	1981	Military
Libya	ED	199	Brackish	1981	Military
Libya	ED	1.000	Brackish	1981	Municipal
Libya	ED	200	Brackish	1983	Municipal
Libya	ED	120	Brackish	1985	Tourism
Libya	ED	120	Brackish	1985	Tourism
Libya	RO	360	Brackish	1985	Tourism
Libya	ED	1.000	Brackish	1985	Tourism
Libya	ED	2.000	Brackish	1985	Municipal
Libya	ED	2.000	Brackish	1985	Municipal
Libya	RO	1.500	Brackish	1985	Municipal
Libya	RO	2.250	Brackish	1986	Industry
Libya	ED	100	Brackish	1986	Tourism
Libya	ED	300	Brackish	1986	Tourism
Libya	RO	2.250	Brackish	1986	Municipal
Libya	RO	600	Brackish	1987	Industry
Libya	RO	3.500	Brackish	1987	Municipal
Libya	RO	150	Seawater	1988	Industry
Libya	RO	250	Seawater	1989	Industry
Libya	RO	1.000	Seawater	1989	Industry
Libya	RO	240	Brackish	1989	Industry
Libya	RO	220	Seawater	1992	Industry
Libya	RO	240	Brackish	1994	Municipal
Libya	RO	288	Brackish	1994	Demonst.

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 32 (Continued)

Libya. Desalting Plants presumed on line (2011)

Denomination/ Location	Method	Production M^3/day	Raw Water	Year	Use
Libya	RO	265	Seawater	2007	Municipal
Libya	RO	180	Brackish	2007	Municipal
Mersa El Brega	MSF	2.400	Seawater	1980	Industry
Mersa El Brega	MSF	4.800	Seawater	1982	Industry
Misurata	MSF	500	Seawater	1985	Industry
Misurata	MED	500	Seawater	1981	Industry
Misurata	MED	4.500	Seawater	1982	Industry
Misurata	MSF	31.500	Seawater	1987	Industry
Osmo 50 AM	RO	1.200	Brackish	2007	Industry
Port Brega	MED	946	Seawater	1980	Industry
Port Brega	MED	1.892	Seawater	1983	Industry
Ras Lanuf	MSF	8.400	Seawater	1982	Municipal
Ras Lanuf	MSF	25.200	Seawater	1979	Industry
Ras Lanuf	MSF	1.500	Seawater	1980	Industry
Ras Lanuf	MSF	1.000	Seawater	1979	Industy
Ras Lanuf	MED	250	Seawater	1981	Industry
Ras Tajura	MSF	1.500	Seawater	1980	Military
Sirte	MSF	20.000	Seawater	1993	Industry
Sirte	MSF	1.893	Seawater	1987	Industry
Sirte	MSF	10.000	Seawater	1985	Municipal
Sirte	MSF	9.084	Seawater	1979	Municipal
Soussa	MSF	3.785	Seawater	1980	Municipal
Tobruk	RO	100	Brackish	1991	Industry
Trípoli	MSF	2.500	Seawater	1984	Municipal
Trípoli	RO	160	River	1991	Industry
Trípoli	RO	385	Seawater	1988	Industry
Trípoli	RO	100	Seawater	1992	Industry
Trípoli	RO	250	Brackish	1991	Tourism
Tripoli - West 2	MED	500	Seawater	1989	Municipal
Tripoli - West 2	RO	1.000	Brackish	1989	Municipal
Tripoli - West 2	RO	2.000	Brackish	1989	Municipal
Tripoli - West 2	RO	8.000	Brackish	1989	Municipal
Zleten	MSF	30.000	Seawater	1988	Municipal
Zuetina II	MSF	30.000	Seawater	1981	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**321.248 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 33

Libya. Desalting Plants under construction (2011)

Location	**Method**	**Production m^3/day**	**Raw Water**	**Year**	**Use**
Tobruk	RO	40.000	Seawater	2012	Municipal
Zuara Ext.	MED	40.000	Seawater	2012	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

EGYPT

ir a ÍNDICE

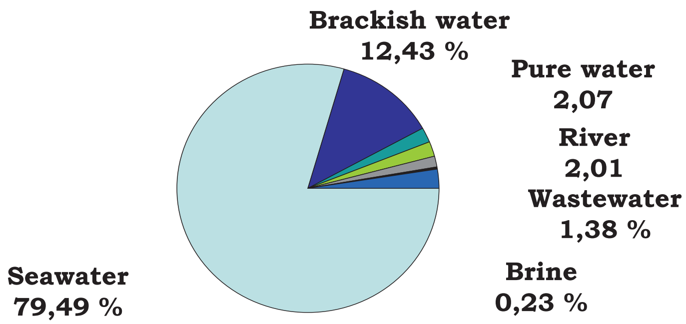
ir a ÍNDICE

EGYPT

The IDA Worldwide Desalting Plants Inventory (2011), reports on 385 desalting plants working on line in Egypt with capacity to produce 541.873 m^3/day (TABLE 34; and reports on 153 desalting plants able to produce 141.404 m^3/day, presumed as working on line (TABLE 35). Finally, there are 39 desalting plants, with capacity to produce 196.448 m^3/day, were under construction (TABLE 36). So, the presumed capacity to produce desalinated water in Egypt was 683.277 m^3/day. This means 0,42 % of the renewable water resources in this country.

The total capacity of water desalination was served by 543.109 m^3/day (79,49 %) of seawater; 84.339 m^3/day (12,34 %) of brackish water; 14.178 m^3/day (2,07 %) of pure water; 13.771 m^3/day (2,01 %) of river water; 9.430 m^3/day (1,38 %) from wastewater; 1.600 m^3/day of brine. The origin of 16.850 m^3/day (2,46 %) was not reported. The GRAPHIC 19 represents this distribution.

GRAPHIC 19
Desalinated water production according to feed water origin in EGYPT



The total of desalinated water capacity was applied as follows:

- 317.962 m^3/day (46,53 %) to tourism.
- 221.576 m^3/day (32,42 %) to municipal supply.
- 116.407 m^3/day (15.70 %) to industry.
- 12.252 m^3/day (1,79 %) to power.

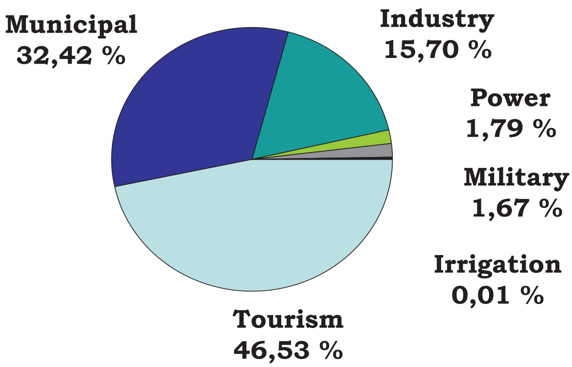
- 11.460 m^3/day (1,67 %) to military supply.

- 1.500 m^3/day (0,01 %) to irrigation.

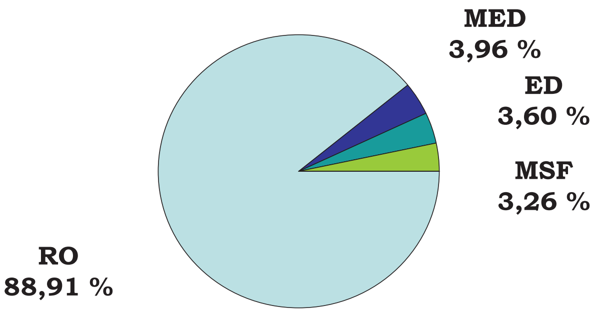
- 120 m^3/day (0.03 %) to discharge

The application of 2.000 m^3/day (0,30 %) was not reported. GRAPHIC 20 represents the distribution of desalinated water uses in Egypt.

GRAPHIC 20
Uses distribution of desalinated water in EGYPT



GRAPHIC 21
Frecuency of water desalination methods in EGYPT



Reverse osmosis is the principal method employed in Egypt to produce desalinated water in Egypt. According to the data studied, 607.571 m^3/day (88,91 %) are provide by RO systems; 27.062 m^3/day (3,96 %) by MED; 24.570 m^3/day (3,60 %) by ED; 22.334 m^3/day (3,26 %) by MSF; and 120 m^3/day (0,01 %) by EDI. The methods applied to produce 1.530 m^3/day (0,23 %) was not reported. GRAPHIC 21 represents the distribution of these figures.

ir a ÍNDICE

ir a ÍNDICE

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 34

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Abu Ramad	RO	500	Seawater	1996	Municipal
Abu Rawash	RO	100	Brackish	2004	Tourism
Abu Soma	MED	1.500	Seawater	1998	Tourism
Al Ain Al Sokhna	RO	1.000	Brackish		Municipal
Al Arish	RO	100	Seawater		Municipal
Al Arish	RO	100	Seawater		Municipal
Al Dabaa	RO	100	Seawater	2005	Municipal
Al Raouf	RO	1.200	Seawater	2008	Tourism
Alexandria	RO	330	Brackish	1999	Industry
Alexandria	RO	130	Seawater	2000	Industry
Alexandria	RO	1.900	Seawater	2003	Municipal
Alexandria	RO	201	River	2004	Industry
Alexandria Fiber	RO	3.600	Brackish	2005	Industry
Almaza	RO	2.000	Seawater	2010	Industry
Almaza Resort	RO	2.000	Seawater	2009	Tourism
Al Nahda CementCo.	RO	2.880	Brackish		Industry
Amigo Sharm BOOT	RO	500	Seawater		Industry
Aqua Marina Hurghada	RO	750	Seawater	2009	Municipal
Bahabia Hotel (Radisson Sas)	RO	3.000	Seawater	2008	Tourism
Beer Asel	RO	500	Seawater		Municipal
Borg El Arab	RO	100	Brackish	2004	Tourism
Borg Al Arab	EDI	120	Brackish	2009	Industry
Cairo	RO	2.397	River		Industry
Cairo	RO	150	Seawater	1996	Industry
Cairo	RO	960	Seawater	1996	Municipal
Cairo	RO	100	Waste	1999	Industry
Cairo	ED	150	Seawater	2001	Industry
Cairo	RO	100	Brackish	2002	Military
Cairo	RO	150	Seawater	2002	Tourism
Cairo	RO	230	Brackish	2002	Tourism
Cairo	RO	3.600	Seawater	2002	Industry
Cairo	RO	2.000	Seawater	2004	Industry
Cairo	RO	1.000	Seawater	2006	Municipal
Cairo	RO	1.000	Seawater	2006	Industry
Cairo	RO	144	Brackish	2009	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw Water	Year	Use
Cairo (Tender nº 37)	RO	500	Seawater	2007	Industry
Cairo (Tender nº 38)	RO	200	Brackish	2007	Municipal
Cataract 1, Marsa Alam	RO	500	Seawater	1999	Tourism
Cataract 2, Marsa Alam	RO	500	Seawater	1999	Tourism
Cataract 3, Marsa Alam	RO	500	Seawater	1999	Tourism
Cataract 4, Marsa Alam	RO	500	Seawater	2000	Tourism
Coral Sea	RO	500	Seawater	2008	Tourism
Crown Plaza Hotel	RO	500	Seawater	2007	Tourism
Dahab	RO	1.000	Seawater		Industry
Dahab	RO	7.000	Seawater		Municipal
Dahab	RO	7.000	Seawater		Municipal
Dahab	RO	3.600	Seawater	1998	Tourism
Dahab	RO	500	Seawater	2006	Industry
Damietta	MED	432	Seawater	2004	Industry
Desert Road	RO	100	Brackish	2002	Tourism
Dessole Nesco	RO	2.000	Pure		Tourism
Diamond Sharm	RO	500	Seawater	2007	Tourism
Doris	RO	500	Pure		Tourism
Dream Beach	RO	100	Seawater	2008	Municipal
DSL 02 NRMV	RO	1.000	Seawater	2008	Tourism
DSL 03 STY	RO	500	Seawater	2007	Tourism
DSL 03 COR	RO	500	Seawater	2008	Tourism
EG 02 GL5	RO	1.500	Seawater	2000	Tourism
EG 02 MRD	RO	2.500	Seawater	2000	Tourism
EG 02 SLH	RO	500	Seawater	2002	Tourism
EG 02 RMW	RO	3.000	Seawater	2002	Tourism
EG 02 LNG	RO	1.000	Seawater	2002	Tourism
EG 02 VRD	RO	1.000	Seawater	2002	Tourism
EG 02 BLG	RO	500	Seawater	2008	Tourism
EG 03 GRD	RO	1.000	Seawater	2001	Tourism
EG 03 MGL	RO	1.500	Seawater	2008	Tourism
EG 03 RAF	RO	1.500	Seawater	2008	Tourism
EG 03 GRN	RO	750	Seawater	2008	Tourism
EG 03 NMA	RO	750	Seawater	2008	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw Water	Year	Use
EG 03 NBQ	RO	500	Seawater	2008	Tourism
EG 03 RJN	RO	500	Seawater	2008	Tourism
EG 04 ALX	RO	1.000	Seawater	2000	Tourism
EG 04 NFR	RO	500	Seawater	2001	Tourism
EG 04 ASL	RO	500	Seawater	2002	Tourism
EG 04 DRM	RO	300	Seawater	2008	Tourism
EG 05 RDS	RO	500	Seawater	2008	Tourism
EG 06 MTR	RO	1.900	Seawater	2001	Tourism
EG 06 MTR	RO	1.900	Seawater	2001	Tourism
EG 06 MRN	RO	500	Seawater	2004	Tourism
Egypt	RO	3.000	Seawater	1996	Municipal
Egypt	RO	6.057	Seawater	1997	Tourism
Egypt	ED	450	Brackish	1997	Tourism
Egypt	RO	400	Seawater	1997	Power
Egypt	RO	400	Seawater	1997	Tourism
Egypt	RO	300	Seawater	1997	Municipal
Egypt	RO	300	Seawater	1997	Municipal
Egypt	RO	300	Seawater	1997	Tourism
Egypt	RO	1.500	Seawater	1997	Municipal
Egypt	RO	300	Seawater	1998	Tourism
Egypt	RO	300	Seawater	1998	Tourism
Egypt	RO	380	Seawater	1998	Power
Egypt	RO	168	Brackish	1998	Power
Egypt	MED	2.000	Seawater	1998	Industry
Egypt	RO	500	Seawater	1998	Tourism
Egypt	RO	325	Brackish	1999	Industry
Egypt	RO	500	Seawater	1999	Tourism
Egypt	ED	1.636	Brackish	1999	Municipal
Egypt	ED	500	Brackish	1999	Tourism
Egypt	RO	800	Seawater	1999	Tourism
Egypt	ED	750	Brackish	2000	Industry
Egypt	RO	2.100	Brackish	2000	Industry
Egypt	RO	3.000	Seawater	2000	Industry
Egypt	ED	10.000	Brackish	2000	Industry
Egypt	RO	2.157	Seawater	2000	Municipal
Egypt	RO	2.000	Seawater	2001	Municipal
Egypt	MED	4.800	Seawater	2001	Municipal
Egypt	RO	1.000	Seawater	2003	Municipal
Egypt	RO	350	Seawater	2006	Tourism
Egypt	RO	3.161	Seawater	2008	Municipal
Egypt	RO	2.071	Seawater	2008	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Egypt	RO	1.581	Seawater	2008	Tourism
Egypt	RO	5.450	Seawater	2009	Municipal
Egypt	RO	2.208	Seawater	2009	Industry
Egypt	RO	650	Seawater		Tourism
Egypt	RO	650	Seawater		Tourism
Egyptian Propilene	RO	3.300	Seawater		Industry
Egyptian Propilene & P	RO	3.300	Seawater		Industry
El Ain El Shokna	RO	300	Seawater	2002	Tourism
El Ain El Shokna	RO	300	Seawater	2002	Tourism
El Ain El Shokna	RO	300	Seawater	2002	Tourism
El Ain El Shokna	RO	300	Seawater	2002	Tourism
El Alamain	RO	2.000	Brackish	1996	Tourism
El Arousa	RO	500	Seawater	2010	Tourism
El Behira	RO	250	Brackish	2006	Industry
El Dhabia	RO	1.500	Seawater	2008	Tourism
El Dhabia	RO	1.500	Seawater	2008	Tourism
El Fayrouz Resort	RO	750	Seawater		Tourism
El Malkia Resort	RO	500	Seawater	2009	Tourism
El Quseir	RO	300	Seawater	1994	Tourism
El Sherouk City		1.400	Seawater		Municipal
Elshrouk II	RO	500	Brackish	1998	Industry
Elshrouk III	RO	500	Brackish	1998	Tourism
Enppi	RO	240	Brackish	2009	Industry
Enppi	RO	24	Brackish	2010	Industry
ERC 2	RO	2.000	Seawater	2008	Tourism
ERC 3	RO	6.000	Seawater	2009	Tourism
Fantazia	RO	1.200	Seawater	2008	Tourism
Fares	RO	480	Brackish	2000	Municipal
Fouka Plant Marasa Matrouh	RO	100	Seawater	2007	Municipal
Giza	RO	250	Brackish	1987	Tourism
Giza	RO	200	Brackish	1997	Tourism
Golden 5	RO	500	Pure		Tourism
Gran Hotel	RO	500	Seawater		Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Happy Life	RO	700	Seawater		Tourism
Happy Life	RO	200	Seawater	2008	Tourism
Happy Life	RO	200	Seawater	2008	Tourism
Hausa Beach	RO	700	Seawater		Tourism
Helwan	RO	100	Brackish	1999	Military
Hilton Marsa Alam	RO	1.000	Seawater	2007	Tourism
Hilton Marsa Alam	RO	1.000	Seawater	2008	Tourism
Hilton Sharks Bay	RO	500	Seawater		Tourism
Hotel	RO	2.000	Seawater		Tourism
Hurgada	RO	750	Seawater		Tourism
Hurgada	RO	500	Seawater		Tourism
Hurgada	RO	500	Seawater		Municipal
Hurgada	RO	500	Seawater		Municipal
Hurgada	RO	500	Seawater		Municipal
Hurgada	RO	500	Seawater		Municipal
Hurgada	RO	500	Seawater		Municipal
Hurgada	RO	500	Seawater		Tourism
Hurgada	RO	500	Seawater		Municipal
Hurgada	RO	500	Seawater		Tourism
Hurgada	RO	400	Seawater		Tourism
Hurgada	RO	300	Seawater		Municipal
Hurgada	RO	300	Seawater		Municipal
Hurghada	RO	1.000	Seawater		Municipal
Hurghada	RO	1.000	Seawater		Municipal
Hurghada	RO	1.000	Seawater		Municipal
Hurghada	RO	750	Seawater		Municipal
Hurghada	RO	700	Seawater		Municipal
Hurgada	RO	300	Seawater	1997	Tourism
Hurgada	RO	300	Seawater	1997	Tourism
Hurgada	RO	300	Seawater	1997	Tourism
Hurgada	RO	300	Seawater	1997	Tourism
Hurgada	RO	450	Seawater	1997	Tourism
Hurgada	RO	500	Seawater	2000	Municipal
Hurgada	RO	200	Seawater	2000	Tourism
Hurgada	RO	500	Seawater	2001	Municipal
Hurgada	RO	300	Seawater	2001	Tourism
Hurgada	RO	500	Seawater	2002	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Hurgada	RO	200	Seawater	2002	Tourism
Hurgada	RO	500	Seawater	2004	Tourism
Hurgada	RO	500	Seawater	2005	Tourism
Hurgada	RO	350	Seawater	2005	Industry
Hurgada	RO	500	Seawater	2006	Tourism
Hurgada	RO	500	Seawater	2006	Tourism
Iberotel Palace	RO	500	Seawater	2008	Tourism
Kirosiez Three Corners Resort	RO	500	Seawater	2007	Tourism
Little Venice	RO	3.000	Brackish		Tourism
Little Venice	RO	3.000	Seawater		Tourism
Maison Arab Resort	RO	500	Seawater	2008	Tourism
Marina Banyias	RO	500	Seawater	2008	Tourism
Marsa Alam	RO	1.200	Seawater		Tourism
Marsa Alam	RO	1.000	Seawater		Tourism
Marsa Alam	RO	500	Seawater		Municipal
Marsa Alam	RO	100	Seawater	1996	Municipal
Marsa Alam	RO	100	Seawater	1998	Tourism
Marsa Alam	RO	200	Seawater	2000	Municipal
Marsa Alam	RO	500	Seawater	2001	Tourism
Marsa Alam	RO	500	Seawater	2002	Tourism
Marsa Alam	RO	500	Seawater	2002	Tourism
Marsa Alam	RO	500	Seawater	2002	Tourism
Marsa Alam	RO	500	Seawater	2002	Tourism
Marsa Alam	RO	3.000	Seawater	2004	Municipal
Marsa Alam	RO	500	Seawater	2004	Tourism
Marsa Alam	RO	500	Seawater	2005	Tourism
Marsa Alam	RO	300	Seawater	2005	Tourism
Marsa Alam	RO	300	Seawater	2005	Tourism
Marsa Alam	RO	300	Seawater	2005	Tourism
Marsa Alam	RO	1.500	Seawater	2005	Municipal
Marsa Matrah	RO	150	Seawater		Municipal
Marsa Matrouh	RO	500	Seawater		Tourism
Marsa Matrouh	RO	1.500	Seawater	2002	Municipal
Matrouh	RO	700	Seawater		Tourism
Melia Pharaoh	RO	500	River	2008	Tourism
Mirage 3	RO	4.000	Seawater		Tourism
Montazah	RO	200	Seawater	2003	Municipal
Montazah	RO	4.000	Seawater	2005	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Montazah	RO	6.000	Brackish	2009	Tourism
Moreen Beach	RO	300	Seawater	2008	Tourism
Nabq	RO	1.000	Waste	2003	Tourism
Nabq Central	RO	3.000	Seawater	2008	Municipal
Nabq Ext.	RO	1.500	Seawater	2008	Municipal
Nakheel Sunrise Resort	RO	500	Seawater	2009	Tourism
Ne´ma Bay	RO	1.750	Seawater	2008	Tourism
Nemma View	RO	300	Seawater	2008	Tourism
Nesco Sharm El Sheik	RO	2.000	Seawater	2003	Municipal
Neuiba	RO	150	Seawater	2000	Tourism
Noeibeh	RO	10.000	Seawater	2009	Industry
North Coast	RO	1.000	Seawater	2002	Tourism
Nuweiba	RO	10.500	Seawater		Tourism
Nuweiba	RO	200	Seawater	1998	Tourism
Nuweiba	RO	10.000	Seawater	2002	Municipal
Nuweiba Exp.	RO	8.000	Seawater	2008	Tourism
O.I. SW 200	RO	200	Seawater	2001	Power
Oriental Coast I	RO	6.000	Seawater	2009	Tourism
Panorama Bungalows	RO	700	Seawater		Tourism
Port Said	RO	500	Seawater	2000	Industry
Pyramisa Sahl Hashis	RO	1.000	Seawater	2007	Tourism
Pyramisa Blue Lagon	RO	1.000	Seawater	2008	Tourism
Radamis Resort	RO	700	Seawater	2009	Tourism
Rainbow Resort	RO	1.200	Seawater	2008	Tourism
Ras Masala	RO	2.000	Brackish	2004	Tourism
Ras Matarma	RO	100	Brackish	2002	Tourism
Ras Sudr	RO	1.000			Municipal
Ras Sudr	RO	250	Seawater	1999	Tourism
Ras Sudr	RO	100	Seawater	2000	Municipal
Ras Sudr	RO	150	Seawater	2000	Tourism
Ras Sudr	RO	300	Seawater	2000	Tourism
Ras Sudr	RO	200	Seawater	2002	Tourism
Red Sea resorts	RO	3.000	Seawater	2001	Tourism
Resort	RO	1.500	Pure		Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw Water	Year	Use
Ridgewood Egypt	RO	27.252	Seawater		Tourism
Ridgewood	RO	2.500	Pure		Industry
Riviera Resort	RO	1.000	Seawater	2008	Tourism
Sada City	RO	10.673	River	2009	Municipal
Safaga	RO	500	Seawater	1998	Tourism
Safaga	RO	1.000	Seawater	2003	Tourism
Salam Gas Tains 3 and 4 Khalda	RO	168	Brackish	2007	Industry
Saloum	RO	3.000	Seawater	2002	Tourism
Savoy	RO	1.000	Seawater	2009	Tourism
Sea Club Hotel	RO	1.400	Seawater	2008	Tourism
Sea View Resort	RO	300	Seawater	2007	Tourism
Sea Water RO Membranes Army	RO	900	Seawater	2010	Municipal
Semadco	RO	5.000	Sewater	1998	Municipal
Seta Osmo SW 2000	RO	2.000	Seawater	2000	Industry
Seta Osmo SW 2000	RO	2.000	Seawater	2000	Industry
Seta Osmo SW 2000	RO	500	Seawater	2000	Tourism
Seta Osmo SW 300	RO	300	Seawater	2001	Tourism
Shahd	RO	1.512	Seawater	2009	Industry
Shalatin	RO	100	Seawater	1996	Municipal
Shalatin	RO	500	Seawater	2000	Industry
Sharm El Sheikh	RO	500	Seawater		Municipal
Sharm El Sheikh	RO	500	Seawater		Municipal
Sharm El Sheikh	RO	450	Seawater		Municipal
Sharm El Sheikh	RO	250	Seawater		Municipal
Sharm El Sheikh	RO	250	Seawater		Municipal
Sharm El Sheikh	RO	250	Seawater		Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw Water	Year	Use
Sharm El Sheikh	RO	500	Seawater		Tourism
Sharm El Sheikh	RO	500	Seawater		Tourism
Sharm El Sheikh	RO	500	Seawater		Tourism
Sharm El Sheikh	RO	200	Seawater		Municipal
Sharm El Sheikh	RO	600	Seawater		Municipal
Sharm El Sheikh	RO	1.500			Municipal
Sharm El Sheikh	RO	950			Municipal
Sharm El Sheikh	RO	1.000			Municipal
Sharm El Sheikh	RO	1.900			Municipal
Sharm El Sheikh	RO	2.000			Municipal
Sharm El Sheikh	MED	500	Seawater	1996	Tourism
Sharm El Sheikh	RO	500	Seawater	1996	Tourism
Sharm El Sheikh	RO	250	Brackish	1996	Tourism
Sharm El Sheikh	RO	500	Seawater	1997	Tourism
Sharm El Sheikh	RO	100	Seawater	1997	Tourism
Sharm El Sheikh	RO	7.000	Seawater	1997	Municipal
Sharm El Sheikh	RO	2.000	Seawater	1997	Tourism
Sharm El Sheikh	RO	3.000	Seawater	1997	Tourism
Sharm El Sheikh	RO	500	Seawater	1998	Tourism
Sharm El Sheikh	RO	500	Seawater	1998	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw Water	Year	Use
Sharm El Sheikh	RO	500	Seawater	1998	Municipal
Sharm El Sheikh	RO	500	Seawater	1998	Tourism
Sharm El Sheikh	RO	500	Seawater	1998	Industry
Sharm El Sheikh	RO	300	Seawater	1998	Tourism
Sharm El Sheikh	RO	200	Seawater	1998	Tourism
Sharm El Sheikh	RO	600	Seawater	1998	Tourism
Sharm El Sheikh	RO	1.200	Seawater	1998	Tourism
Sharm El Sheikh	RO	1.000	Seawater	1998	Tourism
Sharm El Sheikh	RO	150	Seawater	1999	Tourism
Sharm El Sheikh	MED	500	Seawater	1999	Tourism
Sharm El Sheikh	MED	500	Seawater	1999	Tourism
Sharm El Sheikh	RO	500	Seawater	1999	Tourism
Sharm El Sheikh	RO	250	Seawater	1999	Tourism
Sharm El Sheikh	RO	200	Seawater	1999	Tourism
Sharm El Sheikh	RO	1.000	Seawater	1999	Tourism
Sharm El Sheikh	RO	300	Seawater	2000	Tourism
Sharm El Sheikh	RO	500	Seawater	2000	Tourism
Sharm El Sheikh	RO	500	Seawater	2000	Industry
Sharm El Sheikh	MED	300	Seawater	2000	Tourism
Sharm El Sheikh	MED	300	Seawater	2000	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw Water	Year	Use
Sharm El Sheikh	RO	250	Seawater	2000	Tourism
Sharm El Sheikh	RO	250	Seawater	2000	Tourism
Sharm El Sheikh	RO	600	Seawater	2000	Tourism
Sharm El Sheikh	RO	1.000	Seawater	2000	Tourism
Sharm El Sheikh	RO	14.000	Seawater	2001	Tourism
Sharm El Sheikh	RO	500	Seawater	2001	Tourism
Sharm El Sheikh	RO	500	Seawater	2002	Tourism
Sharm El Sheikh	RO	500	Seawater	2002	Tourism
Sharm El Sheikh	RO	500	Seawater	2002	Tourism
Sharm El Sheikh	RO	500	Seawater	2002	Tourism
Sharm El Sheikh	RO	500	Seawater	2002	Tourism
Sharm El Sheikh	RO	1.000	Seawater	2002	Industry
Sharm El Sheikh	RO	1.200	Seawater	2002	Tourism
Sharm El Sheikh	RO	1.500	Seawater	2002	Tourism
Sharm el Sheikh	RO	2.000		2002	
Sharm el Sheikh	RO	6.500		2003	Municipal
Sharm El Sheikh	RO	1.000	Seawater	2003	Tourism
Sharm El Sheikh	RO	2.500	Seawater	2003	Industry
Sharm El Sheikh	RO	1.000	Seawater	2003	Tourism
Sharm El Sheikh	RO	2.500	Seawater	2003	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw Water	Year	Use
Sharm el Sheikh	RO	6.000	Seawater	2003	Municipal
Sharm El Sheikh	RO	1.500	Seawater	2004	Municipal
Sharm El Sheikh	RO	2.000	Seawater	2004	Industry
Sharm El Sheikh	RO	1.000	Seawater	2005	Tourism
Sharm El Sheikh	RO	500	Seawater	2005	Tourism
Sharm El Sheikh	RO	500	Seawater	2005	Tourism
Sharm El Sheikh	RO	1.500	Seawater	2005	Municipal
Sharm El Sheikh	RO	500	Seawater	2005	Municipal
Sharm El Sheikh	RO	300	Seawater	2005	Tourism
Sharm El Sheikh	RO	1.500	Seawater	2005	Tourism
Sharm El Sheikh	RO	1.500	Seawater	2005	Tourism
Sharm El Sheikh	RO	500	Seawater	2006	Tourism
Sharm El Sheikh	RO	500	Seawater	2006	Tourism
Sharm El Sheikh	RO	2.500	Seawater	2007	Municipal
Sharm El Sheikh	RO	500	Seawater	2007	Municipal
Sharm El Sheikh	RO	400	Seawater	2007	Municipal
Sharm El Sheikh	RO	400	Seawater	2007	Municipal
Sheraton Sharm	RO	700	Seawater	2007	Tourism
Sidi Krir	MSF	10.000	Seawater	1999	Tourism
Sinai	RO	300	Seawater	1996	Municipal
Sinai	RO	100	Seawater	2002	Military
Sinai	RO	17.500	Seawater	2006	Municipal
Sofitel Hurgada	RO	300	Seawater	2008	Tourism
Sofitel Hurgada	RO	300	Seawater	2008	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 34 (Continued)

