Friends of the Earth Middle East
جمعية أصدقاء الأرض الشرق الأوسط
ידידי כדור הארץ המזרח התיכון

Desalination: How much and what is the alternative?

For decades, the Israel has managed its water economy with an ever-increasing deficit. This policy has led to a deterioration in the quality of the water sources and to the verge of a state of emergency regarding the water supply.[1] However, the problem of water deficit, like any other shortage problem has two possible solutions: increase supply and/or reduce consumption (reduce leakages, manage demand, reclamation of wells, recycling, etc.; see section 2).

Background:

Increasing the supply – desalination: many see desalination as the sole savior of the deficit in the water economy. Desalination is indeed essential for Israel and its implementation was delayed for too long – after the water economy was already in a state of deficit. Desalination is vital to put a halt to the over-pumping of the already depleted ground water supply. Currently, desalination is necessary to secure the supply of water for essential needs in the case of prolonged drought when reduced pumping from natural reservoirs will be necessary. The current desalination policy, however, aims to increase the volume of desalination threefold over the coming decades (see Table 1 below)

Table 1 - Desalination Programs in Israel up to 2030:

Year	Facilities	Output per Facility*	Accumulative Output
2011	Ashkelon, Palmachim, Hadera	300	300
2012	Ashdod	100	400
2013	Soreq	150	550
2016	Western Galilee	50	600
2020			750
2030			940

* Data Source: Water Authority

[1] See for example, the report of the National Inquiry Committee on the subject of water economy management: http://elyon1.court.gov.il/heb/mayim.htm

The down side of desalinization:

The desalination policy at these planned volumes "solves" one problem while creating other problems:

a. The high energy consumption involved in the desalination of seawater **will bring about an increase in air pollution and greenhouse gas emissions**. The desalination of seawater requires 3 to 4 times the quantity of electricity required to produce water from Israel's natural reservoirs. The desalination plans of the State of Israel are liable to raise the electricity consumption of the water economy in a substantial manner (see Figure 1) reaching up to 10% of the total electricity consumption of the entire economy.[2] The desalination of 750 million cubic meters (mcm) of water in 2020 (in accordance with the Water Authority plan) will consume 2,900 megawatt of electricity, that is more power than the entire output of the Rottenberg Power Station in Ashkelon. [3] Because almost all the electricity in Israel is generated by burning fossil fuels (coal, gas, and heavy fuel oil), this policy will significantly increase the emission of greenhouse gases in Israel particularly during a period in which Israel has undertaken to reduce the rate of increase of greenhouse gas emissions within its jurisdiction by 20%.

A partial solution to the problem of energy that arises from the desalination approach to increasing water supply is to integrate a direct osmosis plant that dilutes seawater with marginal water prior to the desalination. This will save a great deal of energy and allow the dilution of the desalination concentrate. [4] Therefore, there is an **advantage in deferring the construction of non-essential desalination plants until such technologies will be available and safe for implementation.**

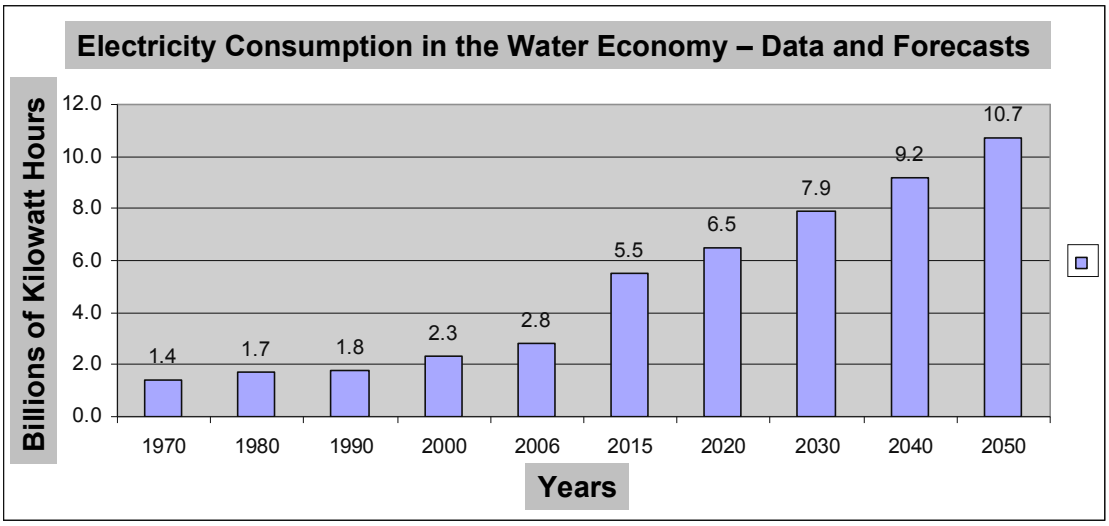
[2] The desalination plans for 750 mcm will consume 2.9 billion kilowatt, that is, almost 4% of the electricity consumption in 2020 (for desalination alone). The remaining electricity consumption for the water economy is mainly due to pumping, distribution to the various towns and villages and individual homes, and sewage purification plants.