Egypt. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw Water	Year	Use
Steel Mill	RO	1.678	Pure		Industry
Stella 2	RO	2.400	Seawater		Tourism
Stella Makady	RO	1.200	Seawater	2008	Tourism
Suez Fertilizer	RO	3.000	Seawater	2008	Tourism
Sultan Garden	RO	750	Seawater		Tourism
Sun Rise Bahia Palace	RO	500	Seawater	2008	Tourism
Sun Rise Royal Makady	RO	1.000	Seawater	2008	Tourism
Sunshine	RO	500	Pure		Tourism
Swani Samalous HBWRO	RO	100	Brackish	2008	Municipal
Taba	MED	1.000	Seawater	1995	Municipal
Taba	MED	2.000	Seawater	1995	Municipal
Taba	RO	2.400	Seawater	2000	Tourism
Taba	RO	10.000	Seawater	2002	Municipal
Taba	RO	1.000	Seawater	2006	Tourism
Taba Heights	RO	1.000	Seawater	2005	Tourism
Tiba I	RO	6.000	Brackish	2009	Tourism
Tirana Aqua Park	RO	700	Seawater	2008	Tourism
UN Forces Darfour	RO	100	Brackish	2007	Military
Various	RO	1.500	Seawater	2006	Military
West Desert	RO	148	Seawater	1999	Industry
Western Desert	RO	150	Brackish	2003	Industry
West Zone	RO	600	Seawater	2006	Industry
ZERO LDP	RO	8.330	Waste	2010	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**541.873 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 35

Egypt. Desalting Plants presumed on line (2011)

Location	Method	Production m^3/day	Raw water	Year	Use
Abu Ramad	RO	500	Brackish	1993	Municipal
Abu Ramad	RO	100	Brackish	1993	Municipal
Abu Ramad	RO	100	Seawater	1995	Municipal
Abu Qir	RO	4.000	Brackish	1987	Power
Abu Soma	MED	3.000	Seawater	1994	Tourism
Abu Tartour	RO	500	Seawater	1993	Industry
Al Abd Village	RO	500	Seawater	2009	Tourism
Al Arish	MED	1.200	Seawater	1994	Power
Al Dabaa	RO	100	Seawater		Power
Al Fayoum	RO	1.000	Brackish	1991	Industry
Albatros Hurgada	RO	700	Seawater	2007	Municipal
Alexandria	ED	2.400	Brackish	1985	Industry
Alexandria	RO	4.560	Brackish	1988	Industry
Alexandria	RO	600	Seawater	1995	Military
Alf Leila Urgada	RO	700	Seawater	2007	Municipal
Alf Lila W Lila	RO	2.400	Seawater	2009	Tourism
Blue Bay Ras Sudr	RO	1.150	Seawater	2007	Municipal
Borg El Arab	RO	4.000	Brackish	1995	Tourism
Cairo	RO	150	Brackish	1992	Municipal
Cairo	RO	300	Seawater	1996	Military
Cairo	RO	2.400	Seawater	2002	Industry
Coral Beach, Hurgada	RO	1.400	Seawater	2007	Municipal
Dahab	RO	240	Seawater	1992	Tourism
Dahab	RO	2.000	Seawater	1995	Municipal
Delta Sharm Resort	RO	1.000	Seawater	2007	Industry
Egypt	ED	200	Brackish	1982	Tourism
Egypt	ED	397	Brackish	1982	Municipal
Egypt	ED	397	Brackish	1982	Municipal
Egypt	ED	180	Brackish	1982	Tourism
Egypt	ED	400	Brackish	1983	Military
Egypt	MED	500	Seawater	1984	Industry
Egypt	MED	500	Seawater	1984	Industry
Egypt	MED	500	Seawater	1985	Tourism
Egypt	MED	500	Seawater	1986	Industry
Egypt	MED	1.000	Seawater	1986	Military
Egypt	RO	300	Brackish	1986	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 35 (Continued)

Egypt. Desalting Plants presumed on line (2011)

Location	Method	Production m³/day	Raw Water	Year	Use
Egypt	ED	120	Brackish	1986	Tourism
Egypt	RO	1.000	Brackish	1987	Municipal
Egypt	MED	120	Seawater	1987	Industry
Egypt	ED	100	Brackish	1988	Industry
Egypt	ED	300	Brackish	1988	Military
Egypt	ED	110	Brackish	1988	Industry
Egypt	MED	120	Seawater	1989	Discharge
Egypt	MED	120	Brackish	1989	Industry
Egypt	MSF	500	Seawater	1990	Industry
Egypt	MSF	250	Seawater	1990	Industry
Egypt	MED	200	Seawater	1990	Tourism
Egypt	ED	200	Brackish	1990	Industry
Egypt	MSF	5.280	Seawater	1992	Industry
Egypt	RO	606	Seawater	1992	Tourism
Egypt	ED	4.080	Brackish	1993	Industry
Egypt	RO	606	Seawater	1993	Tourism
Egypt	RO	400	Seawater	1995	Municipal
Egypt	RO	240	Seawater	1995	Municipal
Egypt	RO	1.500	Seawater	2006	Irrigation
El Gouna Hurgada	RO	500	Seawater	2007	Tourism
El Moweh	ED	200	Brackish	1989	Municipal
El Nequila	ED	200	Brackish	1989	Municipal
ERC Egyptian Resort Company	RO	6.000	Seawater	2010	Tourism
ERC1 Hurgada	RO	2.000	Seawater	2007	Municipal
Fayrouz Plaza, Marsa Alam	RO	500	Seawater	2006	Municipal
Gabriel	ED	400	Brackish	1989	Municipal
Gran 2 Hurgada	RO	500	Seawater	2006	Municipal
Gran Golf	RO	700	Seawater	2009	Tourism
Gran Makady	RO	700	Seawater	2009	Tourism
Gran Makady 2 Hurgada	RO	700	Seawater	2006	Municipal
Grand Nabag	RO	700	Seawater	2009	Tourism
Grand Sharm	RO	600	Seawater	2009	Tourism
Halayeb	RO	500	Brackish	1993	Municipal
Halayeb	RO	100	Brackish	1993	Municipal
Halayeb	RO	100	Seawater	1995	Municipal
Halayeb	RO	500	Seawater	2006	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 35 (Continued)

Egypt. Desalting Plants presumed on line (2011)

Location	Method	Production m³/day	Raw Water	Year	Use
Hamata	RO	100	Brackish	1993	Municipal
Hamata	RO	100	Seawater	1995	Municipal
Hilton Sharm Dream	RO	230	Seawater	2006	Municipal
Hurgada	RO	5.000	Seawater	1990	Municipal
Hurgada	RO	5.000	Pure	1991	Municipal
Hurgada	RO	200	Seawater	1991	Tourism
Hurgada	RO	500	Brackish	1993	Municipal
Hurgada	MED	500	Seawater	1993	Municipal
Hurgada	RO	400	Seawater	1993	Tourism
Hurgada	RO	130	Brackish	1993	Municipal
Hurgada	RO	500	Brine	1994	Tourism
Hurgada	RO	500	Brackish	1994	Tourism
Hurgada	RO	5.000	Seawater	1994	Tourism
Hurgada	RO	300	Brine	1994	Tourism
Hurgada	RO	500	Seawater	1995	Municipal
Hurgada	RO	300	Brine	1995	Tourism
Hurgada	RO	500	Brine	1996	Tourism
Las Kabanas	RO	750	Seawater	2009	Tourism
Marsa Alam	RO	500	Brackish	1993	Municipal
Marsa Alam	RO	100	Brackish	1993	Municipal
Marsa Alam	RO	500	Seawater	1995	Municipal
Marsa Alam Project	RO	1.000	Seawater	2010	Industry
Marsa Hemera	RO	100	Seawater	1995	Municipal
Marsa Matrouh	RO	576	Seawater	1989	Municipal
Matrouh	MSF	500	Seawater	1988	Municipal
Meleiha	RO	168	Seawater	1990	Municipal
Mersa Hemera	RO	100	Brackish	1993	Municipal
Military Zone	RO	480	Seawater	1987	Military
Mirage BOO	RO	1.150	Seawater	2006	Municipal
Montazah	RO	6.000	Brackish	2009	Tourism
Montazah 2	RO	4.000	Seawater	2006	Municipal
Morgana Hotel Taba	RO	500	Seawater	2007	Tourism
Nuweiba, Sinai	RO	300	Seawater	1994	Tourism
Oriental Golf	RO	3.000	Seawater	2009	Tourism
Paradise Resort Marsa Alam	RO	300	Seawater	2007	Tourism
Ras Ghareb	RO	500	Brackish	1993	Municipal
Ras Ghareb	RO	1.000	Seawater	1994	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 35 (Continued)

Egypt. Desalting Plants presumed on line (2011)

Location	Method	Production m^3/day	Raw Water	Year	Use
Ras Gharir	MSF	5.304	Seawater	1995	Power
Rowisat	RO	700	Seawater	2009	Tourism
Salam Base	RO	200	Seawater	1989	Industry
Sallum	RO	200	Brackish	1989	Municipal
Shalatin	RO	500	Brackish	1993	Municipal
Shalatin	RO	100	Brackish	1993	Municipal
Shalatin	RO	500	Seawater	1995	Municipal
Shamus	ED	200	Brackish	1989	Municipal
Sharm El Sheikh	RO	200	Seawater	1990	Tourism
Sharm El Sheikh	RO	200	Seawater	1992	Tourism
Sharm El Sheikh	RO	240	Seawater	1992	Tourism
Sharm El Sheikh	RO	200	Seawater	1992	Tourism
Sharm El Sheikh	RO	300	Seawater	1993	Tourism
Sharm El Sheikh	RO	200	Seawater	1994	Tourism
Sharm El Sheikh	RO	500	Seawater	1994	Municipal
Sharm El Sheikh	RO	450	Seawater	1994	Tourism
Sharm El Sheikh	RO	400	Seawater	1994	Tourism
Sharm El Sheikh	RO	500	Seawater	2005	Tourism
Sharm El Sheikh	RO	500	Seawater	2008	Municipal
Sharming Sharm	RO	300	Seawater	2006	Municipal
Sheraton Taba	RO	700	Seawater	2008	Tourism
Sidi Barrani	RO	600	Seawater		Municipal
Sidi Barrani	MED	2.500	Seawater	1988	Military
Sidi Barrani	ED	400	Brackish	1989	Municipal
Sinai	MED	500	Seawater	1990	Tourism
Sinai	RO	200	Seawater	1992	Tourism
Sinai	MED	300	Seawater	1992	Industry
Sinai	MED	450	Seawater	1995	Municipal
Sinai	RO	300	Seawater	1995	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 35 (Continued)

Egypt. Desalting Plants presumed on line (2011)

Location	Method	Production m³/day	Raw Water	Year	Use
Sinai	RO	590	Brackish	1990	Industry
Siwa Oasis	ED	400	Brackish	1989	Municipal
Suez	MSF	500	Seawater	1987	Power
Suez	RO	420	Seawater	1989	Military
Sun Rise Royal Makady	RO	950	Seawater	2007	Municipal
Taba Heights	RO	2.500	Seawater	2007	Municipal
Umm El Rakha	ED	400	Brackish	1989	Municipal
Varwina	RO	3.560	Seawater	1982	Military
Wadi Degla	RO	700	Seawater	2009	Industry
Wadi Lahmy	RO	500	Seawater	2009	Municipal
West Desert	RO	110	Brackish	1982	Industry
Zeit Bay	MED	240	Seawater	1983	Industry
Zeit Bay	MED	240	Seawater	1985	Industry
Zeit Bay	MED	240	Seawater	1987	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**141.404 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 36

Egypt. Desalting Plants under construction (2011)

Location	Method	Production m³/day	Raw water	Year	Use
Abu Qir	MED	10.000	Seawater	2012	Power
Al Ain El Sukhna	MED	8.000	Seawater	2012	Municipal
Al Ain El Sukhna PP	MED	8.000	Seawater		Industry
Al Ain El Sukhna SCTPP	MED	8.000	Seawater	2013	Industry
Al Arish	RO	5.000	Seawater	2012	Municipal
Al Montazah Desalination Plant	RO	5.000	Waste		Irrigation
Atouf New	RO	2.400	Seawater		Municipal
Egypt	RO	23.966	River		Industry
Egypt	RO	2.180	Seawater		Industry
Egypt	RO	432	Seawater	2012	Municipal
Egyptian Resort C	RO	2.000	Seawater	2012	Tourism
El Sheikh Zowayed	RO	5.000	Seawater	2012	Municipal
EPPC	RO	10.000	Seawater		Industry
Grand Group	RO	1.400	Seawater	2012	Tourism
Grand Group	RO	1.000	Seawater	2012	Tourism
HL 400	RO	440	Seawater	2012	Tourism
Lagoona	RO	1.400	Seawater	2012	Industry
Madinaty	RO	10.000	Brackish	2012	Demonst.
Marsa Alam Project	RO	1.000	Seawater	2012	Industry
Marsa Alam Project	RO	1.000	Seawater	2012	Industry
Montazah	RO	18.000	Seawater		Tourism
Morgan Village	RO	500	Seawater	2012	Tourism
Nabq	RO	12.000	Seawater	2012	Municipal
Nuweiba C	MED	4.000	Seawater	2012	Power
Oriental Cost II	RO	3.000	Seawater	2012	Tourism
Oriental 4K	RO	24.000	Seawater		Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 36 (Continued)

Egypt. Desalting Plants under construction (2011)

Location	Method	Production m³/day	Raw water	Year	Use
Pharoah Golden Mine	RO	1.000	Seawater		Tourism
Rafah	RO	5.000	Seawater	2012	Municipal
Red Sea Sharm	RO	4.000	Brine		Tourism
Resco 500	RO	550	Seawater	2012	Tourism
RS 500	RO	550	Brackish	2012	Tourism
Safaga Marsa Alam&Barnes	RO	1.800	Seawater		Municipal
Savoy 800	RO	880	Seawater	2012	Municipal
Sharm Grand	RO	8.000	Seawater	2012	Tourism
Silver Sand Resort	RO	750	Brackish	2012	Tourism
Soma Bay	RO	700	Seawater	2012	Industry
South Marsa Alam	RO	1.000	Seawater	2012	Tourism
Stella Sharm	RO	500	Seawater	2012	Industry
Utopia 2	RO	4.000	Brackish		Tourism
TOTAL CAPACITY OF WATER PRODUCTION				**196.448 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ISRAEL

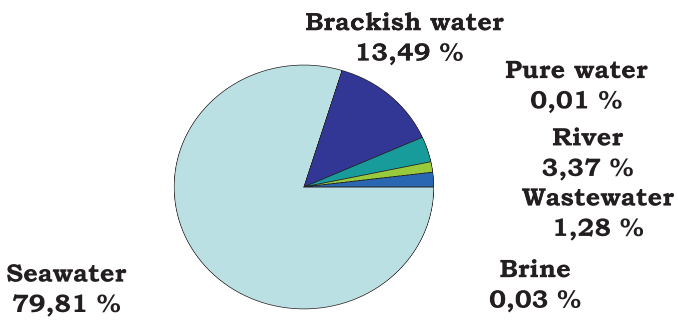
ir a ÍNDICE

ISRAEL

The IDA Worldwide Desalting Plants Inventory (2011) reports on 39 desalting plants on line in Israel which total capacity is 1.124.712 m^3/day (TABLE 37); 11 desalting plants, with total capacity of 44.762 m^3/day, are presumed on line (TABLE 38); and, four desalting plants with capacity to produce 911.000 m^3/day of water are under construction (TABLE 39). Actually, the presumed capacity of desalinated water production is 1.169.474 m^3/day. This means 21,34 % of the renewable water resources of the country.

The total capacity of desalinated water production is served by 933.415 m^3/day (79,81 %) of seawater; 157.796 m^3/day (13,49 %) of brackish water; 39.480 m^3/day (3,37 %) of river water; 15.000 m^3/day (1,28 %) of wastewater; 400 m^3/day (0,03 %) of brine; 144 m^3/day (0.01 %) of pure water. The origin of 23.239 m^3/day (1,98 %) was not reported. The GRAPHIC 22 represents this distribution.

GRAPHIC 22
Desalinated water production according to feed water origin in ISRAEL



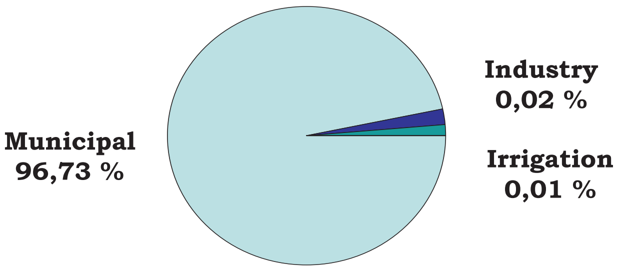
The total desalinated water capacity is applied as follows:

- 1.131.317 m^3/day (96,73 %) to municipalities.
- 23.157 m^3/day (0,02 %) to industry.
- 15.000 m^3/day (0,01 %) to irrigation.

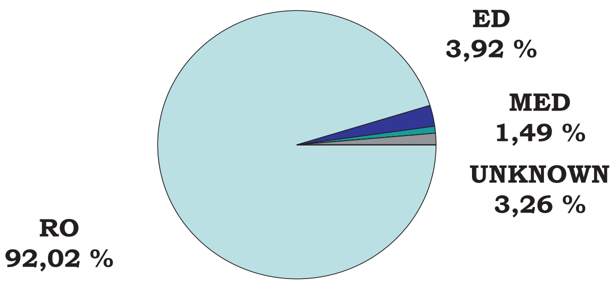
The GRAPHIC 23 represents the distribution of desalinated water uses in Israel.

Reverse osmosis is the principal method applied in Israel to produce desalinated water. 1.076.214 m^3/day (92,02 %) are provide by RO systems; 45.197 m^3/day (3,92 %) by ED; 17.432 m^3/day (1,49 %) by MED; 431 m^3/day (0,03 %) by EDI. The system applied to produce 23.000 m^3/day (1,96 %) was not reported. The GRAPHIC 24 represents the distribution of these figures.

GRAPHIC 23
Uses distribution of desalinated water in ISRAEL



GRAPHIC 24
Frecuency of water desalination methods in ISRAEL



There is information on Ashkelon Desalination Plant, the largest in the world, finished at 2006. Has a production capacity of 320.000 m^3/day, it produces the 13 % of the total country domestic consume equivalent to 5-6 % of Israel total water needs.

The leading desalination project is located near Eilat, a city on the Red Sea at the southern tip of Israel - the driest region of the country, with negligible amounts of precipitation. The population of Eilat is about 40.000 inhabitants plus an annual influx of some 500.000 tourists. Until 1997, all the drinkable water supplied to Eilat was obtained from desalination of underground brackish water.

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 37

Israel desalting plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Abu Zeghan Wells	RO	45.000	Brackish	2004	Municipal
Akko	EDI	120	Brackish	2009	Industry
Akko	EDI	72	Brackish	2009	Industry
Ashkelon	RO	326.144	Seawater	2005	Municipal
Carmel Olefins	RO	15.000	Waste		Irrigation
CCD	RO	600	Brackish		Industry
DSW	RO	600	River		Municipal
Eilat	RO	144	Pure	2002	Municipal
Eilat	RO	8.000	Seawater	1997	Municipal
Eilat Sabcha C	RO	10.000	Brackish	1993	Municipal
EPT	RO	600	Brackish		Industry
Granot	RO	9.589	Brackish	2004	Municipal
Hadera	RO	368.000	Seawater	2010	Municipal
Hadera Extension	RO	74.000	Seawater	2010	Municipal
Hadera	ED	2.400	River	2003	Municipal
Haifa	RO	5.000	Brackish	1998	Industry
Haifa	RO	3.360	River	2000	Industry
Hof Hacarmel	RO	4.800	Brackish	2001	Municipal
Israel	ED	1.920	River	1997	Municipal
Israel	ED	2.640	Brackish	2001	Municipal
Israel	ED	2.640	Seawater	2001	Municipal
Israel	ED	2.880	Seawater	2000	Municipal
Israel	EDI	239		2000	Industry
Israel	ED	818	Brackish	2000	Municipal
Israel	ED	1.419	Seawater	2000	Industry
Ketziot	RO	8.000	Brackish	2002	Municipal
Kiryat Gat	RO	3.266	Brackish		Industry
Kziot	Other	6.480	Brackish	2006	Municipal
Maagan Michael	RO	23.000	Seawater	2004	Municipal
Maagan Michael		23.000		2004	Municipal
Neve Yam	RO	6.000	Brackish	2003	Municipal
Palmachim	RO	110.000	Seawater	2007	Municipal
Qiryiat Gat	RO	1.361	Brackish		Industry
Ramat Hasahron	ED	2.400	River	2001	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 37 (Continued)

Israel desalting plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Ramot Hashavim	ED	14.400	River	2001	Municipal
Ramot Hashavin	ED	14.400	River	2001	Municipal
Sdom	RO	1.920	Brackish	1996	IndustrY
Shizaphon	RO	4.500	Brackish	2006	Municipal
Talmei Yafe	RO	20.000	Brackish	2011	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**1.124.712 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 38

Israel desalting plants presumed on line (2006)

Location	Method	Production m^3/day	Raw Water	Year	Use
Ashdod	RO	4.800	Brackish	1995	Industry
Ashdod	MED	17.032	Seawater	1982	Municipal
Ashdod Pilot 1	RO	300	Seawater	1986	Municipal
Eilat Sabha ¾	RO	8.300	Brackish	1986	Municipal
Eilat Sabha 5/6	RO	8.000	Brackish	1986	Municipal
Eilat Sabha 7/8	RO	4.500	Brackish	1995	Municipal
Eilat Sabha P1	RO	130	Brackish	1992	Municipal
Eilat Sabha P2	RO	100	Brackish	1993	Municipal
Haifa	MED	200	Brine	1984	Industry
Haifa	MED	200	Brine	1984	Industry
Maagan Michael	RO	1.200	Brackish	1994	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**44.762 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 39

Israel desalting plants under construction (2011)

Location	Method	Production m³/day	Raw Water	Year	Use
Ashdod	RO	320.000	Seawater	2013	Municipal
Ashkelon Expansión	RO	41.000	Seawater		Municipal
Palmachim Expansión	RO	40.000	Seawater		Municipal
Soreq	RO	510.000	Seawater	2013	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**55.362 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

JORDAN

ir a ÍNDICE

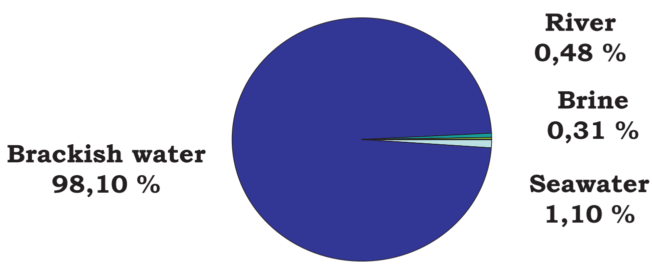
ir a ÍNDICE

JORDAN

The IDA Worldwide Desalting Plants Inventory (2011) reports on 36 desalting plants on line in Jordan which total production capacity is 245.963 m^3/day (TABLE 40); and, 3 desalting plants, with total capacity to produce 2.892 m^3/day, are presumed on line (TABLE 41). So, presumed capacity of desalinated water production is 248.855 m^3/day. This means 9,08 % of the renewable water resources of the country.

The total capacity of desalinated water production is served by 2.740 m^3/day of seawater (1.10 %); 244.137 m^3/day of brackish water (98,10 %); 1.200 m^3/day of river water (0,48 %); and 778 m^3/day of brine (0.31 %). The GRAPHIC 25 represents this distribution.

GRAPHIC 25
Desalinated water production according to feed water origin in JORDAN

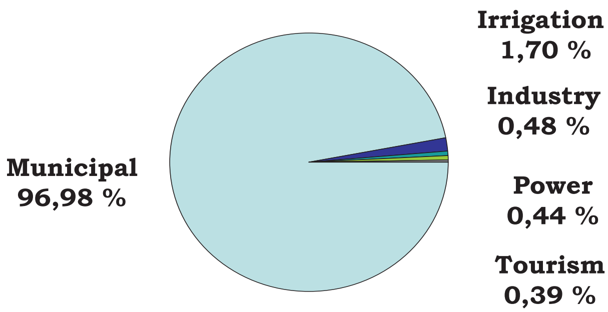


The total of desalinated water capacity is applied as follows:

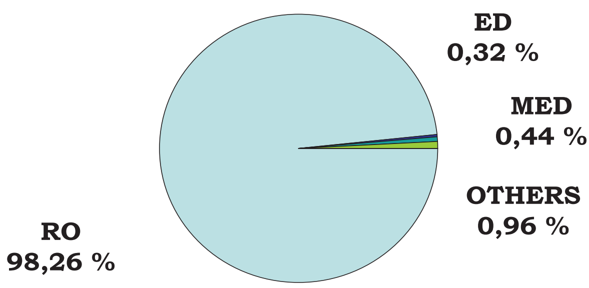
- 241.346 m^3/day (96,98 %) to municipalities.
- 4.242 m^3/day (1,70 %) to irrigation.
- 1.200 m^3/day (0,48 %) to industry.
- 1.100 m^3/day (0,44 %) to power.
- 967 m^3/day (0,39 %) to tourism.

The GRAPHIC 26 represents the distribution of water desalinated uses in Jordan.

GRAPHIC 26
Uses distribution of desalinated water in JORDAN



GRAPHIC 27
Frecuency of water desalination methods in JORDAN



Reverse osmosis is the main method used to desalt water in Jordan. According to the studied information, 244.537 m^3/day (98,26 %) are produced by plants working with RO systems; 1.100 m^3/day (0,44 %) are provided by MED plants; 818 m^3/day by ED systems (0,32 %). 2.400 m^3/day of desalinated water are produced by other methods (0,96 %). The GRAPHIC 27 represents this distribution.

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

TABLE 40

Jordan desalting plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Abu Zeghan Wells	RO	45.000	Brackish	2010	Municipal
Al Karameh Dam	RO	11.800	Brackish	2009	Municipal
Al Kraymeh	RO	2.400	Brackish	2008	Municipal
Al Qnayyed UP	Others	2.400	Brackish	2008	Municipal
Amman	RO	200	Brackish	1999	Municipal
Aqaba	MED	1.100	Seawater	1997	Power
Aqaba	RO	120	Seawater	1997	Municipal
Banana Farm	RO	982	Brackish	1999	Irrigation
Byrain UFWT	RO	2.640	Brackish	2010	Municipal
C Osmo 30 AM	RO	750	Brackish	2009	Irrigation
C Osmo 12 AM	RO	350	Brackish	2009	Irrigation
Ghor Al Safi	RO	2.400	Brackish	2005	Municipal
Ghour FIFA	RO	960	Brackish	2008	Municipal
Ghwaba	RO	312	Brackish	2008	Municipal
Jordan Valley	RO	960	Brackish	2004	Irrigation
Jordan Valley	RO	960	Brackish	2004	Municipal
Mobile Unit	RO	2.400	Brackish	2004	Municipal
Mobile Unit	RO	1.200	Brackish	2003	Municipal
Mobile Unit	RO	1.200	Brackish	2003	Municipal
Mobile Unit	RO	1.200	River	2003	Municipal
Private Banana Farm	RO	1.200	Brackish	2001	Irrigation
Private Farm	RO	1.800	Brackish	2002	Municipal
Ras El Ain	RO	24.000	Brackish	2003	Municipal
Trubeel MC	RO	168	Brackish	2003	Municipal
Wadi Kharar	RO	778	Brine	2000	Tourism
Wadi Ma'in	RO	128.767	Brackish	2005	Municipal
Jordan	ED	818	Brackish	1999	Municipal
Jordan	RO	800	Seawater	2001	Municipal
Jordan	RO	1.200	Brackish	2000	Municipal
Jordan	RO	1.680	Brackish	2001	Municipal
Jordan	RO	2.400	Brackish	2002	Municipal
Jordan	RO	720	Brackish	2002	Municipal
Jordan	RO	720	Seawater	2005	Municipal
Jordan	RO	189	Brackish	2006	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 40 (Continued)

Jordan desalting plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Jordan	RO	189	Brackish	2006	Tourism
Zara Experimental Water Well	RO	1.200	Brackish	2005	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**245.963 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 41

Jordan desalting plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Hussein TP	RO	792	Brackish	1994	Municipal
Pepsi Cola Factory	RO	900	Brackish	1992	Municipal
Jordan	RO	1.200	Brackish	2007	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**2.892 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

LEBANON

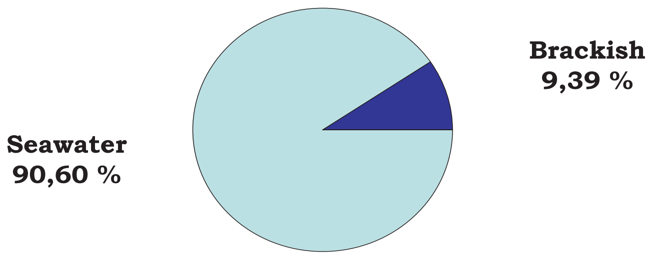
ir a ÍNDICE

LEBANON

The IDA Worldwide Desalting Plants Inventory (2011) informs on 13 desalting plants on line in Lebanon (TABLE 42) which total capacity is 20.069 m^3/day; others 7 desalting plants are presumed on line with capacity to produce 9.056 m^3/day (TABLE 43). So, the presumed water desalination capacity in Lebanon is 29.125 m^3/day. This means the 0,26 % of renewable water resources of this country.

Total capacity of desalinated water is served by 26.390 m^3/day (90,60 %) of seawater; 2.735 m^3/day (9,39 %) of brackish water. The GRAPHICS 28 represents this distribution.

GRAPHIC 28
Desalinated water production according to feed water origin in LEBANON



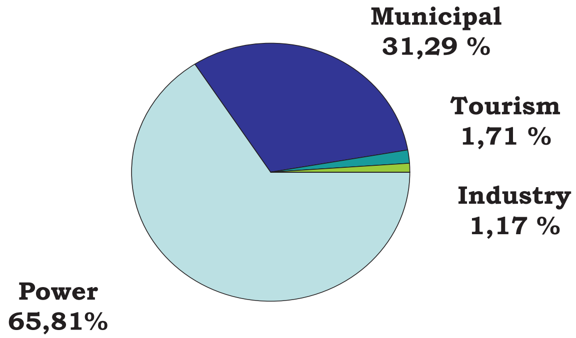
The total desalinated water capacity is applied as follows:

- 19.170 m^3/day (65,81 %) to power.
- 9.113 m^3/day (31,29 %) to municipal supply.
- 500 m^3/day (1,71 %) to tourism.
- 342 m^3/day (1,17 %) to industry.

The GRAPHIC 29 represents the distribution of desalinated water uses in Lebanon.

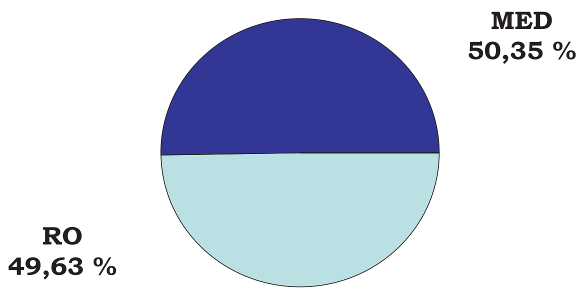
ir a ÍNDICE

GRAPHIC 29
Uses distribution of desalinated water in LEBANON



MED is the principal method of water desalination employed in Lebanon. According to the information analized, 14.670 m^3/day (50,36 %) are produced by MED systems; RO systems provides 14.455 m^3/day (49,63 %). The GRAPHIC 30 represents the distribution of these data.

GRAPHIC 30
Frecuency of water desalination methods in LEBANON



TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 42

Lebanon. Desalting plants on line (2011)

Location	Method	Production m^3/day	Raw water	Year	Use
Beirut	RO	500	Seawater		Tourism
Beirut	RO	700	Seawater	1998	Municipal
Beirut	RO	370	Seawater	1997	Municipal
Beirut	RO	1.893	Brackish	1996	Industrial
Beirut	RO	150	Brackish	1996	Municipal
Beirut	RO	96	Brackish	2009	Industry
Beirut	RO	150	Brackish	1996	Municipal
Lebanon	MED	10.560	Seawater	1996	Power
Adma	RO	150	Seawater	1997	Municipal
Adma	RO	1.800	Seawater	1999	Municipal
Jal Eldib	RO	1.500	Seawater	1998	Municipal
Beirut	RO	1.200	Seawater	2000	Municipal
Beirut	RO	1.000	Seawater	2001	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**20.069 m^3/day**	

Source: IDA Worldwide Desalting Plant Inventory (2011)

TABLE 43

Lebanon. Desalting Plants presumed on line (2011)

Location	Method	Production m^3/day	Raw water	Year	Use
Beirut	MED	1.300	Seawater	1980	Power
Beirut	MED	2.160	Seawater	1982	Power
Lebanon	RO	4.500	Seawater	1994	Power
Lebanon	RO	100	Brackish	1995	Municipal
Lebanon	RO	100	Brackish	1995	Municipal
Lebanon	RO	246	Brackish	1994	Industry
Lebanon	MED	650	Seawater	1995	Power
TOTAL CAPACITY OF WATER PRODUCTION				**9.056 m^3/day**	

Source: IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

SYRIA

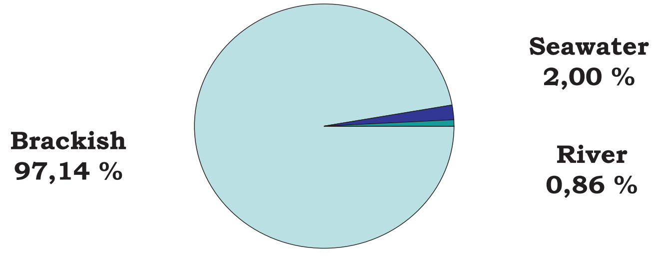
ir a ÍNDICE

SYRIA

The IDA Worldwide Desalting Plants Inventory (2011) informs on 8 desalting plants on line in Syria which total capacity is 7.893 m^3/day (TABLE 44); and 6 desalting plants, with a total capacity of 6.088 m^3/day, are considered presumed on line (TABLE 44). So, the presumed water desalination capacity is 13.981 m^3/day. This means less that 0,02 % of the renewable water resources of the country.

The total capacity of desalinated water production is served by 13.581 m^3/day of brackish water (97,14 %); 280 m^3/day of seawater (2,00 %); and 120 m^3/day of river water (0,86 %). GRAPHIC 31 represents this distribution.

GRAPHIC 31
Desalinated water production according to feed water origin in SYRIA

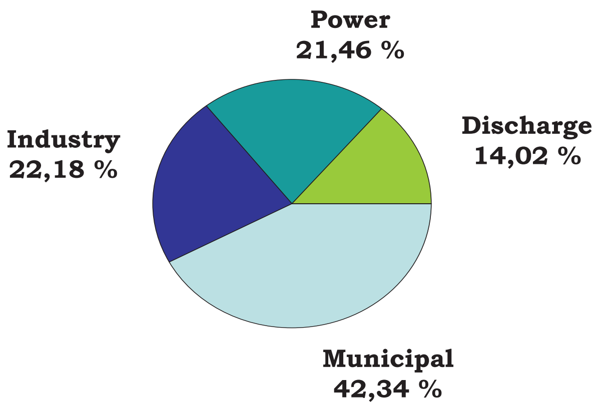


Total desalinated water capacity is applied as follows:

- 5.920 m^3/day (42,34 %) to municipalities.
- 3.101 m^3/day (22,18 %) to industry.
- 3.000 m^3/day (21,46 %) to power.
- 1.960 m^3/day (14,02 %) to discharge.

The GRAPHIC 32 represents the application of desalinated water in Syria.

GRAPHIC 32
Uses distribution of desalinated water in SYRIA



Reverse osmosis is the systems employed in 100 % of referred plants in Syria.

There is a notice about a desalting plant in construction under denomination Lafarge SCP, with capacity to produce 5.500 m3/day of desalinated water from brackish water to industrial purposes.

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 44

Syria. Desalting plants on line (2011)

Denomination /Location	Method	Production M³/day	Raw water	Year	Use
Latakia	RO	280	Seawater	1999	Municipal
Merhade	RO	5.040	Brackish	1997	Municipal
Noor CF	RO	500	Brackish		Industry
PRVOC	RO	212	Brackish	2005	Industry
Syria	RO	102	Brackish	2005	Industry
Syria	RO	600	Brackish	2006	Municipal
Syrian PC	RO	962	Brackish	2003	Industry
UJSC	RO	197	Brackish	2002	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**7.893 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 45
Syria. Desalting plants presumed on line (2011)

Denomination /Location	Method	Production M³/day	Raw water	Year	Use
Al Furat	RO	120	River	1989	Industry
Damascus	RO	480	Brackish	1994	Industry
Omar Field	RO	980	Brackish	1992	Discharge
Syria	RO	3.000	Brackish	1987	Power
Syria	RO	528	Brackish	1988	Industry
Tanak Base	RO	980	Brackish	1992	Discharge
TOTAL CAPACITY OF WATER PRODUCTION				**6.088 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

ir a ÍNDICE

TURKEY

ir a ÍNDICE

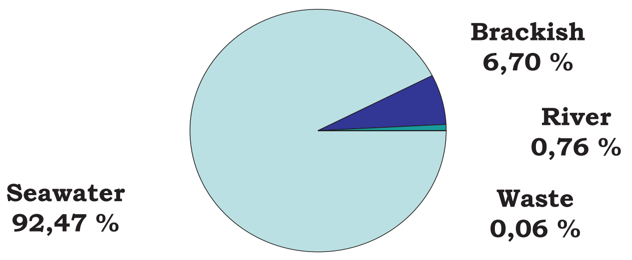
ir a ÍNDICE

TURKEY

The IDA Worldwide Desalting Plants Inventory (2011) informs on 59 desalting plants on line in Turkey since 1952 which total capacity is 457.121 m^3/day (TABLE 46); others 12 desalting plants, with capacity to produce 11.628 m^3/day, are presumed on line (TABLE 47). So, the presumed water desalination capacity is 468.749 m^3/day. This means less that 0,01 % of renewable water resources of the country.

The total capacity of desalinated water production is shared by 433.464 m^3/day (92,47 %) proceeding from seawater; 31.380 m^3/day (6,70 %) from brackish water; 3.602 m^3/day (0,76 %) from river water; and 303 m^3/day (0,06 %) from waste water. The GRAPHIC 33 represents this distribution.

GRAPHIC 33
Desalinated water production according to feed water origin in TURKEY



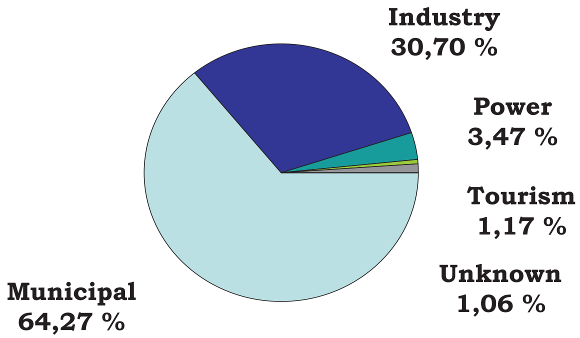
The total desalinated water capacity is applied as follows:

- 301.299 m^3/day (64,27 %) to municipalities.
- 143.923 m^3/day (30,70 %) to industry.
- 16.285 m^3/day (3,47 %) to power.
- 2.242 m^3/day (0,47 %) to tourism.

The application of 5.000 m^3/day (1,06 %) was not reported.

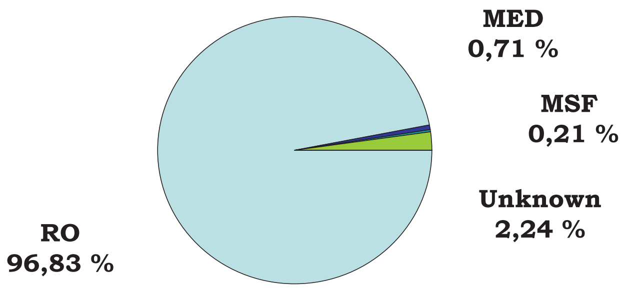
GRAPHIC 34 represents the distribution of desalinated water uses in Turkey.

GRAPHIC 34
Uses distribution of desalinated water in TURKEY



Reverse osmosis is the principal method employed in Turkey to produce desalinated water. According to the data studied, 453.889 m^3/day (96,83 %) are produced by RO systems; 3.360 m^3/day (0,71 %) by MED systems; and 1.000 m^3/day (0,21 %) by MSF. The production of 10.500 m^3/day (2,24 %) was not described. The GRAPHIC 35 represents the distribution of these figures.

GRAPHIC 35
Frecuency of water desalination methods in TURKEY



There are 11 desalting plants in construction with capacity to produce 103.248 m^3/day of desalinated water. The TABLE 48 contents a description of these plants.

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

TABLE 46

Turkey. Desalination Plants on line (2011)

Denomination/ Location	Method	Production m³/day	Raw water	Year	Use
Ankara	RO	250	Seawater	1998	Industry
Arcelik AF	RO	376	Brackish	1996	Municipal
Avsa	RO	4.000	Seawater	2008	Municipal
Bafra	RO	2.400	Seawater	2010	Municipal
Bafra Expan.	RO	4.000	Seawater		Municipal
Bandirma	RO	1.440	Seawater	2009	Municipal
Bandirma DGKAS	RO	1.440	Seawater	2009	Power
Bodrum	RO	500	Seawater		Industry
Bodrum	RO	384	Seawater		Industry
Bodrum	RO	360	Seawater		Industry
Bodrum	RO	300	Seawater	2008	Municipal
Bodrum	RO	1.000	Seawater	2008	Municipal
Cigli	RO	1.088	Brackish		Industry
Cigli Izmir	RO	600	Brackish	2009	Industry
Coca Cola	RO	1.700	Seawater		Industry
Colakoglu (Iztmit)	RO	24.000	Seawater	2007	Industry
Colakoglu Steel Mill	RO	1.800	Seawater	2008	Industry
Diler Demir	RO	12.000	Seawater	2009	Industry
Diler Steel Mill	RO	3.600	Seawater	2008	Industry
Eren Eneril	RO	17.000	Seawater	2009	Muncipal
Eren Enerji	RO	38.000	Seawater	2008	Industry
Eren Project	RO	144.000	Seawater	2009	Municipal
Hotel Aqua Star	RO	288	Seawater	2008	Tourism
ICIDAS	RO	6.000	Seawater	2008	Industry
Incirlik Air Base	RO	2.750	River	2010	Municipal
Iskenderun		5.250	Seawater	2001	Power
Iskenderun		5.250	Seawater	2010	Municipal
Istanbul	RO	720	Brackish	1998	Industry
Istanbul	RO	500	Brackish	1999	Industry
Instanbul	RO	2.000	Seawater	2005	Municipal
Istanbul	RO	8.000	Seawater	2007	Municipal
Istanbul	RO	10.000	Seawater	2008	Municipal
Istanbul	RO	4.315	Brackish	2009	Power
Istambul	RO	288	Brackish	2009	Industry
Izmir	RO	300	Seawater		Industry
Izmir	RO	240	River		Industry
Izmir	RO	1.140	Brackish	2001	Industry
Izmit Steel Mill	RO	20.000	Seawater	2007	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 46 (Continued)

Turkey. Desalination Plants on line (2011)

Denomination/ Location	Method	Production m^3/day	Raw Water	Year	Use
Kesikkopru Ankara	RO	5.000	Brackish	2009	
Kirikkale	RO	72.576	Seawater	2008	Municipal
Kusadasi	RO	1.200	Seawater		Industry
La Blanche Hotel	RO	500	Seawater	2009	Tourism
Marmara/Ereglis	MED	3.360	Seawater	1998	Power
Marmara/Ereglis	MSF	1.000	Seawater	1999	Municipal
Nuh Cimento Ex.	RO	14.000	Seawater	2009	Industry
Nuh Cimento Gulf of Izmit	RO	14.000	Seawater	2007	Municipal
OMV Samsub CCPP	RO	1.920	Seawater		Power
Samsung PP	RO	2.000	Seawater		Industry
Sea Light Hotel	RO	504	Seawater	2008	Tourism
Turkey	RO	1.440	Brackish	1999	Industry
Turkey	RO	1.440	Brackish	1999	Industry
Turkey	RO	1.440	Brackish	2000	Industry
Turkey	RO	980	Brackish	2000	Industry
Turkey	RO	1.920	Brackish	2003	Industry
Turkey	RO	900	Brackish	2003	Industry
Tukey	RO	545	Brackish	2009	Industry
Unimar	RO	4.542	Seawater	2001	Municipal
Yildiz	RO	350	Brackish	2003	Tourism
Ytong BF	RO	225	Brackish	1998	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**457.121 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 47

Turkey. Desalination Plants presumed on line (2011)

Denomination/ Location	Method	Production m³/day	Raw Water	Year	Use
Ankara	RO	120	River	1989	Industry
Ankara	RO	151	River	1995	Industry
Ankara	RO	341	River	1995	Industry
Brafra	RO	2.000	Seawater	2007	Municipal
Bodrum	RO	600	Seawater	1991	Tourism
Efes Adana	RO	2.160	Brackish	2007	Municipal
Efes Izmir	RO	2.280	Brackish	2007	Municipal
Turkey	RO	240	Brackish	1986	Industry
Turkey	RO	303	Waste	1991	Industry
Turkey	RO	201	Brackish	1992	Industry
Turkey	RO	352	Brackish	1995	Industry
Turkey	RO	2.880	Brackish	2007	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**11.628 m³/day**	

Source: IDA Worldwide Desalting Plant Inventory (2011)

TABLE 48

Turkey. Desalting Plants under construction (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Bala	RO	4.800	Brackish	2012	Municipal
Biga SW	RO	4.000	Seawater		Industry
ICDAS Steel Mill	RO	6.000	Seawater	2012	Industry
Diler Steel Mill	RO	3.600	Seawater	2012	Industry
Diler Steel Mill	RO	1.320	River	2012	Industry
Isis Hotel	RO	560	Seawater	2012	Tourism
Karabuck	RO	44.000	River		Municipal
Enka Power	RO	1.848	River	2012	Power
Enka Aliaga 1500MW	RO	1.800	Seawater	2012	Power
Steel Mill MMK Atakas	RO	31.000	Seawater		Industry
Ozkan Steel Mill	RO	4.320	Brackish	2012	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**103.248 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

GREECE

ir a ÍNDICE

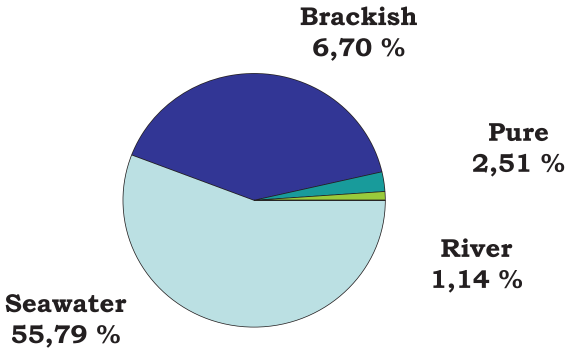
ir a ÍNDICE

GREECE

The IDA Worldwide Desalting Plants Inventory (2011), informs on 157 desalting plants on line in Greece with a total capacity to produce 109.115 m^3/day (TABLE 49); and 35 desalting plants, with a total capacity of 40.135 m^3/day, are presumed on line (TABLE 50). So, the presumed water desalination capacity in Greece is 149.250 m^3/day. This means around 0,07 % of its renewable resources.

The total capacity of desalinated water production is shared by 83.276 m^3/day (55,79 %) proceeding from seawater; 60.524 m^3/day (40,55 %) from brackish water; 3.750 m^3/day (2,51 %) from pure water; and 1.700 m^3/day (1,14 %) from river water. The GRAPHIC 36 represents this distribution.

GRAPHIC 36
Desalinated water production according to feed water origin in GREECE



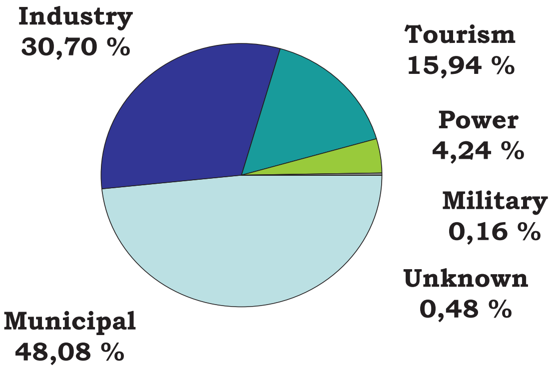
The total desalinated water capacity in applied as follows:

- 71.764 m^3/day (48,08 %) to municipalities.
- 46.375 m^3/day (31,07 %) to industry.
- 23.801 m^3/day (15,94 %) to tourism.
- 6.340 m^3/day (4,24 %) to power.
- 250 m^3/day (0,16 %) to military.
-

The use of 720 m^3/day (0,48 %) was not reported.

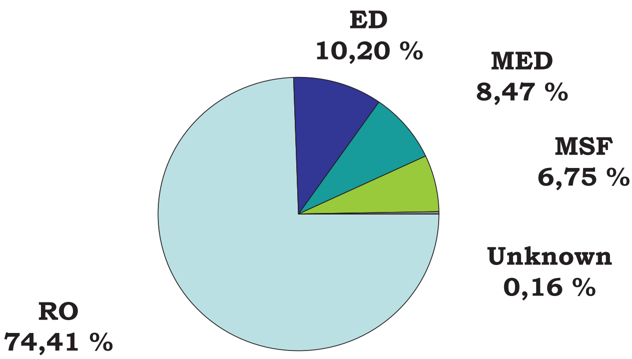
GRAPHIC 37 represents the distribution of desalinated water uses in Greece.

GRAPHIC 37
Uses distribution of desalinated water in GREECE



Reverse osmosis is the principal method employed in Greece to produce desalinated water. According to the data studied, 111.060 m³/day (74,41 %) are produced by RO systems; 15.220 m³/day (10,20 %) by ED; 12.640 m³/day (8,47 %) by MED; and 10.080 m³/day (6,75 %) by MSF. The method applied to produce 250 m³/day (0,16 %) was not reported. The GRAPHIC 38 represents the distribution of these figures.

GRAPHIC 38
Frecuency of water desalination methods in GREECE



The IDA reported on five desalting plants under construction in 2011 with capacity to produce 32.800 m^3/day of desalinated water. TABLE 51 contents data about these plants.

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

TABLE 49

Greece installed desalting plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
AG Georgius	RO	500	Brackish	2002	Municipal
AG Nikolau	RO	380	Seawater		Tourism
Agios Georgios PPC	RO	1.000	Seawater		Industry
Alimounda Mare Hotel	RO	200	Seawater	2010	Tourism
Aliveri	RO	480	Brackish	2003	Power
Anthusa Resort	RO	210	Brackish	2008	Tourism
Apladas Beach, Crete	RO	110	Brackish	2008	Tourism
Argat Larfaga	RO	1.200	Seawater	2007	Industry
Argos	RO	180	Brackish	1996	Industry
Argos	RO	180	Brackish	1997	Industry
Aspis SA K. Dedes, Veroia	RO	170	Brackish	2007	Industry
Astir Beach Hotel, Crete	RO	130	Brackish	2007	Tourism
Athena SA	ED	720	Seawater	2007	
Athena SA	MED	720	Seawater	2007	Municipal
Athens	MED	1.920	Seawater	1999	Industry
Atrium Palace Hotel	RO	200	Brackish		Tourism
Atrium Platinum Hotel	RO	300	Brackish		Tourism
Blue Horizon Hotel	RO	230	Brackish	2008	Tourism
Blue Lagoon Village	RO	1.300	Brackish		Tourism
Calder Palace Hotel	RO	400	Brackish	2008	Tourism
Cassiopi	RO	500	Brackish	2001	Municipal
Chios Island	RO	600	Brackish	2000	Municipal
Chios Island	RO	750	Brackish	2001	Municipal
Chios Island	RO	1.000	Seawater		Industry
Corfu	RO	250	Seawater	2004	Tourism
Corinth	MSF	5.280	Seawater	2005	Industry
Cosmos Profil SA	RO	225	Brackish	2008	Industry
Costa Navarino RH	RO	500	Brackish		Tourism
Creta FGC	RO	260	Brackish	2009	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 49 (Continued)

Greece installed desalting plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Crete	RO	120	Seawater	2002	Tourism
Crete	RO	144	Brackish	2002	Tourism
Crete	RO	240	Brackish	2002	Tourism
Crete	RO	240	Brackish	2002	Tourism
Crete	RO	100	Brackish	2003	Tourism
Crete	RO	400	Brackish	2001	Tourism
Crete	RO	400	Brackish	2001	Power
Crete	RO	400	Brackish	2003	Tourism
Crete	MED	1.600	Seawater	2004	Power
Crete	RO	1.000	Seawater		Industry
Crete, Golf Residensis	RO	240	Brackis	2007	Tourism
Crete, Hatzakis Laundries	RO	235	Brackish	2007	Industry
Crete OSMO SHR 20 AM	RO	250	Seawater	2007	Tourism
Drymou Glass House	RO	220	Brackish	2008	Industry
Elter SA	RO	305	Brackish	2009	Tourism
Elval, Schimatari	RO	185	Brackish	2007	Industry
Ermoni	RO	700	Brackish	2001	Tourism
Ermoni	RO	700	Brackish	2001	Tourism
Ermoupolis WSSC	RO	1.590	Seawater	2007	Municipal
Evia Island	RO	160	Brackish	1998	Industry
Evia Island	RO	400	Brackish	2002	Tourism
Famar, Avióna	RO	100	Pure		Industry
Family Village, Kos Island	RO	200	Brackish	2008	Tourism
GR Inox	RO	700	Brackish		Municipal
Greece	RO	600	Seawater	1996	Municipal
Greece	RO	100	Seawater	1997	Tourism
Greece	RO	425	Brackish	1999	Municipal
Greece	RO	750	Brackish	1999	Tourism
Greece	RO	425	Brackish	1999	Municipal
Greece	RO	750	Brackish	1999	Tourism
Greece	RO	1.500	River	2001	Municipal
Greece	RO	568	Seawater	2001	Municipal
Greece	RO	1.200	Seawater	2001	Municipal
Greece	RO	600	Seawater	2003	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 49 (Continued)

Greece installed desalting plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Greece	RO	384	Seawater	2004	Municipal
Greece	EDI	1.152	Brackish	2009	Industry
Greece	RO	1.172	Brackish	2009	Industry
Grecotel Elounda Village, Agios Giorgios	RO	100	Seawater	2003	Municipal
Grekoi Bros	RO	340	Brackish	2008	Industry
Heraklion	RO	288	Brackish	1997	Industry
Heraklion	RO	860	Brackish	1998	Power
Hotel Alounda	RO	336	Seawater	2008	Tourism
Hotel Elysium, Rhodes	RO	200	Seawater	2008	Tourism
Hotel Nana Beach	RO	336	Seawater	2008	Tourism
Hotel Sifnos, Agios Georgios	RO	200	Seawater	2002	Municipal
Hraklhs	RO	1.300	Seawater	2007	Tourism
Ithaki Island	RO	535	Seawater		Municipal
Ios Island	RO	1.000	Seawater		Industry
Ios Island	RO	1.000	Seawater		Muncipal
Johnson & Johnson SA, Attica	RO	200	Brackish		Industry
Johnson & Johnson Hellas SA	RO	228	Brackish	2007	Industry
Johnson & Johnson SA, Mándra	RO	200	River	2009	Industry
Kalithea Mare	RO	300	Brackish		Tourism
Kimolos Island	RO	100	Seawater	1996	Municipal
Korres, Oinófita	RO	104	Brackish	2007	Industry
Kozani MUWS	RO	300	Brackish	2009	Industry
Kresten Palace Hotel	RO	300	Brackish		Tourism
Krommidakis SA	RO	400	Seawater	2009	Tourism
Laguna Resort Hotel	RO	720	Seawater		Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 49 (Continued)

Greece installed desalting plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw Water	Year	Use
Lavrion	MED	2.400	Seawater	1998	Power
Leros Island	RO	240	Brackish	2001	Municipal
Lindos Princess Hotel	RO	450	Brackish	2007	Municipal
Linoperamata PPC	RO	1.000	Seawater		Muncipal
Liveris SA, Rhodes	RO	200	Brackish	2008	Tourism
Lutania Hotel Rodhes	RO	250	Brackish		Tourism
Mast Foods SA	RO	228	Brackish	2009	Industry
MEWSMVA	RO	5.000	Brackish	2009	Municipal
Miramare Resort Hotel	RO	270	Brackish		Tourism
Moiragestis Gioba Barca SA	RO	240	Brackish	2009	Industry
Municipal Enterprise of Water and Sewage Meizonos Volos Area	RO	4.500	Seawater	2008	Municipal
Municipality of Ios	RO	500	Seawater	2002	Municipal
Myconos	RO	2.000	Seawater	2001	Municipal
Mykonos	RO	4.500	Seawater	2008	Tourism
Mykonos WSSC	RO	4.500	Seawater	2008	Municipal
Mykonos WSSC	RO	600	Seawater	2009	Municipal
Nana Beach	RO	360	Seawater	2008	Tourism
Nissaki Beach	RO	200	Seawater	2006	Municipal
Nissyros	RO	300	Seawater	2001	Municipal
Ocean Blue Resort, Rodos	RO	165	Brackish	2007	Tourism
Oeanis Hotel	RO	300	Brackish	2008	Tourism
Olympic Brewery SA	RO	350	Brackish	2009	Industry
Osmo 4AM, Crete	RO	100	Pure	2007	Industry
Pentheon Hotel, Crete	RO	165	Brackish	2007	Tourism
Paros Island	RO	1.200	Brackish	2001	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 49 (Continued)

Greece installed desalting plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Paros Island	RO	1.200	Brackish	2001	Municipal
Paros Island	RO	2.600	Seawater		Industry
Patmos Aktis Hotel, Patmos	RO	120	Brackish		Tourism
Paxoi Mun.	RO	250	Seawater	2007	Municipal
Rhodes	RO	280	Brackish	2009	Tourism
Rodopi SA	RO	750	Brackish		Industry
Rodos Paladium Hotel, Rodos	RO	200	Seawater	2008	Tourism
Shelman	RO	340	Brackish	2007	Industry
Sifnos Mun. Johnson & Johnson Hellas SA	RO	250	Seawater	2001	Municipal
Sifnos	RO	500	Seawater	2008	Municipal
Sifnos Island	RO	1.800	Seawater	2008	Municipal
Sifnos Island	RO	750	Brachish	2008	Municipal
Small Town Hotel Crete	RO	280	Brackish	2008	Tourism
Souranakis SA, Crete	RO	200	Brackish	2009	Tourism
Sovel SA	RO	2.400	Brackish	2008	Industry
Sovel SA	RO	1.200	Brackish		Industry
Spetsopoula Island	RO	300	Seawater		Industry
Stella Village Hotel	RO	300	Brackish	2008	Tourism
Sunshine Corfu Hotel	RO	360	Seawater	2008	Tourism
Sunshine Vacation Hotel	RO	300	Brackish		Tourism
Sunshine Vacation Hotel	RO	220	Brackish		Tourism
Symi Island	RO	550	Seawater	2007	Municipal
Symi Island	RO	600	Seawater	2008	Municipal
Syros	RO	600	Seawater	1997	Municipal
Syros	RO	150	Pure	1997	Industry
Syros		250	Seawater	1997	Industry
Syros	RO	500	Seawater	1998	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 49 (Continued)

Greece installed desalting plants on line (2011)

Location	Method	Production m^3/day	Raw water	Year	Use
Syros	RO	250	Seawater	2000	Municipal
Syros	RO	500	Seawater	2001	Municipal
Syros	RO	500	Seawater	2002	Municipal
Syros	RO	500	Seawater	2002	Municipal
Syros	RO	2.000	Seawater	2002	Municipal
Temes SA	RO	1.000	Brackish	2010	Municipal
Thessaloniki	RO	960	Brackish	1997	Industry
Thessaloniki	RO	1.000	Pure	1999	Industry
Thessaloniki	RO	1.000	Brackish	1999	Industry
Thessaloniki	MED	600	Seawater	2004	Power
Thira Island	RO	320	Seawater	2001	Municipal
Thira Island	RO	160	Seawater	2002	Municipal
Tholari Tourism&H	RO	1.000	Seawater	2009	Tourism
Tinos Island	RO	1.000	Seawater	2001	Municipal
Troulis	RO	210	Brackish	2009	Tourism
Vivartia SA	RO	350	Brackish	2009	Industry
Zeva	RO	1.000	Seawater		Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**109.115 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 50

Greece. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Athens	MED	3.600	Seawater	1993	Industry
Chalkis	RO	230	Brackish	1995	Industry
Chios Island	RO	1.920	Seawater	1995	Industry
Corfu	ED	14.500	Brackish	1978	Municipal
Corfu	RO	144	Brackish	1986	Industry
Corfu	RO	120	Brackish	2006	Tourism
Corinth	MSF	2.400	Seawater	1980	Industry
Corinth	MSF	2.400	Seawater	1984	Industry
Crete	RO	144	Brackish	2006	Industry
Delta Dairy, Athens	RO	1.300	Brackish	2006	Municipal
Distion, Evia Island	RO	480	Brackish	2007	Municipal
Ermoupolis	RO	740	Seawater	2006	Municipal
Greece	RO	473	Seawater	1992	Municipal
Ithaca Island	RO	500	Seawater	1984	Municipal
Limnos Village Hotel, Lemnos	RO	290	Brackish	2008	Municipal
Myconos	RO	1.200	Seawater	1989	Municipal
Neamakri	RO	250	Brackish	1986	Military
Nissyros	RO	300	Seawater	1990	Municipal
Nissyros	RO	300	Seawater	1991	Municipal
Oceanking Maritime, Piraeus	RO	100	Seawater	1992	Muncipal
Offshore	MED	1.800	Seawater	1980	Industry
Osmo 12 AM, Corfu	RO	300	Brackish	2006	Industry
Osmo 8 AM, Corfu	RO	190	Brackish	2006	Industry
Osmo 8 AM, Corfu	RO	190	Brackish	2006	Industry
Patras	RO	2.400	Pure	1991	Industry
Paxoi	RO	264	Seawater	2007	Municipal
Santorini Palace Hotel, Santorini	RO	130	Brackish	2007	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 50 (Continued)

Greece. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
SHR 25 AM, Aegina	RO	500	Seawater	2007	Municipal
Sifakis Laundries, Crete	RO	310	Brackish	2006	Municipal
Syros	RO	1.200	Seawater	1989	Municipal
Syros		140	Seawater	1993	Municipal
Syros		140	Seawater	1993	Municipal
Syros	RO	800	Seawater	1993	Municipal
Syros	RO	140	Seawater	1993	Municipal
Tsipokas Laundries, Nafplion	RO	240	Brackish	2006	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**40.135 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 51

Greece. Desalting Plants under construction (2011)

Denomination /Location	Method	Production m³/day	Raw Water	Year	Use
Aquis Hotel Resorts, Crete	RO	200	Seawater		Tourism
Greek Islands (Formely Cycladic Islands)	RO	31.500	Seawater		Municipal
La Marquise Hotel, Rhodes	RO	450	Brackish		Tourism
Pelagos SA, Pélagos	RO	450	Brackish		Tourism
Osmo B 8 AM, Athens	RO	200	Brackish		Industry
TOTAL CAPACITY OF WATER PRODUCTION				**32.800 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

CYPRUS

ir a ÍNDICE

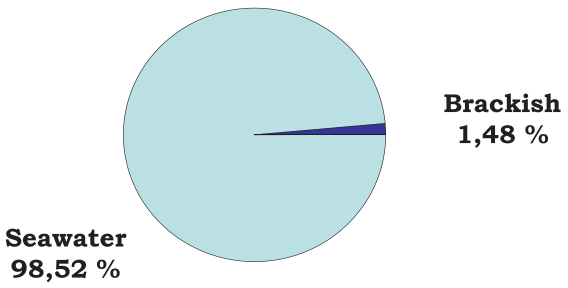
CYPRUS

According to the information provided by Water Development Department of Republic of Cyprus, the evolution of desalinated water production capacity ranged from 6.4 million cubic meters per year in 1997 till 30 million cubic meters per year in 2002)[72].

The IDA Worldwide Desalting Plants Inventory (2011) informs on 17 desalting plants on line which total capacity to produce 223.529 m^3/day (TABLE 52); others 6 desalting plants which total capacity of production is 5.324 m^3/day, are presumed on line (TABLE 53). So, the presumed water desalination capacity in Cyprus is 228.853 m^3/day equivalent to 83,53 millions of cubic meters per year. This means around the 10 % of the total renewable hydric resources of this country.

The total capacity of desalinated water production is shared by 225.457 m^3/day (98,52 %) proceeding from seawater and 3.396 m^3/day (1,48 %) of brackish water. The GRAPHIC 39 represents this distribution.

GRAPHIC 39
Desalinated water production according to feed water origin in CYPRUS



The total of desalinated water capacity is applied as follows:

- 194.675 m^3/day (85,06 %) to municipalities.
- 24.504 m^3/day (10,70 %) to tourism.

[72] Getimis, P., Markantonis, V. (2003). Current Status of Water Sector Restructuring in Cyprus.Panteion University, Athens.

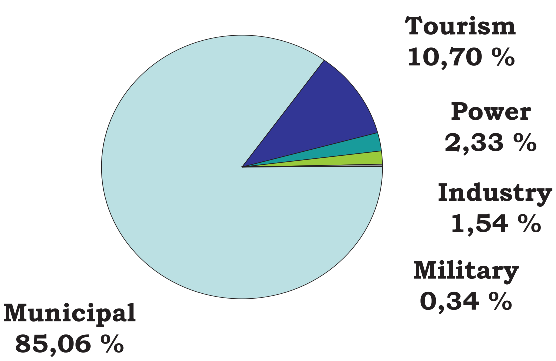
- 5.340 m^3/day (2,33 %) to power.

- 3.534 m^3/day (1,54 %) to industry.

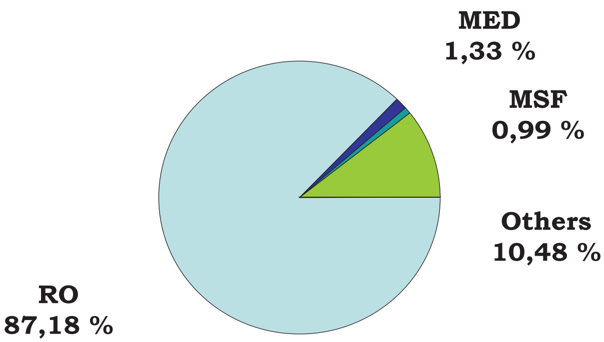
- 800 m^3/day (0,34 %) to military.

GRAPHIC 40 represents the distribution of desalinated water uses in Cyprus.

GRAPHIC 40
Uses distribution of desalinated water in CYPRUS



GRAPHIC 41
Frecuency of water desalination methods in CYPRUS



ir a ÍNDICE

Reverse osmosis is the principal method employed in Cyprus to produce desalinated water. According to the data studied, 199.513 m^3/day (87,18 %) are produced by RO systems; 3.060 m^3/day by MED (1,33); 2.280 m^3/day (0,99 %) by MSF. The method applied to produce 24.000 m^3/day (10,48 %) was not reported. The GRAPHIC 41 represents this distribution.

At the end of 2011, 5 desalting plants with capacity to produce 176.350 m^3/day were under construction in Cyprus (TABLE 54).

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

TABLE 52

Cyprus. Desaltin plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw Water	Year	Use
Aristo	RO	850	Seawater	2010	Municipal
Ayios Nikolaos	RO	300	Brackish	1999	Military
Caramondani, Dekhelia	RO	325	Seawater	2000	Municipal
Caramondani, Dekhelia	Other	24.000	Seawater	2007	Tourism
Dhekelia	RO	40.000	Seawater	1998	Municipal
Dhekelia	RO	500	Seawater	2001	Military
Dhekelia Ex.	RO	20.000	Seawater	2007	Municipal
Hotel	RO	504	Seawater	2008	Tourism
Larnaca	RO	54.000	Seawater	2001	Municipal
Larnaca	RO	9.000	Seawater	2004	Municipal
Larnaca Ex.	RO	10.000	Seawater	2008	Municipal
Moni Temporary	RO	20.000	Seawater	2008	Municipal
Nicosia	RO	1.200	Brackish	2001	Industry
Palm Beach	RO	150	Seawater		Industry
Paphos	RO	40.000	Seawater	2011	Municipal
Vasilikos	MED	900	Seawater		Power
Vasilikos	MED	1.800	Seawater	1999	Power
TOTAL CAPACITY OF WATER PRODUCTION				**223.529 m³/day**	

Source: IDA Worldwide Desalting Plant Inventory (2011)

TABLE 53

Cyprus. Desalting plants presumed on line (2011)

Location	Method	Production m³/day	Raw Water	Year	Use
CSWRO	RO	500	Seawater	2006	Municipal
Dhekelia	MSF	1.440	Seawater	1982	Power
Dhekelia	MSF	840	Seawater	1992	Power
Lefkosa, Mersin	RO	288	Seawater	2006	Industry
Moni	MED	360	Seawater	1993	Power
Vasilikos	RO	1.896	Brackish	1980	Industrial
TOTAL CAPACITY OF WATER PRODUCTION				**5.324 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 54

Cyprus. Desalting plants under construction (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Episkopi, Limasol	RO	40.000	Seawater		Municipal
Kunkoi/Morphou	RO	24.000	Seawater	2012	Tourism
Larnaca	RO	52.000	Seawater		Municipal
Nuh´un Gemisi Hotel	RO	350	River		Tourism
Vassilikos Power Station	RO	60.000	Seawater	2012	Power
TOTAL CAPACITY OF WATER PRODUCTION				**176.350 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

MALTA

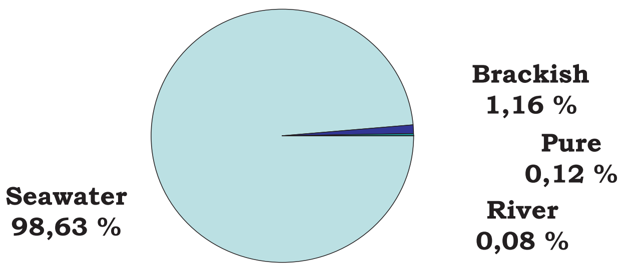
ir a ÍNDICE

MALTA

The IDA Worldwide Desalination Plants Inventory (2011) informs on 15 desalting plants on line in Malta which total capacity is 131.273 m^3/day (TABLE 55); and 16 desalting plants presumed on line with capacity to produce 119.878 m^3/day (TABLE 56). So, the presumed water desalination capacity in Malta is 251.151 m^3/day. This means 183 % of natural renewable resources of this country.

The total capacity of desalinated water production is shared by 247.720 m^3/day (98,63 %) proceeding from seawater; 2.931 m^3/day (1,16 %) from brackish water; 300 m^3/day (0,12 %) from pure water; and 200 m^3/day (0,08 %) from river. The GRAPHIC 42 represents this distribution.

GRAPHIC 42
Desalinated water production according to feed water origin in MALTA



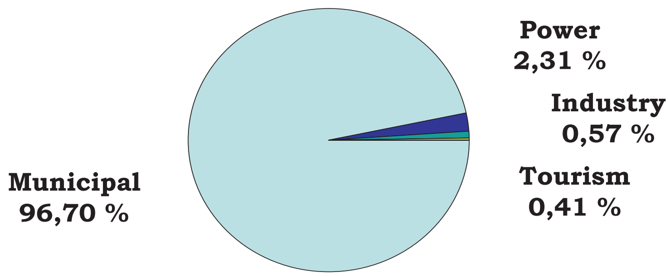
The total of desalinated water capacity is applied as follows:

- 242.876 m^3/day (96,70 %) to municipalities.
- 5.800 m^3/day (2,31 %) to power.
- 1.430 m^3/day (0,57 %) to industry.
- 1.045 m^3/day (0,41 %) to tourism.

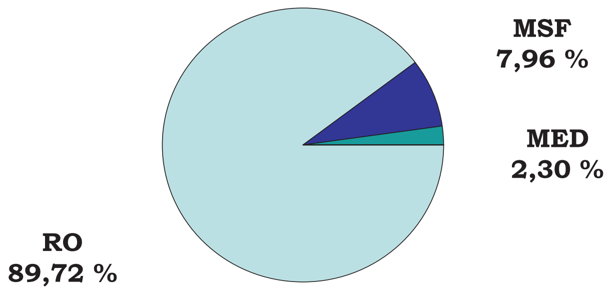
GRAPHIC 43 represents the distribution of desalinated water uses in Malta.

Reverse osmosis is the principal method employed in Malta to produce desalinated water. According to the data studied, 225.351 m³/day (89,72 %) are produced by RO systems; 20.000 m³/day (7,96 %) by MSF; and 5.800 m³/day (2,30 %) by MED. GRAPHIC 44 represents the distribution of these figures.

GRAPHIC 43
Uses distribution of desalinated water in MALTA



GRAPHIC 44
Frecuency of water desalination methods in MALTA



TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

TABLE 55

Malta. Desalting plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw Water	Year	Use
Aqua Cleer MFP 4, Birkirkara	RO	300	Pure	2007	Industry
Delimara	MED	1.400	Seawater	1997	Power
Delimara DP	MED	1.500	Seawater	2010	Power
Gel Malta	RO	200	Seawater	2006	Municipal
Ghar Lapsi II	RO	50.000	Seawater	2008	Municipal
Hilton Malta	RO	150	Seawater	1999	Municipal
Malta	RO	300	Seawater	1996	Tourism
Malta	RO	108	Brackish	1996	Municipal
Malta	RO	100	Brackish	2000	Industry
Malta	RO	150	Brackish	2002	Industry
Malta	RO	245	Seawater	2004	Municipal
Malta	RO	40.500	Seawater	2006	Municipal
Malta	RO	200	River	2009	Tourism
Pembroke	RO	36.000	Seawater	2007	Municipal
Radison Baypoint Hotel	RO	120	Seawater	1996	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**131.273 m^3/day**	

Source: IDA Worldwide Desalting Plant Inventory (2011)

TABLE 56

Malta. Desalting plants presumed on line (2011)

Denomination /Location	Method	Production m^3/day	Raw Water	Year	Use
Cirkewwa	RO	18.600	Seawater	1989	Municipal
Cirkewwa	RO	9.900	Seawater	2007	Municipal
Comino	RO	305	Seawater	1987	Tourism
Ghar Lapsi	RO	4.000	Seawater	1986	Municipal
Ghar Lapsi	RO	7.600	Seawater	2007	Muncipal
Malta	ED	550	Brackish	1989	Industry
Malta	RO	240	Brackish	1991	Tourism
Malta	RO	120	Brackish	1992	Industry
Malta	MED	1.400	Seawater	1991	Power
Marsa	MED	1.500	Seawater	1993	Power
Marsa	RO	1.453	Brackish	1987	Municipal
Mlita	MSF	20.000	Seawater	1995	Municipal
Pembroke	RO	8.800	Seawater	1993	Municipal
Pembroke	RO	17.600	Seawater	1991	Municipal
Pembroke	RO	27.600	Seawater	1994	Municipal
Qormi	RO	210	Brackish	1994	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**119.878 m^3/day**	

Source: IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

ITALY

ir a ÍNDICE

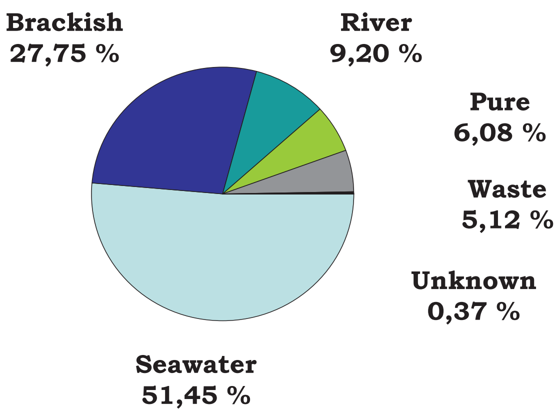
ir a ÍNDICE

ITALY

The IDA Worldwide Desalting Plants Inventory (2011), informs about 195 desalting plants on line in Italy with capacity to produce 361.558 m^3/day (TABLE 57) and 124 desalting plants, with capacity to produce 337.333 m^3/day, are presumed on line (TABLE 58). So, the presumed water desalination capacity is 698.891 m^3/day. This means the 0,13 % of renewable water resources in Italy.

The total capacity of desalinated water production is shared by 359.602 m^3/day (51,45 %) proceeding from seawater; 193.934 m^3/day (27,75 %) from brackish water; 64.352 m^3/day (9,20 %) from river water; 42.492 m^3/day (6,08 %) from pure water; 35.671 m^3/day (5,10 %) from waste water. The origin of 2.640 m^3/day (0,37 %) was not reported. The GRAPHIC 45 represents this distribution.

GRAPHIC 45
Desalinated water production according to feed water origin in ITALY



The total of desalinated water capacity is applied as follows:

- 406.372 m^3/day (58,14 %) to industry.
- 188.452 m^3/day (26,96 %) to municipalities.
- 73.053 m^3/day (10,45 %) to power.
- 12.656 m^3/day (1,81 %) to military.
- 11.958 m^3/day (1,71 %) to irrigation

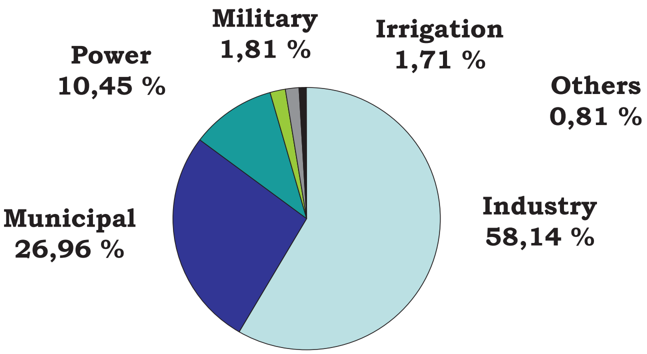
- 3.470 m³/day (0,50 %) to discharge.

- 2.210 m³/day (0,31 %) to tourism.

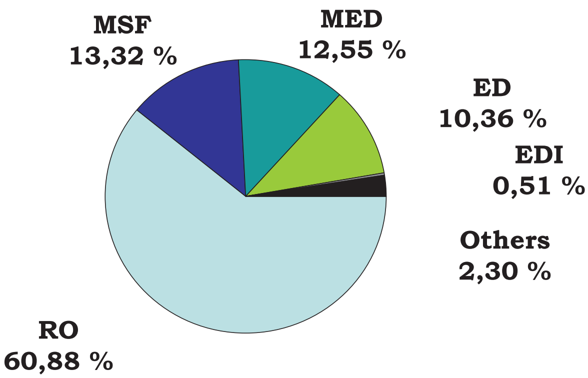
- 720 m³/day (0,10 %) to demonstration.

GRAPHIC 46 represents the distribution of desalinated water uses in Italy.

GRAPHIC 46
Uses distribution of desalinated water in ITALY



GRAPHIC 47
Frecuency of water desalination methods in ITALY



Reverse osmosis is the principal method employed in Italy to produce desalinated water. According to the analyzed data, 425.482 m^3/day (60,88 %) are produced by RO systems; MSF systems provide 93.134 m^3/day (13,32 %); MED, 87.751 m^3/day (12,55 %); ED, 72.416 m^3/day (10,36 %); EDI, 3.596 m^3/day (0,51 %); and 16.512 m^3/day (2,30 %) by others. The GRAPHIC 47 represents the distribution of these figures.

ir a ÍNDICE

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

TABLE 57

Italy. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Agrate	RO	4.300	Pure water	1998	Industry
Agrate Brianza	RO	720	Pure water	2000	Industry
Agrate Brianza	RO	120	Pure water	2002	Industry
Agrate Brianza	EDI	216	Pure water	2001	Industry
Agrate Brianza	RO	250	Pure water	2001	Industry
Ancona	RO	100	Brackish	2000	Industry
Ancona	RO	240	Brackish	1997	Industry
Ancona	RO	1.320	Brackish	1998	Municipal
Aqua Cleer IWE 20, Bologna	RO	380	Brackish	2007	Industry
Aqua Cleer IWE 20, Catania	RO	240	Brackish	2007	Municipal
Aqua Clerr IW 5, Isernia	RO	100	Brackish	2007	Power
Aqua Cleer IWE 20, Lucca	RO	800	Brackish	2007	Industry
Aqua Cleer IWE 20, Milano	EDI	40	Brackish	2007	Industry
Aqua Cleer IWE 20, Padova	EDI	240	Brackish	2007	Industry
Aqua Cleer IWE 20, Parma	RO	720	Brackish	2007	Municipal
Aqua Cleer IWE 20, Ravena	EDI	288	Brackish	2007	Industry
Aqua Cleer IWE 5, Tarento	RO	120	Brackish	2007	Industry
Ascoli Piceno	RO	100	Brackish	2000	Industry
Ascoli Piceno	RO	120	Brackish	1997	Irrigation
Assemini	RO	3.120	Brackish	2006	Industry
Bari	RO	144	Brackish	1999	Irrigation
Bari	RO	360	Brackish	2003	Industry
Black Water Treatment System	Other	960	Waste	2009	Discharge
Bra	RO	120	River	2009	Industry
Brindisi	RO	100	Brackish	2002	Irrigation
Brindisi	RO	100	Brackish	2003	Irrigation
Cagliari	RO	288	Waste	2002	Industry
Cagliari	RO	330	Brackish	2001	Industry
Cagliari	RO	3.500	Brackish	2000	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 57 (Continued)

Italy. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Cap Milano, Milano	RO	6.480	Pure	2000	Municipal
Caserta	RO	240	Brackish	1997	Irrigation
Caserta	RO	480	Brackish	2001	Power
Catania	RO	8.172	River	1994	Industry
Catania	ED	2.500	Brackish	1996	Military
CBWRO 25 AM, Cuneo	RO	600	Brackish	2007	Industry
Como	RO	264	Brackish		Industry
CONC 800 NF EEXD	RO	800	Seawater		Industry
CONC 400 UF EEXD	RO	400	Seawater		Industry
Cuneo	RO	192	Brackish	2003	Industry
Desalination Pakage TOWN 800 DPLX	RO	1.600	Brackish		Industry
Enel Vado Ligure	RO	5.700	Waste	2004	Industry
Ferentino	RO	192	River	2009	Industry
Firenze	RO	288	Brackish	1999	Power
Firenze/Lonate	RO	1.200	Brackish	2006	Municipal
Foggia	RO	100	Brackish	2002	Municipal
Foggia	RO	120	Brackish	2003	Municipal
Foggia	RO	230	Brackish	2002	Irrigation
Foggia	RO	500	Brackish	2000	Industry
Foggia	RO	500	Brackish	2001	Industry
Foggia	RO	570	Brackish	2002	Industry
Foggia	RO	580	Brackish	2001	Industry
Foggia	RO	720	Brackish	2001	Industry
Frosinone	RO	120	Waste	1997	Industry
Frosinone industry	RO	100	Pure	2009	Industry
Gela	RO	5.040	Brackish	2006	Industry
Gela	MSF	14.400	Seawater	2000	Industry
Gela	MSF	17.280	Seawater	2001	Municipal
Gela	RO	5.040	Brackish	2006	Industry
Genoa	RO	154	Seawater	2006	Municipal
HD 6 AM, Foggia	RO	150	Brackish	2007	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 57 (Continued)

Italy. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
HD 6 AM, Milano	RO	180	Pure	2007	Tourism
HD 6 AM, Sicily	RO	150	Brackish	2006	Irrigation
Ionex Pharm	RO	30	Pure		Industry
Italy	RO	2.400	Brackish	1998	Industry
Italy	RO	1.900	Seawater	1999	Industry
Italy	RO	1.000	Brackish	2000	Power
Italy	RO	240	Brackish	2001	Power
Italy	EDI	272	Seawater	2001	Power
Italy	EDI	1.090	Seawater	2001	Power
Italy	RO	1.100	Brackish	2001	Power
Italy	EDI	1.090	Seawater	2001	Power
Italy	RO	1.200	Brackish	2001	Power
Italy	RO	1.500	Brackish	2001	Power
Italy	RO	3.500	Brackish	2001	Municipal
Italy	RO	500	Seawater	2002	Industry
Italy	ED	1.000	Waste	2002	Industry
Italy	RO	336	River	2009	Industry
Italy	RO	336	River	2009	Industry
Italy	RO	336	River	2009	Industry
Latina	RO	100	Brackish	2003	Irrigation
Latina	RO	144	Brackish	1999	Industry
Latina	RO	144	Brackish	2000	Industry
Latina	RO	500	Brackish	2000	Industry
Latina	RO	100	Brackish	2003	Irrigation
Mestre	RO	336	Pure	1999	Power
Milano	RO	200	Brackish	1996	Industry
Milano	RO	350	Brackish	1996	Industry
Milano	RO	11.734	Brackish	1997	Municipal
Milano	RO	325	Pure	1996	Industry
Milano	RO	144	Brackish	1998	Industry
Milano	RO	144	Brackish	2003	Industry
Milano	RO	192	Brackish	1998	Industry
Milano	RO	216	Brackish	2003	Industry
Milano	RO	432	Brackish	1996	Municipal
Milano	RO	640	Brackish	1999	Industry
Milano	RO	719	Brackish	1996	Municipal
Milano	RO	864	Brackish	1997	Municipal
Milano	RO	1.006	Brackish	1996	Municipal
Milazzo	MED	1.000	Seawater	1997	Industry
Milazzo	MED	4.800	Seawater	1998	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 57 (Continued)

Italy. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Napoli	RO	1.728	Brackish	2000	Municipal
Napoli	RO	144	Brackish	1998	Industry
Napoli	RO	480	Brackish	1999	Industry
Napoli	RO	480	Seawater	2009	Industry
Nettune	RO	150	Brackish	1996	Industry
Novara	RO	3.850	Pure	1998	Industry
Novara	RO	120	Pure	2000	Industry
Novi Ligure	RO	72	Brackish	2009	Industry
OI BW 350, Sta. Margherita de Pula	RO	350	Brackish	2007	Industry
Osimo	RO	2.160	Brackish	1997	Municipal
Osmo 6 AM	RO	200	Brackish		Irrigation
Osmo 24 AM	RO	1.000	Brackish		Industry
Osmo 42 AM + Osmo 24 AM	RO	1.000	River		Industry
Osmo 42 AM + Osmo 26 AM	RO	1.000	River		Industry
Osmo 12 AM, Cuneo	RO	500	Brackish		Industry
Osmo 25 AM, Cuneo	RO	1.000	Pure	2008	Industry
Osmo 25 AM, Cuneo	RO	720	Brackish	2008	Tourism
Osmo 72 AM, Fano	RO	2.000	Brackish	2008	Municipal
Osmo 4 AM, Foggia	RO	150	Brackish	2009	Irrigation
Osmo 4 AM, Foggia	RO	150	Brackish		Industry
Osmo 4 AM, Forlimpopoli	RO	150	Brackish		Industry
Osmo 25 AM, Milano	RO	600	Seawater	2009	Industry
Osmo 20 AM, Padova	RO	480	Brackish	2009	Industry
Osmo 36 AM, Parma	RO	1.200	Brackish		Industry
Osmo SHR 84 AM	RO	1.000	Seawater	2008	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 57 (Continued)

Italy. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Osmo 10 AM, Vittoria	RO	500	Brackish		Irrigation
Osmo 30 AM, Vittoria	RO	750	Brackish	2009	Irrigation
Osmo 30 AM, Vittoria	RO	750	Brackish	2009	Industry
Palermo	RO	144	Brackish	1999	Municipal
Palermo	RO	288	Brackish	2002	Municipal
Palermo	RO	1.100	Brackish	2001	Industry
Palermo	RO	288	Brackish	2002	Municipal
Parma	RO	480	Brackish	1997	Industry
Perugia		140	Waste	2000	Industry
Pesaro	RO	100	Brackish	2000	Industry
Pesaro	RO	216	Brackish	1997	Municipal
Pesaro	RO	240	Brackish	1998	Municipal
Pescara	RO	300	Brackish	2000	Industry
Pisa	RO	144	Brackish	1999	Industry
Pistoia	RO	100	Brackish	2002	Irrigation
Pomigliano	RO	5.400	Seawater	1997	Municipal
Pordenone	RO	200	Brackish	1996	Industry
Potenza	RO	430	Brackish	2001	Irrigation
Power Plant, Brindisi	MSF	1.000	Seawater	1993	Power
Power Plant, Piombino	MSF	2.880	Seawater	1987	Power
Power Plant, Termini Imerese	MSF	2.880	Seawater	1994	Power
Power Plant, Torrevaldaliga	MSF	1.440	Seawater	1988	Power
Priolo Gargallo	MED	14.400	Seawater	1998	Industry
Promoco	RO	8.000	Pure	2008	Industry
Ragusa	RO	100	Brackish	2002	Irrigation
Ragusa	RO	280	Brackish	1998	Irrigation
Raguna	RO	100	Brackish	2006	Irrigation
Reffineria de Gela	RO	16.800	Waste	2003	Industry
Reggio Calabria	RO	25.000	Seawater	2007	Industry
Reggio Emilia	RO	144	Brackish	1999	Power
Reggio Emilia	RO	216	Brackish	1999	Power

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 57 (Continued)

Italy. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Reggio Emilia	RO	480	Brackish	1999	Industry
Reggio Emilia	RO	600	Brackish	2001	Power
Reggio Emilia	RO	1.000	Brackish	2000	Industry
Reggio Emilia	RO	4.000	Brackish	2000	Industry
Reggio Emilia	RO	144	Brackish	2006	Industry
Rimimi	RO	100	Brackish	2001	Industry
Rome	RO	144	Brackish	1996	Industry
Rome	RO	240	Brackish	1998	Power
Romana Emilia	RO	100	Pure	2003	Industry
Rome	RO	1.200	Seawater	2004	Power
Rome	RO	1.200	Seawater	2004	Power
Rovigo	RO	120	Pure	2000	Industry
Salerno	RO	288	Brackish	2003	Industry
Salerno	RO	768	Brackish	2001	Municipal
San Filippo del Mela	RO	5.400	Seawater	2000	Municipal
San Ilario	RO	160	Brackish	1996	Industry
Sarlux Refinery, Sarroch	MED	17.280	Seawater	1999	Industry
Savona	RO	3.500	Pure	1997	Municipal
Sicily	RO	16.800	Seawater	2003	Industry
Sicily	RO	5.400	Brackish	2007	Industry
Sicily	RO	16.800	Seawater	2003	Industry
Sicily	RO	5.400	Brackish	2007	Industry
Siracusa	RO	576	Brackish	1999	Industry
St. Ilario	RO	160	Brackish	1996	Industry
Simeri Crichi	MED	6.480	Seawater	2007	Irrigation
Taranto	RO	9.000	Brackish	2006	Industry
Tirrenia	RO	900	Brackish	1996	Military
Toranto	RO	480	Brackish	1997	Industry
Taranto	RO	9.000	Brackish	2006	Industry
Trapani	RO	450	Brackish	1996	Industry
Trapani	RO	400	Brackish	2001	Industry
Trapani	RO	1.728	Brackish	2000	Municipal
Treviso	RO	144	Brackish	2000	Irrigation
Trieste	RO	160	Brackish	1996	Industry
Vado Ligure	RO	8.000	Seawater	1999	Power
Verona	RO	144	Brackish	1998	Industry
Verona	RO	220	Brackish	1998	Power
Vicenza	RO	340	Brackish	1996	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 57 (Continued)

Italy. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Vigano Di Gaggiano	EDI	360	Brackish	2009	Industry
TOTAL CAPACITY OF WATER PRODUCTION				**361.558 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 58

Italy. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Agrate	RO	4.560	Seawater	1992	Municipal
Agrate	RO	1.450	Pure	1993	Industry
Agrigento	RO	300	Brackish	1989	Industry
Agrigento	RO	900	Brackish	1990	Military
Alessandria	RO	7.700	Brackish	1992	Industry
Ancona	ED	1.080	Pure	1993	Municipal
Ascoli Piceno	RO	100	Brackish	1995	Power
Avezzano	RO	700	Pure	1994	Industry
Avezzano	RO	2.500	Pure	1995	Industry
Avezzano	RO	2.780	Pure	1991	Industry
Bari	RO	100	Brackish	1994	Industry
Bari	RO	150	Waste	1994	Industry
Brescia	RO	163	Waste	1995	Industry
Brindisi	RO	5.040	Brackish	1992	Industry
Brindisi	RO	5.760	Seawater	1992	Industry
Brindisi	MSF	960	Seawater	1992	Power
Brindisi	MED	900	Seawater	1984	Power
Brindisi 3/4	MSF	954	Seawater	1981	Power
Cagliari	RO	1.000	Seawater	1991	Power
Cagliari	RO	6.000	Seawater	1991	Industry
Caltaniset	RO	4.800	Waste	1993	Industry
Camp Darby	RO	900	Brackish	1987	Military
Capaci	MED	500	Brackish	1992	Municipal
Carloforte	RO	1.000	Seawater	1990	Military
Catania	ED	1.020	Brackish	1989	Military
Civisavecchia	MED	450	Seawater	1981	Power
Elba	RO	110	Brackish	1992	Tourism
Ferrara	RO	9.840	River	2006	Power
Forli	RO	100	Brackish	1990	Power
Galatina	RO	300	Brackish	1989	Industry
Gela	MSF	14.400	Seawater	1991	Industry
Gela		14.400	Seawater	1988	Industry
Gibellina	RO	450	Brackish	1990	Military
Ionex 200/500 MB Eexd	Other	1.152	Brackish	2006	Power
Italy	ED	350	Brackish	1980	Municipal
Italy	ED	1.136	Brackish	1983	Military
Italy	ED	1.000	Brackish	1986	Municipal
Italy	RO	511	Seawater	1986	Municipal
Italy	ED	1.000	Brackish	1987	Municipal
Italy	MED	150	Waste	1987	Discharge

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 58 (Continued)

Italy. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Italy	ED	200	Brackish	1988	Industry
Italy	ED	227	Brackish	1988	Industry
Italy	ED	960	Brackish	1988	Power
Italy	ED	1.000	River	1988	Industry
Italy	ED	1.000	Brackish	1988	Industry
Italy	ED	4.560	Waste	1988	Industry
Italy	ED	228	Brackish	1990	Municipal
Italy		240	Waste	1991	Discharge
Italy	ED	200	Brackish	1991	Industry
Italy	ED	2.400	Brackish	1991	Municipal
Italy	ED	3.645	Brackish	1991	Industry
Italy	ED	4.000	Brackish	1991	Industry
Italy	RO	240	Seawater	1991	Industry
Italy	RO	480		1991	Industry
Italy	RO	960		1991	Industry
Italy	RO	1.200		1991	Industry
Italy	RO	227	Brackish	1992	Industry
Italy	ED	500	Brackish	1993	Municipal
Italy	ED	1.450	Brackish	1994	Municipal
Italy	MED	3.000	Seawater	1995	Municipal
Italy	ED	600	River	1995	Power
Italy	RO	600	Waste	1995	Irrigation
Italy	RO	2.455	Pure	2007	Industry
Lampedusa	MED	450	Seawater	1987	Municipal
Linosa	MED	500	Seawater	1987	Municipal
Lipari	MED	4.800	Seawater	1987	Municipal
Livorno	ED	500	Brackish	1995	Industry
Maddalena	RO	500	Seawater	1990	Military
Marettimo	MED	500	Seawater	1987	Municipal
Melfi	RO	9.600	River	1994	Industry
Melilli	MED	900	Seawater	1981	Power
Milano	RO	1.008	Brackish	1995	Municipal
Milano	RO	1.056	Brackish	1995	Municipal
Modena	RO	170	Brackish	1992	Discharge
Montalto	MSF	7.200	Seawater	1994	Power
Napoli	ED	14.400	Brackish	1992	Industry
Napoli	ED	14.400	River	1992	Industry
Napoli	RO	1.500	Brackish	1994	Industry
Open Adriatic Sea	RO	480	Seawater	2007	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 58 (Continued)

Italy. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Osmo 84 AM, Firenze	RO	2.000	Brackish	2007	Industry
Osmo 24 AM, Firenze	RO	1.200	Brackish	2006	Municipal
Osmo 90 AM, Pescara	RO	4.800	Brackish	2007	Municipal
Palermo	RO	720	Brackish	1993	Industry
Palermo	RO	720	Brackish	1993	Municipal
Pantelleria	RO	600	Brackish	1991	Municipal
Pantelleria	MED	3.200	Seawater	1987	Municipal
Piombino	MSF	600	Seawater	1992	Power
Piombino 1/2	MSF	1.440	Seawater	1984	Power
Piombino 1/4	MSF	1.440	Seawater	1987	Power
Pomigliano	ED	14.400	River	1995	Industry
Porto Empedocle	MED	4.800	Seawater	1992	Municipal
Porto Tolle	ED	2.000	River	1990	Power
Portoferraio	RO	1.200	Seawater	1990	Tourism
Ragusa	RO	120	Brackish	1994	Irrigation
Ragusa	RO	720	River	1995	Irrigation
Ravenna	MSF	720	Seawater	1981	Demonst.
Revamping Osmodemi 500 DPLX	RO	1.440	Pure	2006	Power
Rome	RO	500	Brackish	1993	Discharge
Rome	RO	690	Brackish	1990	Military
Rome	RO	1.160	Brackish	1995	Municipal
Rome	RO	1.160	Seawater	1990	Military
S. Gilla	MED	300	Seawater	1990	Power
Salina	MED	1.200	Seawater	1987	Municipal
Sarroch	MSF T	8.500	Seawater	1994	Industry
Sicily	RO	18.000	Seawater	1993	Municipal
Sicily	RO	17.000	Seawater	1992	Municipal
Sicily	MED	18.000	Seawater	1993	Municipal
Sicily	RO	18.000	Seawater	1993	Municipal
Sicily	RO	250	Seawater	1992	Municipal
Sulcis 1/2	MSF	1.200	Seawater	1987	Power
Sulcis 3/4	MSF	1.200	Seawater	1992	Power
Taranto	MSF	6.000	Seawater	1979	Industry
Tarquinta	RO	1.450	Brackish	1993	Discharge
Termini	MSF	2.880	Seawater	1994	Power

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 58 (Continued)

Italy. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Termini 1	MED	961	Seawater	1980	Power
Termini Imerese	MED	1.980	Seawater	1980	Municipal
Torino	RO	140	Pure	1991	Industry
Torino	RO	300	River	1991	Industry
Torrevaldaliga	MSF	2.880	Seawater	1980	Power
Torrevaldaliga	MSF	2.880	Seawater	1984	Power
Ustica	MED	1.200	Seawater	1987	Municipal
Valdagno	RO	160	Brackish	1995	Industry
Velletri	RO	720	Seawater	2007	Municipal
Villasimius	RO	1.500	Seawater	1990	Military
TOTAL CAPACITY OF WATER PRODUCTION				**193.934 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

FRANCE

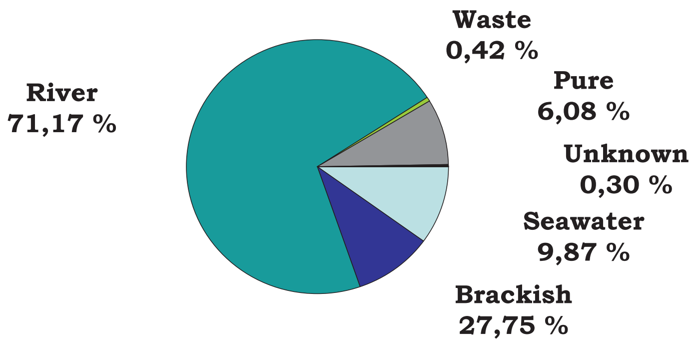
ir a ÍNDICE

FRANCE

The IDA Worldwide Desalting Plants Inventory (2011), informs about 39 desalting plants on line in France which total capacity is 212.152 m³/day (TABLE 59) and 23 desalting plants presumed on line with capacity to produce 20.952 m³/day (TABLE 60). So, the presumed water desalination capacity in France is 233.104 m³/day. This means 0.04 % of the renewable water resources of this country.

The total capacity of desalinated water production is shared by 23.024 m³/day (9,87 %) proceeding from seawater; 23.008 m³/day (9,87%) from brackish water; 165.907 m3/day (71,17 %) from river water; 988 m³/day (0,42 %) from waste water; and 19.457 m³/day (8,34 %) from pure water. The origin of 720 m³/day (0,3 %) was not reported. The GRAPHIC 48 represents this distribution.

GRAPHIC 48
Desalinated water production according to feed water origin in FRANCE



The totsl of desalinated water capacity is applied as follows:

- 155.572 m³/day (66,74 %) to municipalities.

- 72.860 m³/day (31,25 %) to industry.

- 1.600 m³/day (0,68 %) to power.

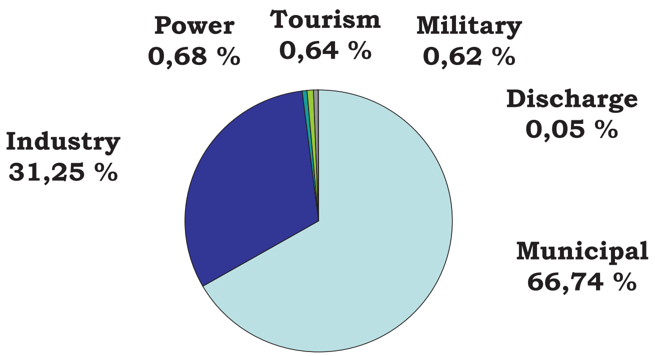
- 1.512 m³/day (0,64 %) to tourism.

- 1.440 m^3/day (0,62 %) to military.

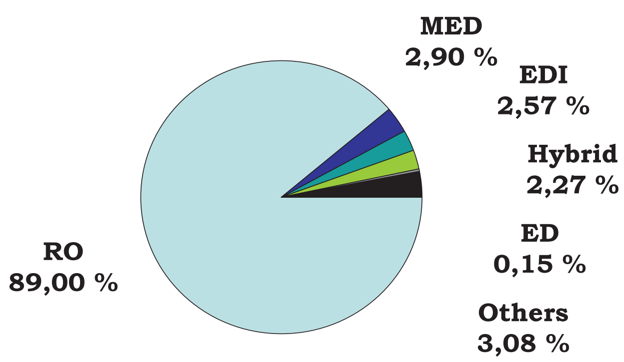
- 120 m^3/day (0,05 %) to discharge.

GRAPHIC 49 represents the distribution of desalinated water uses in France.

GRAPHIC 49
Uses distribution of desalinated water in FRANCE



GRAPHIC 50
Frecuency of water desalination methods in FRANCE



Reverse osmosis is the principal method employed in France to produce desalinated water. According with the revised data, 207.477 m^3/day (89,00 %) are produced by RO systems; 6.764 m^3/day (2,90 %) by MED; 6.007 m^3/day (2,57 %) by EDI; 5.300 m^3/day (2,27 %) by hybrid systems; and 356 m^3/day (0,15 %) by ED. Methods applied to produce 7.200 m^3/day (3,08 %) were not described. The GRAPHIC 50 represents the distribution of these figures.

ir a ÍNDICE

ir a ÍNDICE

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 59
France. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Aqua Cleer IW 6	RO	120	Brackish	2009	Industry
Corbeil	RO	3.600	Brackish	1998	Industry
Corbeil	RO	3.600	Pure	2000	Industry
Corbeil	RO	3.600	Pure	2000	Industry
Corsica	RO	600	Seawater	2002	Municipal
Custines	RO	110	Waste	1997	Industry
Flamanville	HYB	5.300	Seawater	2009	Municipal
France	RO	1.325	River	1996	Industry
France	RO	110	Waste	1997	Industry
France	RO	300	River	1997	Industry
France	RO	300	Brackish	1997	Industry
France	RO	6.600	River	1998	Industry
France	RO	480	River	1998	Municipal
France	RO	300	River	1999	Industry
France	EDI	2.180	Seawater	2000	Industry
France	EDI	1.200	Pure	2001	Industry
France	RO	3.600	Pure	2001	Industry
France	RO	144	Brackish	2001	Industry
France	RO	3.600	Brackish	2001	Industry
France	RO	1.152	Brackish	2002	Municipal
France	RO	1.200	Seawater	2006	Municipal
France	RO	648	Waste	2009	Tourism
France	RO	552	Brackish	2009	Industry
Haubourdin	RO	2.200	Brackish	1999	Industry
Jarny	MED	3.000	River		Industry
Mayotte	RO	2.000	Seawater	1996	Municipal
Mery-sur-Oise	RO	140.000	River	1999	Municipal
Mery-sur-Oise	RO	3.000	River		Municipal
Mobile	MED	1.440	Seawater	1992	Military
Mobile Unit	RO	2.400	Brackish	2001	Industry
Moineville	RO	3.400	Brackish		Industry
Perpignan	RO	720	Pure		Tourism
Rouget	EDI	2.627	Pure	1998	Industry
Santes Nord	RO	300	River	1997	Industry
Ship	MED	144	Seawater	1983	Tourism
Ship	MED	120	Seawater	1999	Municipal
Sollac		7.200	Seawater		Industry
Toulouse	RO	2.880	Brackish	1999	Industry
UCDEM St Martin	RO	100	Seawater	2006	Municipal
TOTAL WATER PRODUCTION CAPACITY				**155.572 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 60

France. Desalting Plants presumed on line (2011)

Location	Method	Production m^3/day	Raw water	Year	Use
Chauny	RO	1.200	Brackish	1995	Industry
Colmar	RO	650	Pure	1991	Industry
Colmar	RO	700	Pure	1992	Industry
Corbeil	RO	960	Pure	1992	Industry
Corbeil	RO	1.080	River	1988	Industry
Corbeil	RO	3.240	River	1988	Industry
Flamanville	MED	1.500	Seawater	1984	Power
France	MED	120	Seawater	1988	Industry
France	MED	120	Waste	1989	Discharge
France	ED	356	Brackish	1989	Industry
Mons en Bar	RO	4.800	River	1989	Industry
France	MED	100	Seawater	1990	Power
France	RO	720		1992	Municipal
Grenoble	RO	1.300	Pure	1992	Industry
Grolles	RO	500	Pure	1995	Industry
Haubourdin	RO	960	Brackish	1992	Industry
Montmelian	RO	144	Brackish	1995	Industry
Paris	RO	379	River	1988	Industry
Paris	RO	719	River	1988	Industry
Ship	MED	100	Seawater	1989	Municipal
Toulon	MED	120	Seawater	1981	Industry
Tours	RO	384	River	1988	Industry
UCDEM St Barthelemy	RO	800	Seawater	2005	Municipal
TOTAL WATER PRODUCTION CAPACITY				**72.860 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

SPAIN

ir a ÍNDICE

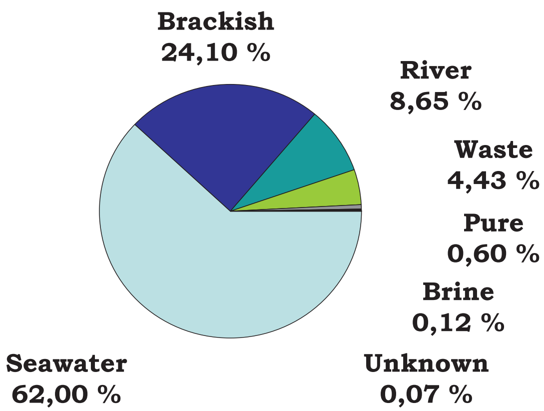
ir a ÍNDICE

SPAIN

The IDA Worldwide Desalting Plants Inventory (2011) informs on 527 desalting plants on line in Spain which total capacity is 4.278.288 m^3/day (TABLE 61) and 277 desalting plants presumed on line with capacity to produce 491.294 m^3/day (TABLE 62); 34 desalting plants, with capacity to produce 622.054 m^3/day, are under construction (TABLE 63). So, the presumed water desalination capacity is 4.769.582 m^3/day. This means 1,55 % of the renewable resources of water in this country.

The total capacity of desalinated water production is served by 2.956.854m^3/day (62,00 %) proceeding from seawater; 1.149.747 m^3/day (24,10 %) proceeding from brackish water; 412.361 m^3/day (8,65 %) from river water; 211.449 m^3/day (4,43 %) proceeding from waste water; 29.995 m^3/day (0,60 %) from pure water; and 5.860 m^3/day (0,12 %) from brine. The origin of 3.316 m^3/day (0,07 %) was not reported. The GRAPHIC 51 represents this distribution.

GRAPHIC 51
Desalinated water production according to feed water origin in SPAIN



The total of desalinated water capacity is applied as follows:

- 3.432.853 m^3/day (71,97 %) to municipalities.
- 811.621 m^3/day (17,01 %) to irrigation.
- 226.984 m^3/day (4,75 %) to industry.
- 116.665 m^3/day (2,44 %) to tourism.

- 43.302 m³/day (0,90 %) to power.

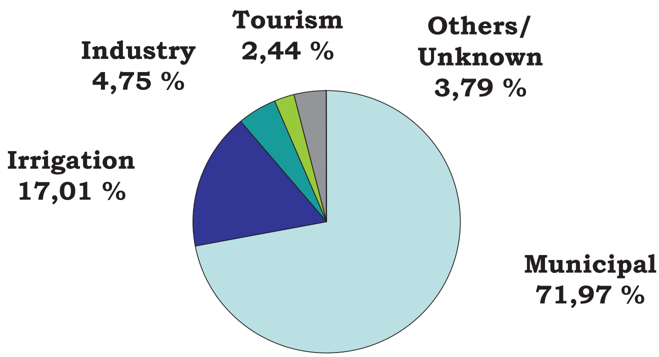
- 1.600 m³/day (0,03 %) to military.

- 1.060 m³/day (0,02 %) to demonstration.

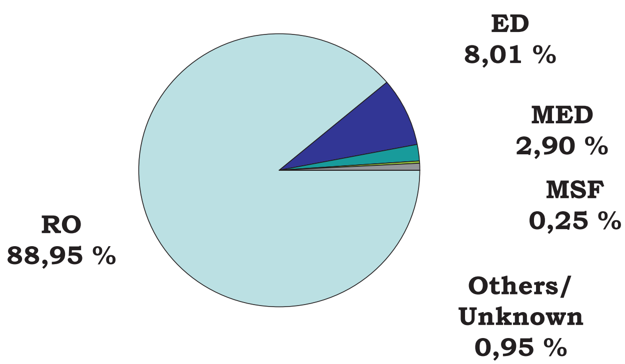
- 497 m³/day (0,01 %) to discharge.

The application of 135.000 m³/day (2,83 %) was not reported. The GRAPHIC 52 represents the distribution of water desalination uses in Spain.

GRAPHIC 52
Uses distribution of desalinated water in SPAIN



GRAPHIC 53
Frecuency of water desalination methods in SPAIN



Reverse osmosis is the principal method employed in Spain to produce desalinated water. According to de data studied, 4.242.793 m^3/day (88,95 %) are produced by RO systems; 382.379 m^3/day (8,01 %) by ED; 86.644 m^3/day (1,81 %) by MED; 12.300 m^3/day (0,25 %) by MSF; and 45.466 m^3/day (0,95 %) by other methods. The GRAPHIC 53 represents the distribution of these figures.

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 61

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m3/day	Raw water	Year	Use
A Coruña	RO	120	Brackish	2002	Industry
Abarán	RO	1.080	Brackish	2006	Municipal
Abrera Water Treatment	ED	200.000	Brackish	2008	Muncipal
Adeje I	RO	10.000	Seawater	1998	Municipal
Adeje 2	RO	5.000	Seawater	2000	Municipal
Adeje 3	RO	5.200	Seawater	2001	Municipal
Adeje Arona	ED	8.000	Waste	2004	Irrigation
Agragua ½	RO	15.000	Seawater	1998	Irrigation
Agragua	RO	5.000	Seawater	2004	Irrigation
Agua de proceso para planta cosmética, Burgos	RO	144	Brackish	2010	Industry
Águilas	RO	20.800	Seawater	2003	Irrigation
Águilas	RO	16.000	Seawater	2006	Irrigation
Águilas, Guadalentín	RO	180.000	Seawater	2009	Municipal
Albacete	RO	25.000	Brackish	2009	Municipal
Alcaliber, Toledo	RO	216	Brackish		Industry
Alcudia	MED	1.500	Seawater	2005	Municipal
Alcudia	RO	14.000	Seawater	2007	Municipal
Aldea	RO	5.400	Seawater	2000	Irrigation
Alfaz del Pi	RO	2.500	Brackish	2001	Municipal
Aliaga	RO	480	Seawater	2007	Municipal
Alicante	RO	2.800	Waste	1996	Irrigation
Alicante	RO	865	Brackish	1996	Irrigation
Alicante	RO	1.730	Brackish	1996	Irrigation
Alicante	RO	2.000	Brackish	1997	Municipal
Alicante	RO	550	Brackish	1998	Tourism
Alicante	RO	4.300	Brackish	1998	Irrigation
Alicante	RO	4.320	Brackish	1998	Irrigation
Alicante Orihuela	RO	2.300	Brackish	1998	Irrigation
Alicante	RO	450	Brackish	1998	Irrigation
Alicante	RO	865	Brackish	2000	Irrigation
Alicante	RO	4.000	Brackish	2001	Municipal
Alicante	RO	250	Brackish	2002	Municipal
Alicante	RO	1.000	Brackish	2002	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Alicante Calpe	RO	4.000	Brackish	2002	Municipal
Alicante	RO	55.000	Seawater	2003	Municipal
Alicante	RO	750	Brackish	2004	Industry
Alicante	RO	1.350	Seawater	2004	Municipal
Alicante	RO	3.000	Brackish	2005	Municipal
Alicante II	RO	65.000	Seawater	2007	Municipal
Alicante Sur	RO	10.000	Brackish	2009	Municipal
Almanzora	RO	20.000	Brackish	2003	Irrigation
Almeria	RO	400	Seawater	1996	Industry
Almería	RO	3.100	Brackish	1996	Irrigation
Almeria	MED	1.000	Seawater	1997	Industry
Almería	RO	2.800	Brackish	1998	Irrigation
Almeria	RO	100	Seawater	1999	Industry
Almeria	RO	400	Seawater	2000	Industry
Almería	RO	5.500	Brackish	2000	Irrigation
Almeria	RO	360	Brackish	2001	Industry
Almería	RO	3.000	Brackish	2001	Irrigation
Almería	RO	3.110	Brackish	2002	Irrigation
Almeria City	RO	50.000	Seawater	2003	Municipal
Almería Pulpi	RO	10.500	Brackish	2001	Irrigation
Almoguera	RO	123.840	River	2008	Municipal
Amfi del Mar 3	RO	300	Seawater	1996	Municipal
Amfi del Mar 4	RO	300	Seawater	1996	Municipal
Valencia	RO	1.500	Brackish	1997	Industry
Andalucía	RO	1.300	Seawater	2008	Industry
Andasol I & II	ED	620	Brackish	2008	Industry
Andratx	RO	14.000	Seawater	2007	Municipal
Antigua Beach	RO	3.000	Seawater	2000	Tourism
Arco Sur	RO	7.000	Waste	2006	Irrigation
Aripe	ED	12.000	Brackish	2000	Municipal
Arrecife	RO	3.000	Waste	2002	Irrigation
Arucas II	RO	16.000	Seawater	2008	Municipal
Arucas-Moya Exten. Phase 1	RO	4.000	Seawater	2001	Municipal
Arucas-Moya	RO	8.000	Seawater	2001	Municipal
Arucas-Moya Ext. Phase 2	RO	3.000	Seawater	2003	Municipal
Atrium Beach	MED	2.400	Seawater	2000	Tourism
Asturias	RO	1.000	Brackish	1998	Industry
Asturias	RO	1.200	Brackish	2002	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Avilés	RO	1.300	Brackish	2003	Industry
Azuara	RO	480	Seawater	2007	Municipal
Badajoz	RO	100	Brackish	1997	Industry
Baena	RO	200	Brackish	2001	Power
Bahía de Palma	RO	100	Brackish	2000	Industry
Bahía de Palma	RO	68.000	Seawater	2001	Municipal
Bahía de Palma	RO	43.200	Seawater	2001	Municipal
Bahía de Palma Ext.	RO	23.100	Seawater	2001	Municipal
Bahía del Duque	RO	600	Seawater	2009	Tourism
Bajo Almanzora	RO	60.000	Seawater	2009	Municipal
Balearic Islands	RO	7.700	Seawater	2000	Municipal
Barceló	RO	300	Seawater	1996	Municipal
Barcelona	RO	2.400	Brackish	1996	Power
Barcelona	RO	100	Seawater	1997	Municipal
Barcelona		850	Brackish	1998	Industry
Barcelona	RO	450	Brackish	1999	Industry
Barcelona	RO	6.910	Brackish	2000	Municipal
Barcelona	RO	325	Brackish	2000	Industry
Barcelona exp.	RO	480	Pure	2000	Industry
Barcelona	MED	768	Seawater	2001	Power
Barcelona	RO	8.640	Brackish	2002	Municipal
Barcelona	RO	8.640	Brackish	2002	Municipal
Barcelona	RO	780	Brackish	2002	Industry
Barcelona	RO	1.680	Brackish	2002	Industry
Barcelona El Prat	ED	6.500	Waste	2004	Irrigation
Barcelona El Prat	RO	7.400	Brackish	2005	Industry
Barcelona	RO	8.640	Brackish	2006	Municipal
Barcelona	RO	5.600	Seawater	2008	Municipal
Barcelona	Other	720	Pure	2009	Industry
Barcelona	Other	240	Pure	2009	Industry
Barcelona	Other	4.440	River	2010	Industry
Barcelona	RO	1.488	Pure		Industry
Barranco Seco	ED	18.000	Waste	2002	Irrigation
Belchite	RO	760	Waste	2007	Municipal
Beniadlá-Denia	RO	8.000	Seawater	2002	Municipal
Benidorm	RO	5.000	Seawater	2002	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Benidorm	RO	5.000	Waste	2003	Irrigation
Benidorm	RO	25.000	Waste	2009	Irrigation
Benissa	RO	4.000	Brackish	2000	Municipal
Besalu, Cataluña	RO	336	Brackish	2009	Industry
Bilbao	RO	120	Brackish	2000	Industry
Burriana	RO	4.000	Brackish	2001	Municipal
Calahorra	RO	21.600	Brackish	2008	Municipal
Calpe	RO	6.000	Brackish	1999	Municipal
Calpe, Alicante	RO	4.000	Brackish	2002	Municipal
Calviá Mallorca	RO	5.500	Seawater	2000	Municipal
Campo Cartagena	RO	330	Brackish	1996	Irrigation
Campo Cartagena	RO	600	Brackish	1997	Irrigation
Campo Cartagena	RO	2.000	Brackish	2000	Irrigation
Campo Dalias	RO	20.000	Waste	2001	Irrigation
Campo Dalias	RO	12.000	Pure	2008	Irrigation
Canal de Cartagena	RO	65.000	Seawater	2006	
Canal de Cartagena Ext.	RO	65.000	Seawater	2006	
Canary Islands	RO	200	Seawater	1993	Municipal
Canary Islands	RO	350	Seawater	1996	Tourism
Canary Islands	RO	350	Seawater	1996	Tourism
Canary Islands	RO	400	Seawater	1996	Tourism
Canary Islands	RO	400	Seawater	1996	Tourism
Canary Islands	RO	400	Seawater	1996	Tourism
Canary Islands	RO	800	Seawater	1996	Tourism
Canary Islands	RO	225	Seawater	1998	Tourism
Canary Islands	RO	200	Seawater	1998	Tourism
Canary Islands	RO	600	Seawater	1998	Tourism
Canary Islands	RO	600	Brackish	1998	Municipal
Canary Islands	RO	1.175	Brackish	1998	Municipal
Canary Islands	RO	400	Seawater	1998	Tourism
Canary Islands	RO	500	Seawater	1998	Tourism
Canary Islands	RO	150	Brackish	1999	Industry
Canary Islands	RO	1.500	Seawater	1999	Tourism
Canary Islands	RO	2.600	Seawater	1999	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Canary Islands	RO	150	Brackish	1999	Industry
Canary Islands	RO	600	Seawater	2000	Tourism
Canary Islands	RO	1.698	Brackish	2001	Municipal
Canary Islands	RO	4.000	Seawater	2001	Municipal
Canary Islands	RO	600	Seawater	2004	Municipal
Cantabria	RO	100	Brackish	2000	Industry
Cantabria	RO	240	Brackish	2000	Industry
Carboneras	RO	120.000	Seawater	2002	Municipal
Carboneras	MSF	2.200	Seawater		Municipal
Cardus	RO	197	Waste	1997	Discharge
Cartagena	RO	4.000	Brackish	2001	Power
Cartagena	MED	1.000	Seawater	2005	Power
Cartagena	RO	2.700	Pure	2007	Municipal
Castellón	RO	7.500	Brackish	1997	Municipal
Castellon Val d´Uixo	RO	7.500	Brackish	1997	Municipal
Castellón	RO	4.000	Brackish	1998	Municipal
Cementera Ulci	RO	500	Seawater	2002	Industry
Ceuta 1	RO	16.000	Seawater	1998	Municipal
Ceuta 2	RO	7.300	Seawater	2004	Municipal
Ciudad Real	RO	750	Brackish	1997	Industry
Ciudad Real	RO	750	Brackish	1998	Municipal
Ciudad Real	RO	1.000	Brackish	1997	Municipal
Ciudad Real	RO	1.000	Brackish	1997	Municipal
Ciudad Real	RO	1.500	Brackish	1998	Municipal
Ciudad Real	RO	1.500	Brackish	1998	Industry
Ciudad Real	RO	2.000	Brackish	1997	Municipal
Ciudad Real	RO	2.000	Brackish	1997	Municipal
Ciudad Real	RO	500	Brackish	1997	Industry
Ciudad Real	RO	325	Brackish	2002	Industry
Colebega, Valencia	RO	1.440	Brackish	2008	Industry
Cordoba	RO	280	Brackish	1999	Industry
Cornellá de Llobregat	RO	16.000	Brackish	2002	Municipal
CTCC Cas Tresorer, Mallorca	RO	1.800	Seawater	2005	Power
Cuenca	RO	150	Brackish	1998	Industry
Cuenca	RO	1.000	Brackish	1998	Municipal
Cuenca	RO	2.000	Brackish	1998	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Cuenca	RO	320	Brackish	2002	Industry
Cuenca	RO	500	Brackish	2006	Industry
Denia-Beniadlá	RO	8.000	Brackish	2002	Municipal
Denia Racons	RO	16.000	Brackish	1992	Municipal
Denia Racons	RO	5.400	Brackish	2005	Municipal
Des de Santa María de Guía	RO	5.000	Seawater	2005	Municipal
El Prat de Llobregat	RO	16.000	Seawater	2008	Tourism
El Prat de Llobregat	RO	200.000	Seawater	2009	Municipal
El Atabal	RO	165.000	Brackish	2005	Municipal
El Sobradillo	RO	800	Seawater	2003	Tourism
Emalsa	RO	8.000	Seawater	2000	Municipal
Endesa (Besós V)	VC	768	Seawater	2009	Power
Endesa (Unelco 10), Granadilla	MED	750	Seawater	2009	Power
Endesa (Unelco 10), Granadilla	MED	750	Seawater	2009	Power
Escombreras	RO	68.000	Seawater		Municipal
Escombreras	RO	1.500	Seawater	2004	Tourism
Escucha	RO	760	Waste	2007	Municipal
Estercuel	RO	560	Seawater	2007	Municipal
ETAP Campo de Calatrava	RO	12.000	River	2009	Municipal
Felix Santiago, Las Palmas	RO	5.000	Seawater	2009	Irrigation
Formentera	RO	2.000	Seawater	2002	Municipal
Freyette	ED	100	Brackish	2002	Municipal
Fuerteventura	RO	1.000	Seawater	1999	Municipal
Fuerteventura	RO	500	Seawater	2008	Municipal
Fuerteventura	RO	5.000	Seawater	2001	Municipal
Fuerteventura 4	RO	5.000	Seawater	2001	Municipal
Fuerteventura	RO	1.800	Seawater	2002	Municipal
Fuerteventura	RO	180	Brackish	2003	Irrigation
Fuerteventura	RO	2.000	Seawater	2004	Industry
Fuerteventura	RO	2.500	Seawater	2008	Municipal
Fuerteventura	RO	700	Seawater	2008	Irrigation

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Fuerteventura	RO	500	Seawater	2008	Municipal
Fuerteventura	RO	500	Seawater	2008	Municipal
Fuerteventura	RO	500	Seawater		Municipal
Fuerteventura 1	MSF	2.500	Seawater		Municipal
Fuerteventura	RO	3.116	Seawater		Municipal
Galdar (CI)	RO	10.000	Seawater	1998	Municipal
Gerona	RO	225	Brackish	1998	Municipal
Gran Canaria	RO	1.000	Brackish	1996	Irrigation
Gran Canaria	RO	600	Brackish	1996	Tourism
Gran Canaria	RO	4.000	Seawater	1996	Municipal
Gran Canaria	RO	600	Brackish	1996	Tourism
Gran Canaria	RO	800	Brackish	1996	Irrigation
Gran Canaria	RO	830	Brackish	1996	Irrigation
Gran Canaria	RO	850	Brackish	1996	Irrigation
Gran Canaria	RO	3.100	Brackish	1996	Irrigation
Gran Canaria	RO	830	Brackish	1997	Irrigation
Gran Canaria	RO	100	Brackish	1997	Irrigation
Gran Canaria	RO	360	Brackish	1997	Irrigation
Gran Canaria	RO	550	Brackish	1997	Irrigation
Gran Canaria	RO	5.000	Seawater	1998	Irrigation
Gran Canaria	RO	2.600	Brackish	1998	Irrigation
Gran Canaria	RO	2.700	Brackish	1999	Irrigation
Gran Canaria	RO	400	Brackish	1999	Irrigation
Gran Canaria	RO	3.500	Seawater	1999	Municipal
Gran Canaria	RO	200	Brackish	1999	Irrigation
Gran Canaria	RO	600	Brackish	1999	Tourism
Gran Canaria	RO	800	Seawater	2001	Municipal
Gran Canaria	RO	170	Brackish	2002	Irrigation
Gran Canaria	RO	2.000	Seawater	2002	Municipal
Gran Canaria	RO	3.000	Seawater	2008	Industry
Gran Canaria	RO	1.200	Seawater	2008	Irrigation
Gran Canaria	RO	800	Seawater	2008	Municipal
Gran Canaria	RO	630	Seawater	2008	Irrigation
Gran Canaria	RO	5.000	Seawater		Municipal
Gran Canaria	RO	22.000	Seawater		Municipal
Granada	RO	200	Brackish	1999	Municipal
Guadalajara	RO	500	Brackish	1999	Municipal
Guia II	RO	5.000	Seawater	2007	
Guipuzcoa	RO	600	Brackish	2001	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Haria	RO	200	Waste	2002	Irrigation
Helios I y II	RO	720	Brackish		Industry
Herencia	NF	2.250	Brackish	1999	Municipal
Hierro	RO	1.200	Seawater	1999	Municipal
Hierro III	RO	1.200	Seawater	2004	Municipal
Hierro IV	RO	1.200	Seawater	2004	Municipal
Ibersol, Puerto Llano	EDI	408	Brackish	2008	Industry
Ibiza 1	RO	8.200	Seawater	1997	Municipal
Ibiza	RO	1.200	Seawater	2002	Tourism
Ibiza	RO	17.500	Seawater	2005	Municipal
Ibiza	RO	18.000	Seawater		Municipal
IDAM, Cuevas de Almanzora	RO	30.000	Seawater	2003	Irrigation
IDAM, Galdar-Agaete	RO	8.750	Seawater	1998	Municipal
IDAM Inalsa IV, Lanzarote	RO	40.000	Seawater	1998	Municipal
IDAM La Marina	RO	5.000	Seawater	2005	Irrigation
Inalsa 1	RO	5.000	Seawater		Municipal
Incarlopsa	RO	500	Brackish		Industry
Jacarilla	RO	9.000	Brackish	1998	Irrigation
Jaén	RO	750	Brackish	1997	Industry
Jaén	RO	100	Brackish	1999	Industry
Jaén	RO	500	Brackish	2001	Industry
Jaén	RO	200	Brackish	2002	Industry
Janubio	RO	7.000	Seawater	2003	Municipal
La Dehesa	RO	624	Brackish		Industry
La Florida, Extremadura	RO	624	Brackish		Industry
La Guanche	ED	5.900	Brackish	2000	Municipal
La Llagosta	RO	12.960	Brackish	2008	Municipal
La Marina	RO	16.800	Seawater	2008	Municipal
La Oliva	RO	7.000	Seawater	2001	Municipal
La Oliva	RO	2.000	Seawater	2007	Municipal
La Palma (Mu)	RO	500	Brackish	1996	Irrigation
La Puebla de Hijar	RO	3.750	Seawater	2007	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
La Solana de Ciudad Real	RO	2.330	River	2000	Municipal
Lanzarote 2	RO	7.500	Seawater	1986	Municipal
Lanzarote HOH Canarias, SA	RO	100	Seawater	1999	Municipal
Lanzarote	RO	2.000	Waste	2001	Municipal
Lanzarote	RO	300	Seawater	2004	Municipal
Lanzarote	RO	500	Seawater	2004	Municipal
Lanzarote Ext.	RO	1.000	Seawater	2005	Municipal
Lanzarote	RO	600	Seawater	2008	Municipal
Lanzarote 1	MSF	5.000	Seawater		Municipal
Las Palmas	MED	35.000	Seawater	2000	Municipal
Las Palmas 3 Ext.	RO	6.700	Seawater	2001	Municipal
Las Palmas	RO	10.000	Seawater	2004	Municipal
Las Playitas	RO	9.000	Seawater	2006	Municipal
Las Playitas	RO	3.000	Seawater	2008	Tourism
Lebrija	RO	719	River		Industry
M. Torres	HYB	15.400	Seawater	2008	Industry
Madrid	RO	150	Brackish	2000	Industry
Madrid	RO	200	Brackish	2003	Industry
Mahou Lérida	RO	2.400	Brackish	2008	Industry
Málaga	RO	550	Brackish	1998	Irrigation
Mallorca	RO	30.000	Brackish	1995	Municipal
Mallorca	RO	5.000	Seawater	1998	Municipal
Mallorca	RO	42.000	Brackish	1999	Municipal
Mallorca	RO	26.000	Seawater	2002	Municipal
Mallorca	RO	480	Pure	2010	Tourism
Mallorca	Other	240	Pure	2010	Tourism
Mallorca	RO	480	Barckish		Industry
Marbella	RO	56.400	Seawater	1997	Municipal
Martin del Rio	RO	480	Seawater	2007	Municipal
Martos	RO	15.552	River	2004	Municipal
Maspalomas 2	RO	25.200	Seawater	2000	Municipal
Mazarrón	RO	36.000	Seawater	2001	Irrigation
Melilla	RO	1.500	Brackish	1997	Municipal
Melilla	RO	600	Seawater	1998	Tourism
Melilla	RO	280	Brackish	1999	Municipal
Melilla	RO	15.000	Brackish	2006	Municipal
Melilla	RO	20.000	Seawater	2006	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Menorca, Ciutadella	RO	10.000	Seawater	2006	Municipal
Menorca, Ciutadella	RO	15.000	Seawater	2008	Municipal
Morrojable	RO	5.000	Seawater	2002	Municipal
Muniesa	RO	640	Seawater	2007	Municipal
Murcia	MED	100	Seawater	1996	Power
Murcia	MED	800	Seawater	1996	Power
Murcia	RO	1.040	Brackish	1996	Irrigation
Murcia	RO	2.800	Brackish	1997	Irrigation
Murcia	RO	400	Brackish	1998	Irrigation
Murcia	RO	100	Brackish	1999	Industry
Murcia	RO	600	Brackish	1999	Industry
Murcia	RO	120	Pure	1999	Industry
Murcia	RO	1.175	Brackish	1999	Irrigation
Murcia	RO	1.900	Brackish	1999	Irrigation
Murcia	RO	1.800	Brackish	1999	Irrigation
Murcia	RO	2.600	Brackish	2000	Irrigation
Murcia	RO	2.700	Brackish	2000	Irrigation
Murcia	RO	865	Brackish	2001	Municipal
Murcia	RO	220	Brackish	2003	Industry
Murcia	RO	724	River		Industry
Murcia-Almería	RO	1.220	Seawater	2008	Municipal
Murcia-Almería	RO	720	Seawater	2008	Irrigation
Murcia-Almería	RO	600	Seawater	2008	Irrigation
Murcia-Almería	RO	500	Seawater	2008	Irrigation
Navarra	RO	840	Brackish	2002	Industry
Navarra	RO	325	Brackish	2002	Industry
Nules	RO	6.000	Brackish	2002	Municipal
OI BW 550, Alicante	RO	550	Brackish	2003	Municipal
OI BW 275, Alicante	RO	275	Brackish	2003	Municipal
OI BW 480, Aranjuez	RO	480	Brackish	2008	Industry
OI BW 2160, Asturias	RO	2.160	Brackish	2004	Power
OI BW 500, Badajoz	RO	500	Brackish	2004	Industry
OI BW 72, Calahorra	RO	72	Brackish	2008	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
OI BW 408, Castellón	RO	408	Brackish	2008	Industry
OI BW 120, Ciudad Real	RO	120	Brackish	2008	Industry
OI BW 320, Gran Canaria	RO	1.320	Brackish	2004	Power
OI BW 500, Cuenca	RO	500	Brackish	2008	Industry
OI BW 1500, Málaga	RO	1.500	Brackish	2008	Industry
OI BW 400, Sevilla	RO	400	Brackish	2008	Industry
OI BW 400, Sevilla	RO	400	Brackish	2009	Industry
OI BW 250, Toledo	RO	2.160	Brackish	2008	Industry
OI BW 240, Valencia	RO	240	Brackish	2008	Industry
OI BW 500, Valladolid	RO	500	Brackish	2008	Industry
OI BW 408	RO	408	Brackish	2008	Industry
Olcesa, Cuenca	RO	360	Brackish		Industry
Orihuela	RO	3.500	Brackish	1997	Irrigation
Palencia	RO	325	Brackish	1999	Industry
Peñón del Cuervo	Other	20.000	Waste	2010	Irrigation
Pedro Muñoz	MSF	1.600	Seawater	1998	Municipal
Port Aventura	RO	5.000	Waste	2008	Irrigation
Potabilizadora sobre remolque, Zaragoza	RO	100	Seawater	2005	Military
Puerto de Santa María	RO	350	Waste	2007	Municipal
Puerto Rosario	RO	4.000	Seawater	2008	Municipal
Pulpí, Almería	RO	2.000	Brackish	2003	Irrigation
Rambla Morales	RO	60.000	Seawater	2006	Municipal
Ramiterra	RO	2.000	Seawater	2006	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Rincón de León Ext.	RO	34.233	Waste	2009	Irrigation
Sagnier & Mas Blau	RO	20.000	Brackish	2009	Municipal
Sagunto	RO	2.500	Seawater	2006	Power
Samper de Calanda	RO	1.500	Seawater	2006	Municipal
San Antonio de Portomay, Ibiza	RO	10.000	Seawater	1997	Municipal
San Antonio de Portomay, Ibiza	RO	7.500	Seawater	2005	Municipal
San Lorenzo	ED	12.000	Brackish	2002	Irrigation
San Miguel, Lleida	RO	1.680	Brackish	2000	Industry
San Nicolás de Tolentino	RO	5.000	Seawater	2001	Municipal
San Pedro Pinatar	RO	6.000	Brackish	1997	Irrigation
San Roque	MED	768	Seawater	2001	Power
Sant Joan Despí	RO	206.064	River	2009	Municipal
Santa Cruz de Bezana		2.356		2000	Municipal
Santa Cruz de Tenerife	RO	20.700	Seawater	2001	Municipal
Santa Eulalia	RO	1.075	Waste	2001	Irrigation
Santa Eulalia	RO	15.000	Seawater	2011	Municipal
Santo Domingo	RO	5.200	Brackish	1996	Irrigation
Santander	RO	360	Waste		Demonst.
SEAT Car Manuf.	RO	500	Pure	2008	Industry
SETA Osmo BW 2000, Benidorm	RO	2.000	Brackish	2000	Tourism
SETA Osmo SW 500, Fuerteventura	RO	500	Seawater	2005	Tourism
SETA Osmo SW 500, Zamora	RO	400	Seawater	2000	Industry
EDI	RO	100	Seawater	2009	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Solaben II y III	RO	720	Brackish		Industry
Solúcar Solnova 1	RO	2.640	River	2008	Industry
Solúcar Solnova 3	RO	2.640	River	2008	Industry
Soslaire	RO	2.750	Seawater	2002	Irrigation
Spain	RO	2.000	Seawater	1997	Municipal
Spain	RO	2.400	Brackish	1997	Industry
Spain	RO	500	River	1997	Industry
Spain	RO	2.000	Seawater	1997	Municipal
Spain	RO	600	Seawater	1998	Municipal
Spain	ED	818	Waste	1999	Municipal
Spain	RO	1.200	Seawater	1999	Municipal
Spain, HOH Canarias SA	RO	500	Seawater	1999	Municipal
Spain, HOH Canarias SA	RO	300	Seawater	2001	Municipal
Spain, HOH Canarias SA, Lanzarote	RO	300	Seawater	1998	Municipal
Spain, HOH Canarias SA, Lanzarote	RO	300	Seawater	1999	Municipal
Spain, HOH Canarias SA,	RO	100	Seawater	1999	Municipal
Spain	ED	818	Waste	2000	Municipal
Spain	RO	1.400	Brine	2000	Tourism
Spain	ED	2.000	Pure	2000	Irrigation
Spain	ED	2.454	Waste	2000	Municipal
Spain	ED	2.454	Waste	2000	Municipal
Spain	ED	4.000	Waste	2000	Irrigation
Spain	ED	4.000	Pure	2000	Municipal
Spain	ED	1.000	River	2001	Municipal
Spain	ED	1.000	River	2001	Municipal
Spain	RO	1.200	Brine	2001	Tourism
Spain	ED	2.200	River	2001	Municipal
Spain	RO	3.000	Brine	2001	Tourism
Spain	RO	4.000	Seawater	2001	Municipal
Spain	RO	150	Seawater	2002	Municipal
Spain	ED	700	Waste	2002	Irrigation
Spain	RO	800	Seawater	2002	Irrigation

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Spain	ED	2.000	Waste	2002	Irrigation
Spain	ED	4.000	Waste	2002	Irrigation
Spain	ED	4.000	Waste	2002	Irrigation
Spain	RO	4.000	Seawater	2002	Municipal
Spain	ED	2.200	Waste	2003	Irrigation
Spain	ED	4.000	River	2003	Municipal
Spain	RO	2.000	Seawater	2003	Municipal
Spain	RO	960		2003	Municipal
Spain	RO	1.100	Seawater	2005	Municipal
Spain	RO	800	Seawater	2005	Municipal
Spain	ED	4.000	Brackish	2005	Municipal
Spain	ED	2.000	Brackish	2005	Municipal
Spain	ED	2.000	Brackish	2005	Municipal
Spain	ED	800	Brackish	2005	Municipal
Spain	RO	2.250	Seawater	2005	Municipal
Spain	RO	450	Seawater	2005	Municipal
Spain	RO	1.200	Seawater	2005	Municipal
Spain	RO	3.000	Seawater	2005	Municipal
Spain	RO	3.000	Seawater	2005	Municipal
Spain	RO	3.000	Seawater	2005	Municipal
Spain	RO	4.000	Seawater	2005	Municipal
Spain	ED	4.000	Brackish	2005	Municipal
Spain	ED	4.000	Brackish	2005	Municipal
Spain	ED	3.500	Brackish	2005	Municipal
Spain	ED	8.000	Brackish	2005	Municipal
Spain	RO	2.778	Brackish	2007	Municipal
Spain	RO	545	Brackish	2009	Industry
Spain	ED	10.684	Brackish	2009	Industry
Spain	RO	500	Seawater		Industry
Stella Canarias	RO	250	Seawater	2002	Municipal
Sureste 2	RO	15.000	Seawater	1998	Municipal
Sureste tertiary	RO	3.250	Waste	2000	Irrigation
Sureste tertiary ext.	RO	2.750	Waste	2003	Irrigation
Tablero	ED	6.800	Waste	2002	Irrigation
Tarragona	RO	1.600	River	1997	Power
Tarragona	RO	850	Brackish	1998	Industry
Tarragona	RO	360	Brackish	1999	Industry
Tarragona	RO	1.440	River	1999	Power
Tarragona	RO	4.500	Seawater	2002	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Tarragona	RO	3.550	River	2002	Power
Tarragona	RO	600	Brackish	2002	Industry
Tarragona	RO	750	Brackish	2003	Irrigation
Tarragona (CTCC Plana del Vent)	RO	1.400	Seawater	2007	Power
Tarragona	RO	5.400	Seawater	2008	Industry
Tarragona	RO	3.000	Seawater	2008	Industry
Teguise Playa	RO	480	Seawater	1997	Municipal
Telde	RO	37.700	Seawater	1996	Municipal
Telde	RO	5.000	Seawater	2003	Municipal
Telde	RO	10.000	Seawater	2005	Municipal
Telde	RO	16.000	Seawater	2007	Municipal
Telde Phase II	RO	16.000	Seawater	2009	Municipal
Tenerife	ED	4.200	Waste	1996	Irrigation
Tenerife	RO	200	Brackish	1996	Irrigation
Tenerife	RO	420	Brackish	1996	Irrigation
Tenerife	RO	950	Brackish	1996	Irrigation
Tenerife	RO	550	Brackish	1998	Irrigation
Tenerife	RO	190	Seawater	2000	Municipal
Tenerife	RO	2.000	Seawater	2002	Tourism
Tenerife	RO	1.000	Seawater	2002	Municipal
Tenerife	MED	1.500	Seawater	2003	Power
Tenerife	RO	110	Brackish	2005	Municipal
Tenerife	RO	400	Brackish	2005	Municipal
Tenerife	RO	1.000	Seawater	2006	Municipal
Tenerife	RO	200	Seawater	2006	Municipal
Termosolar de Lebrija	RO	432	Brackish	2010	Industry
Termosolar, Morón	RO	360	Brackish		Industry
Termolansa	MSF	1.000	Seawater		Municipal
Teulada	RO	3.800	Brackish	1999	Municipal
Teulada	RO	6.000	Brackish	2000	Municipal
Tias	RO	2.000	Waste	2001	Municipal
Tirajana	MED	1.392	Seawater	2003	Power
Tirajana	MED	696	Seawater	2006	Power
Toledo	RO	600	Brackish	1996	Industry
Toledo	RO	1.200	Brackish	1997	Municipal
Toledo	RO	250	Brackish	1999	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 61 (Continued)

Spain. Desalting Plants on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Toledo	RO	1.300	Brackish	1999	Industry
Toledo	RO	500	Brackish	1999	Industry
Toledo	RO	225	Brackish	2000	Industry
Toledo	RO	840	Brackish	2003	Industry
Toledo	RO	2.880	Pure	2008	Industry
Tordera	RO	28.800	Seawater	2002	Municipal
Torrevieja	RO	240.000	Seawater	2011	Irrigation
Valdelentisco	RO	140.000	Seawater	2007	Municipal
Valencia	RO	1.500	Brackish	1997	Industry
Valencia	RO	550	Brackish	1999	Power
Valencia	RO	350	Brackish	2002	Industry
Valencia	RO	220	Brackish	2003	Industry
Valencia	RO	325	Brackish	2001	Industry
Valencia	RO	750	Brackish	2004	Industry
Valencia	RO	16.000	Brackish	2007	Municipal
Valencia	RO	54	Seawater		Industry
Valencia	RO	30	Pure		Industry
Valencia	RO	23.000	Seawater		Municipal
Valladolid	RO	190	Brackish	2002	Industry
Valls	RO	120	Brackish	2008	Industry
Vergel	RO	2.000	Brackish	2000	Municipal
Zaragoza	RO	150	Brackish	1998	Industry
Zaragoza	RO	1.700	Brackish	2003	Industry
Zaragoza	RO	1.200	Brackish		Municipal
Zona Regable del Chanza XVIII	RO	24.657	Seawater	2008	Industry
TOTAL WATER PRODUCTION CAPACITY				**4.278.288 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 62

Spain. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Abrera	RO	144	Pure	1990	Industry
Albatros, Lanzarote	RO	150	Seawater	1993	Municipal
Alcudia	RO	1.226	Brackish	1992	Industry
Alcudia	MED	1.500	Seawater	2007	Industry
Alicante	RO	300	Brackish	1993	Industry
Albacete	RO	300	Brackish	1995	Industry
Almanzora	RO	10.000	Brackish	1995	Municipal
Almería	RO	1.500	Brackish	1988	Tourism
Almeria	RO	1.500	Brackish	1994	Industry
Almería	RO	3.000	Brackish	1994	Industry
Almeria	RO	1.500	Brackish	2001	Irrigation
Almeria Pulpi	RO	6.000	Brackish	1988	Municipal
Amarilla	RO	250	Seawater	1994	Municipal
Amfi del Mar	RO	200	Seawater	1993	Municipal
Amfi del Mar II	RO	250	Seawater	1994	Municipal
Arucas-Moya	RO	4.000	Seawater	1994	Municipal
Bahía de Palma	MED	1.500	Seawater	1995	Industry
Balearic Islands	RO	500	Seawater	1986	Municipal
Balearic Islands		150	Brackish	1988	Tourism
Balearic Islands	RO	100	Brackish	1990	Tourism
Balearic Islands	RO	359	Pure	1992	Power
Balearic Islands	RO	500	Seawater	1995	Tourism
Balearic Islands	ED	150	Brackish	1995	Municipal
Barcelona	RO	220	Pure	1988	Industry
Barcelona	RO	1.900	Brackish	1989	Industry
Barcelona	RO	144	Pure	1990	Industry
Barcelona	RO	360	Brackish	1990	Industry
Barcelona	RO	300	River	1991	Industry
Barcelona	RO	600	River	1991	Industry
Barcelona	RO	1.470	River	1991	Industry
Barcelona	RO	300	Waste	1992	Discharge
Barcelona	RO	100	Waste	1994	Irrigation
Barcelona	RO	1.000	Brackish	1994	Industry
Barcelona	RO	800	Brackish	1994	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 62 (Continued)

Spain. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Barcelona	RO	1.260	Brackish	2006	Municipal
Beach Club, Lanzarote	RO	250	Seawater	1993	Municipal
Beatriz 2, Lanzarote	RO	300	Seawater	1995	Municipal
Bilbao	RO	100	Waste	1989	Industry
Buñuel	RO	960	Brackish	2006	Industry
Cabo de Gata	RO	1.500	Seawater	1992	Military
Cabo de Gata, ext.	RO	500	Seawater	1995	Municipal
Cáceres	RO	2.900	River	1990	Power
Cadiz - Chiclana	RO	100	Waste	1993	Irrigation
Cadiz	MED	1.000	Seawater	1995	Industry
Campo Cartagena	RO	1.000	Brackish	1995	Irrigation
Campo Cartagena	RO	1.750	Brackish	1995	Irrigation
Campohermoso	RO	250	Seawater	2006	Irrigation
Canary Islands	RO	350	Brackish	1987	Irrigation
Canary Islands	ED	693	Brackish	1989	Industry
Canary Islands	ED	1.100	Brackish	1989	Industry
Canary Islands	RO	600	Seawater	1991	Municipal
Canary Islands	RO	275	Brackish	1992	Irrigation
Canary Islands	RO	200	Seawater	1993	Municipal
Canary Islands	RO	150	Brackish	1994	Irrigation
Canary Islands	RO	350	Seawater	1995	Tourism
Canary Islands	RO	200	Seawater	1998	Tourism
Ciudad Real	RO	1.200	Brackish	2007	Industry
Corralejo (La Oliva)	RO	1.500	Seawater	1994	Municipal
Costa Lanzarote	RO	300	Seawater	1989	Tourism
Cuenca	RO	120	Brackish	1989	Municipal
Cuenca	RO	250	Brackish	1990	Municipal
Del Rosario	RO	4.000	Seawater	1992	Municipal
El Alquian, Almería	RO	650	Seawater	2007	Irrigation
Formentera	MED	500	Seawater	1991	Tourism
Formentera	RO	2.000	Seawater	1995	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 62 (Continued)

Spain. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Fuerteventura	MED	1.000	Seawater	1980	Municipal
Fuerteventura	MED	200	Seawater	1982	Tourism
Fuerteventura	MED	400	Seawater	1982	Tourism
Fuerteventura	MED	1.000	Seawater	1982	Municipal
Fuerteventura	MED	1.000	Seawater	1982	Municipal
Fuerteventura	MED	350	Seawater	1984	Tourism
Fuerteventura	RO	200	Seawater	1986	Tourism
Fuerteventura	RO	330	Brackish	1986	Irrigation
Fuerteventura	MED	600	Seawater	1986	Tourism
Fuerteventura	RO	125	Brackish	1987	Municipal
Fuerteventura	RO	200	Brackish	1987	Tourism
Fuerteventura	RO	300	Brackish	1987	Tourism
Fuerteventura	MED	1.600	Seawater	1987	Municipal
Fuerteventura	RO	300	Brackish	1987	Tourism
Fuerteventura	RO	300	Seawater	1988	Tourism
Fuerteventura	MED	1.200	Seawater	1988	Tourism
Fuerteventura	MED	1.200	Seawater	1988	Tourism
Fuerteventura	RO	400	Seawater	1988	Tourism
Fuerteventura	RO	108	Brackish	1988	Industry
Fuerteventura	RO	200	Brackish	1988	Industry
Fuerteventura	RO	300	Brackish	1988	Municipal
Fuerteventura	RO	300	Seawater	1988	Tourism
Fuerteventura	RO	400	Brackish	1988	Municipal
Fuerteventura	RO	400	Brackish	1988	Tourism
Fuerteventura	RO	600	Brackish	1988	Municipal
Fuerteventura	RO	600	Brackish	1988	Tourism
Fuerteventura	RO	600	Brackish	1988	Tourism
Fuerteventura	RO	400	Seawater	1989	Tourism
Fuerteventura	RO	600	Seawater	1989	Tourism
Fuerteventura	RO	600	Brackish	1989	Municipal
Fuerteventura	RO	300	Seawater	1989	Tourism
Fuerteventura	RO	300	Seawater	1990	Tourism
Fuerteventura	RO	640	Seawater	1990	Tourism
Fuerteventura	RO	3.000	Seawater	1990	Municipal
Fuerteventura	MED	1.000	Seawater	1990	Tourism
Fuerteventura	RO	2.400	Seawater	1991	Municipal
Fuerteventura	RO	190	Brackish	1991	Tourism
Fuerteventura	RO	340	Brackish	1992	Irrigation
Fuerteventura	RO	170	Brackish	1992	Irrigation

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 62 (Continued)

Spain. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Fuerteventura 3	RO	4.000	Seawater	1992	Municipal
Fuerteventura	RO	325	Brackish	1994	Industry
Fuerteventura	RO	150	Brackish	1994	Irrigation
Fuerteventura	RO	400	Brackish	1995	Irrigation
Galdar-Agaete	RO	3.500	Seawater	1999	Municipal
Gando (CI)	RO	1.000	Seawater	1993	Municipal
Gran Agrícola	MED	500	Seawater	1992	Municipal
Gran Canaria	RO	400	Brackish	1986	Irrigation
Gran Canaria	RO	400	Brackish	1987	Irrigation
Gran Canaria	RO	600	Brackish	1987	Irrigation
Gran Canaria	MED	1.000	Seawater	1987	Tourism
Gran Canaria	RO	4.000	Seawater	1988	Irrigation
Gran Canaria	MED	2.400	Seawater	1988	Tourism
Gran Canaria	RO	400	Brackish	1988	Irrigation
Gran Canaria	RO	400	Brackish	1988	Irrigation
Gran Canaria	RO	850	Brackish	1988	Municipal
Gran Canaria	RO	100	Seawater	1988	Tourism
Gran Canaria	RO	850	Brackish	1989	Irrigation
Gran Canaria	RO	1.600	Brackish	1989	Irrigation
Gran Canaria	RO	200	Seawater	1989	Tourism
Gran Canaria	RO	200	Brackish	1989	Irrigation
Gran Canaria	RO	900	Brackish	1989	Irrigation
Gran Canaria	RO	900	Brackish	1989	Irrigation
Gran Canaria	MED	1.000	Seawater	1990	Industry
Gran Canaria	RO	10.000	Seawater	1991	Irrigation
Gran Canaria	RO	400	Brackish	1991	Irrigation
Gran Canaria	RO	1.200	Brackish	1991	Irrigation
Gran Canaria	MED	1.000	Seawater	1992	Power
Gran Canaria	RO	270	Brackish	1992	Irrigation
Gran Canaria	RO	625	Brackish	1993	Irrigation
Gran Canaria	RO	1.300	Brackish	1993	Irrigation
Gran Canaria	RO	300	Brackish	1994	Tourism
Gran Canaria	MED	600	Seawater	1995	Industry
Gran Canaria	RO	400	Brackish	1995	Irrigation
Gran Canaria	RO	930	Brackish	1995	Irrigation
Gran Canaria	MED	1.000	Seawater	1990	Industry
Gran Hotel Arona, Tenerife	RO	200	Seawater	2007	Tourism
Gran Tarajal	RO	1.500	Seawater	1994	Municipal
Guia	MED	1.500	Seawater	1992	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

TABLE 62 (Continued)

Spain. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Hotel Bahía del Duque, Tenerife	RO	600	Seawater	2007	Tourism
Hotel Oasis, Lanzarote	RO	250	Seawater	1993	Municipal
Hotel Vital Plaza, Lanzarote	RO	370	Seawater	1993	Municipal
Hotels Spain	RO	300	Seawater	2006	Tourism
Ibiza	RO	150	Seawater	1991	Tourism
Ibiza	RO	9.000	Seawater	1991	Municipal
Ibiza	RO	8.200	Seawater	1995	Municipal
IDAM, Sagunto	RO	22.900	Seawater	2010	Tourism
Imotel, Canary Islands	RO	250	Seawater	1995	Municipal
Jaén	RO	720	Brackish	1987	Municipal
Jaén	RO	100	Waste	1989	Demonst.
La Oliva	RO	1.000	Seawater	1989	Tourism
La Palma (Mu)	RO	600	Brackish	1995	Irrigation
La Santa Sport,	RO	500	Seawater	1993	Municipal
Lanzarote	MED	500	Seawater	1983	Municipal
Lanzarote	MED	500	Seawater	1984	Tourism
Lanzarote	MED	600	Seawater	1985	Tourism
Lanzarote	MED	600	Seawater	1985	Tourism
Lanzarote	MED	600	Seawater	1986	Tourism
Lanzarote	MED	600	Seawater	1986	Tourism
Lanzarote	RO	750	Seawater	1986	Tourism
Lanzarote	RO	200	Seawater	1986	Tourism
Lanzarote	RO	500	Seawater	1987	Municipal
Lanzarote	RO	2.000	Seawater	1987	Tourism
Lanzarote	RO	350	Seawater	1987	Municipal
Lanzarote	MED	300	Seawater	1988	Tourism
Lanzarote	MED	350	Seawater	1988	Tourism
Lanzarote	MED	1.200	Seawater	1988	Tourism
Lanzarote	MED	1.200	Seawater	1988	Tourism
Lanzarote	RO	300	Seawater	1988	Tourism
Lanzarote	RO	300	Seawater	1989	Tourism
Lanzarote	RO	300	Seawater	1989	Tourism
Lanzarote	RO	800	Seawater	1989	Tourism
Lanzarote 3	RO	20.000	Seawater	1996	Municipal
Lanzarote 4	RO	20.000	Seawater	2001	Municipal
Las Palmas	MED	500	Seawater	1987	Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 62 (Continued)

Spain. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Las Palmas	MED	500	Seawater	1989	Industry
Las Palmas	RO	100	Seawater	1989	Municipal
Las Palmas	RO	300	Brackish	1989	Municipal
Las Palmas 4	RO	12.000	Seawater	1990	Municipal
Las Palmas III	RO	75.000	Seawater	2007	Municipal
León	RO	320	Waste	1990	Power
Linares	RO	750	Pure	1989	Industry
Los Zocos	RO	150	Seawater	1993	Municipal
Madrid	RO	2.271	River	1988	Power
Madrid	RO	2.000	Brackish	2006	Industry
Malaga	RO	600	Brackish	1992	Municipal
Malaga	RO	500	Brackish	1992	Industry
Málaga	RO	400	Pure	2006	Industry
Mallorca	MED	520	Seawater	1982	Power
Marina D´Or, Oropesa	RO	2.000	Seawater	2006	Municipal
Martorell	RO	10.500	River	1992	Industry
Martorelles	RO	100	Pure	1990	Industry
Maspalomas 1	ED	16.000	Brackish	1986	Municipal
Maspalomas	RO	7.500	Seawater	1990	Tourism
Maspalomas	ED	2.000	Brackish	1988	Municipal
Maspalomas ext.	RO	5.000	Seawater	1993	Municipal
Maspalomas ext.	RO	2.500	Seawater	1995	Municipal
Maspalomas I Mar	RO	3.000	Seawater	2006	Municipal
Mazarrón	RO	3.300	Brackish	1992	Irrigation
Mazarrón	RO	13.500	Brackish	1995	Irrigation
Mina Pública, Abrera	RO	750	Brackish	2009	Municipal
Minas de Gandor	RO	1.000	Brackish	1988	Industry
Murcia	RO	400	Brackish	1988	Irrigation
Murcia	RO	190	Brackish	1989	Industry
Murcia	RO	100	Brackish	1995	Industry
Palacio de Isora, Adeje	RO	500	Seawater	2009	Tourism
Palencia	RO	800	Brackish	1995	Industry

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 62 (Continued)

Spain. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Playa Flamingo	RO	170	Seawater	1993	Municipal
Playa Serena	RO	2.500	Seawater	2007	Irrigation
Puertollano	RO	1.800	Brackish	1995	Industry
Sa Pobla	RO	3.000	Brackish	2007	Municipal
Sagunto	RO	750	Brackish	1995	Industry
Sevilla	RO	120	Brackish	1991	Industry
Sevilla	RO	3.800	Brackish	1993	Industry
Sevilla	RO	1.800	Brackish	1995	Industry
Sevilla	RO	200	Seawater	2006	Industry
Spain	RO	260	Brine	1987	Municipal
Spain	ED	300	Brackish	1987	Demonst.
Spain	ED	1.200	Brackish	1988	Irrigation
Spain	ED	1.800	River	1988	Municipal
Spain	ED	1.200	Brackish	1991	Industry
Spain	ED	600	Brackish	1992	Industry
Spain	ED	1.897	Brackish	1994	Irrigation
Spain	ED	2.081	Brackish	1994	Irrigation
Spain	ED	300	Brackish	1987	Demons.
Spain	ED	2.100	River	2003	Irrigation
Spain	ED	3.750	Waste	2006	Irrigation
Spain	ED	4.000	Waste	2007	Irrigation
Spain	RO	4.000	Seawater	2007	Irrigation
Spain	RO	2.500	Seawater	2007	Municipal
Spain	ED	260	Brackish	2007	Municipal
Stella Canarias	RO	250	Seawater	1994	Municipal
Sureste 1	RO	10.000	Seawater	1993	Municipal
Tarragona	RO	997	River	1992	Industry
Tarragona	RO	1.440	River	1995	Industry
Teguise Playa	RO	130	Seawater	1993	Municipal
Tenerife	RO	300	Brackish	1990	Irrigation
Tenerife	RO	300	Brackish	1991	Irrigation
Tenerife	RO	360	Brackish	1991	Irrigation
Tenerife	MED	600	Seawater	1992	Power
Tenerife	RO	460	Brackish	1993	Irrigation
Tenerife	MED	600	Seawater	1994	Power
Tenerife	MED	3.600	Seawater	1994	Industry
Tenerife	ED	2.200	Brackish	1994	Irrigation
Tenerife	RO	3.000	Brackish	1994	Irrigation
Tenerife	RO	200	Seawater	1995	Tourism

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 62 (Continued)

Spain. Desalting Plants presumed on line (2011)

Denomination /Location	Method	Production m³/day	Raw water	Year	Use
Tenerife	ED	2.000	Brackish	1995	Municipal
Tenerife	RO	460	Brackish	1995	Irrigation
Tenerife	RO	420	Brackish	1995	Industry
Tenerife	RO	450	Seawater	2006	Industry
Tias	RO	140	Brackish	1993	Irrigation
Toledo	RO	300	Brackish	1993	Tourism
Toledo	RO	300	Brackish	1993	Industry
Toledo	RO	600	Brackish	2006	Industry
Torrox	RO	500	Seawater	2007	Irrigation
Valencia	RO	200	Brackish	1988	Industry
Valencia	RO	500	River	1988	Industry
Valencia	RO	150	Brackish	1991	Industry
Valencia	RO	1.440	Brackish	1992	Tourism
Valencia	RO	120	River	1994	Power
Valencia	RO	125	Brackish	1995	Industry
Valencia	RO	2.000	Brackish	2006	Industry
Valencia	RO	350	Seawater	2006	Industry
Valencia	RO	350	Brackish	2006	Industry
Valencia	RO	1.200	Seawater	2007	Industry
Valladolid	RO	4.000	Brackish	1992	Industry
Vandellós	MED	2.400	Seawater	1980	Power
Zaragoza	RO	500	River	1989	Industry
Zaragoza, Central Térmica Escatrón	RO	624	River	1989	Industry
Zaragoza	RO	3.800	Brackish	1990	Industry
Zaragoza	RO	715	Brackish	1992	Industry
Zaragoza	RO	850	Brackish	1992	Industry
TOTAL WATER PRODUCTION CAPACITY				**491.294 m³/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 63

Spain. Desalting plants under construction (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Adeje Arona Phase 2	RO	10.000	Seawater		Municipal
Arroyo Culebro, Madrid	RO	14.256	Waste		Municipal
Barcelona	RO	9.600	Waste		Industry
Barcelona	RO	5.000	Waste		Municipal
Bocabarranco, Gran Canaria	RO	10.000			
Camp de Tarragona	RO	20.000	Brackish		Industry
Campo de Dalias, Almería	RO	97.200	Seawater		Municipal
Ceuta Expansion	RO	8.800	Seawater		Municipal
Denia, Alicante	RO	16.000	Seawater		Municipal
El Prat del Llobregat	RO	14.000	Seawater		Municipal
ETAP Campo de Montiel	RO	10.000	Brackish		Industry
Garray, Soria	RO	7.680	Waste		Municipal
Granadilla	RO	14.000	Seawater		Municipal
Grupo SETA, Toledo	RO	300	Brackish		Industry
I.D.A.M. Ibiza	RO	12.000	Seawater		Municipal
I.D.A.M. San Antonio	RO	17.500	Seawater		Municipal
La Caleta, Tenerife	RO	10.000	Seawater		Municipal
Lanzarote V, Canary Islands	RO	24.000	Seawater		Municipal
Lanzarote V, Canary Islands	RO	10.000	Seawater		Municipal
Las Playitas, Canary Islands	RO	3.000	Pure		Tourism
Mijas, Fuengirola	RO	55.000	Seawater		Municipal
Marina baja, El Campello, Muchamiel	RO	50.000	Seawater		Municipal

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 62 (Continued)

Spain. Desalting plants under construction (2011)

Denomination /Location	Method	Production m^3/day	Raw water	Year	Use
Moncófar, Castellón	RO	27.000	Seawater		Municipal
Oropesa, Castellón	RO	41.000	Seawater		
Palma del Rio II, Córdoba	RO	3.600	Brackish		Municipal
PTA, Escombreras	RO	12.000	Brackish		Industry
Puerto de Rosario, Fuerteventura	RO	14.000	Seawater		Municipal
Roque Prieto, Gran Canaria	RO	5.000	Seawater		Municipal
Sagunto, Valencia	RO	22.000	Seawater		
San Beach Hotel, Lanzarote	RO	300	Seawater		Tourism
Spain	RO	818	Brackish		Industry
Tarrona y Vilaseca	RO	30.000	Seawater		Industry
Tordera, Catalunya Expànsión	RO	28.000	Seawater		Municipal
Vilaseca Tertiary, Tarragona	RO	20.000	Waste		Industry
TOTAL WATER PRODUCTION CAPACITY				**622.054 m^3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

PORTUGAL

ir a ÍNDICE

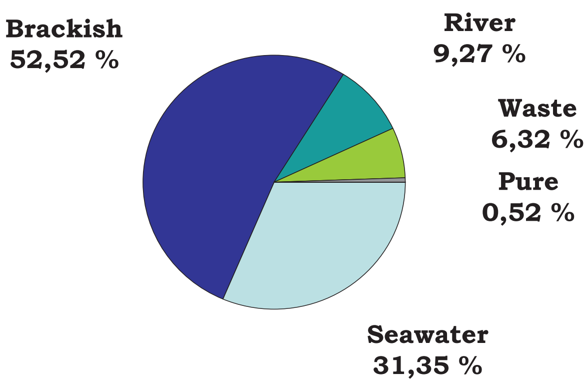
ir a ÍNDICE

PORTUGAL

The IDA Worldwide Desalting Plants Inventory (2011) informs on 14 desalting plants ON LINE in Portugal which total capacity to produce desalinated water is 10.927 m^3/day (TABLE 64) and 5 desalting plants presumed on line with capacity to produce 6.160 m^3/day (TABLE 65). Also, informs on a desalting plant under construction to produce 1.500 m^3/day, by reverse osmosis, for urban supply. So, actually, the presumed water desalination capacity in Portugal is 17.087 m^3/day. This means less than 0,01 % of the renewable resources of this country.

The total capacity of desalinated water production is shared by 5.358 m^3/day (31,35 %) proceeding from seawater; 8.975 m^3/day (52,52 %) from brackish water; 1.580 m^3/day (9,27 %) from river; 1.080 m^3/day (6,32 %) form waste water; and 90 m^3/day (0,52 %) from pure water. The GRAPHIC 54 represents this distribution.

GRAPHIC 54
Desalinated water production according to feed water origin in PORTUGAL

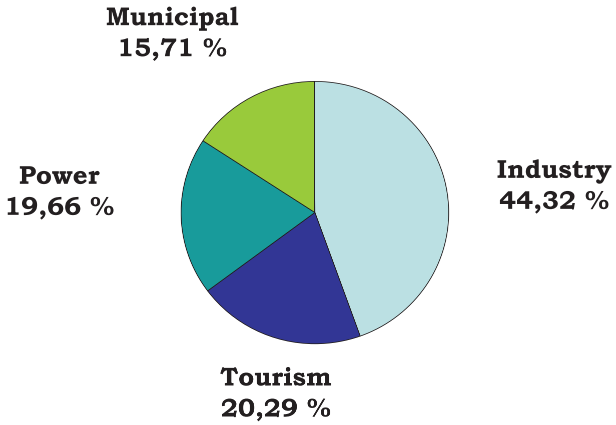


The total of desalinated water capacity of desalinated water is applied as follows:

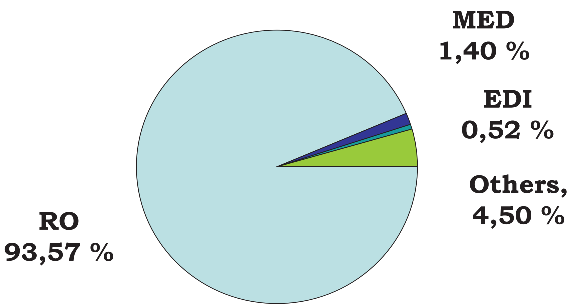
- 7.574 m^3/day (44,32 %) to industry.
- 3.468 m^3/day (20,29 %) to tourism.
- 3.360 m^3/day (19,66 %) to power.
- 2.685 m^3/day (15,71 %) to municipalities.

The GRAPHIC 55 represents the distribution of desalinated water uses in Portugal.

GRAPHIC 55
Uses distribution of desalinated water in PORTUGAL



GRAPHIC 56
Frecuency of water desalination methods in PORTUGAL



Reverse osmosis is the desalting method used to produce 15.989 m^3/day (93,57 %), 240 m^3/day (1,40 %) are produced by MED systems, 90 m^3/day (0,52 %) by EDI and 768 m^3/day (4,50 %) by other methods. These figures illustrate the predominance of RO systems in Portugal. The GRAPHIC 56 represents the frequency of water desalination methods in this country.

TABLES MENTIONED IN THIS SECTION

ir a ÍNDICE

ir a ÍNDICE

TABLE 64

Portugal. Desalting plants on line (2011)

Location	Method	Production m3/day	Raw water	Year	Use
Aqua Cleer IW 16, Lisbon	RO	320	Brackish	2009	Industry
Aqua Cleer SW1000, Lisbon	RO	300	Seawater	2009	Industry
Aqua Cleer SW 4500, Sintra	RO	108	Seawater	2008	Industry
EDI 10	EDI	90	Pure	2009	Industry
Lisbon	RO	225	Brackish	1999	Municipal
Odemira	Other	768	River	2009	Tourism
Oporto	RO	2.210	Brackish	2002	Industry
Porto Santo	RO	250	Seawater	2000	Industry
Portugal	RO	2.400	Brackish	1997	Industry
Portugal	RO	1.080	Waste	1999	Industry
Portugal	RO	2.000	Seawater	2007	Tourism
Portugal	RO	360	Seawater	2007	Municipal
Portugal	RO	600	River	2008	Industry
Portugal	RO	216	River		Industry
TOTAL CAPACITY OF WATER PRODUCTION				**10.927 m3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

TABLE 65

Portugal. Desalting plants presumed on line (2011)

Location	Method	Production m3/day	Raw water	Year	Use
Lisbon	RO	700	Brackish	1984	Tourism
Lisbon	RO	3.120	Brackish	1986	Power
Macao	MED	240	Seawater	1990	Power
Porto Santo	RO	1.500	Seawater	1994	Muncipal
Portugal	RO	600	Seawater	1993	Municipal
TOTAL CAPACITY OF WATER PRODUCTION				**6.160 m3/day**	

Source: The IDA Worldwide Desalting Plant Inventory (2011)

ir a ÍNDICE

ir a ÍNDICE

ir a ÍNDICE

ir a ÍNDICE

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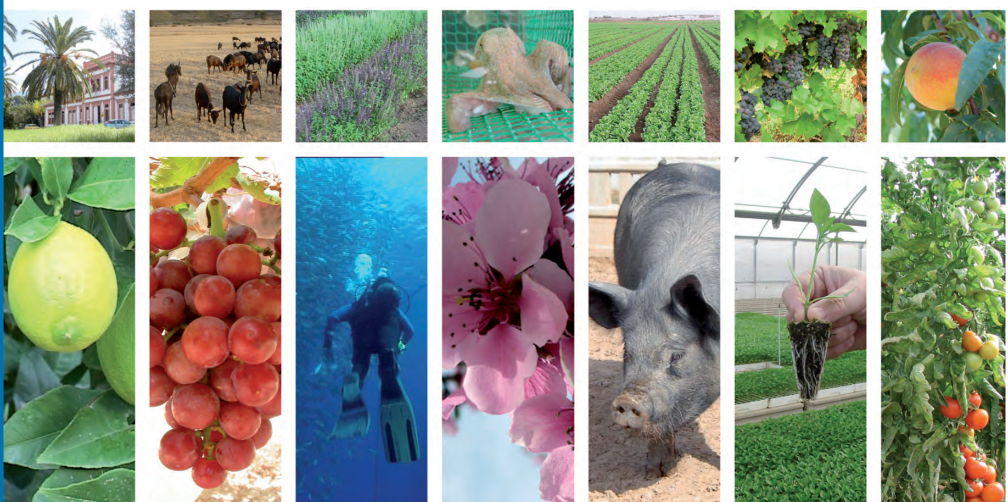

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