[3] According to the forecast of the Water Authority and the Ministry of Infrastructure. See Table 1.

[4] Elimelech M., & Philpe W., 2011. The Future of Seawater Desalination: Energy, Technology and the Environment. Science 313, pp. 712–717.

Figure 1 - The Consumption of Electricity in the Water Economy – Data and Forecast (in Billions of Kilowatt Hours)

* From the Water Authority Report to the Directors General Committee for the Preparedness of the Water Economy for Climate Change – September 2009



The graph illustrates the energy consumption implications of increased reliance of the water economy on desalinization plants. Note the leap in the consumption of electricity from 2006 to 2015, from 2.8 to 5.5 billion kilowatt hours as a result of the establishment of desalination plants.

b. **Desalination plants take up valuable land** (environmental and/or real estate) on the coast and adjacent to it.

c. **The increase in desalination will bring about concentration [of control] of the water economy, whilst transferring control from the Government to a few wealthy companies or individuals**.[5] Desalination requires a huge investment and will require the introduction of private investors into a sector that in the past was under the jurisdiction of public authorities such as Mekorot. The investors, naturally, would like a handsome return on their investment in the desalination plants; thus, the increase in the concentration [of control] will impair the ability of the consumer and the heads of the economy to bargain against a cartel of 2–3 private companies and, at the end of the day, will lead to an increase in the price of water and a reduction in the level of service (for example, the resistance on the part of desalination companies to reintroduce magnesium into the water).

[5] Avi bar Eli, The Marker, September 2011, - "The Concentration [of control] in the Desalination Industry is Drying up the Country".

d. The output from the desalination plants into the sea, made up of seawater concentrate after desalination and the many chemicals used in the preliminary treatment and for rinsing the membranes and filters, has an immediate **negative impact on the marine animal and plant life in the vicinity of the outflow point.** The accumulative effect of a number of desalination plants on the marine environment along the shoreline of Israel has not been investigated sufficiently.[6]

e. Not all the long-term **effects of the consumption of desalinated water on human health** have been investigated. For example, the deficiency of magnesium in desalinated water.[7] To date, no compulsory standard for the addition of magnesium to desalinated water has been approved, contrary to the recommendations of the World Health Organization, the Adin Commission and the [Israeli] Ministry of Health.

f. The **strategic risk** of increasing Israel's dependence on vulnerable engineering facilities, both at the operational level and at the security level.

g. From the point of view of irrigation, the low salinity of waste water sourced from desalinated water has a clear advantage in preventing the salinization of topsoil and ground water. However, a shortage of nutritional components is possible and **the various long-term effects of the water composition on the agricultural crops and topsoil** (for example, the SAR ratio) **need to be examined**.

In its conclusions, the investigative committee on the management of the water economy (2010) was also markedly critical of an unrestrained desalination policy and recommended to reinforce the policy of water conservation and the restraining of demand along with that of desalination. **The reduction in demand ahead of desalination is the leading policy currently in the western world**, both in the European Union's Water Framework Directive as well as in countries such as Australia, Spain, Cyprus, various states in the USA, etc.

However, taking into account all the environmental costs, the State of Israel will have to increase its supply of water by means of seawater desalination in order to prevent the drying up of the water table and the negative impact on the existing reservoirs. **The critical questions are: 1) by how much? and 2) Are there are any alternatives to desalination?** In order to answer these questions, a solution to

[6] National Master Plan 34b and 2/b – Analysis of the Environmental Impact of Seawater Desalination Plants – Background Document, Edited by Tami Trope.

[7] "The Deficiency of Magnesium in Desalinated Water", Shelly Levy, A Report of the Information and Research Center, Israel Knesset, January 2011.

the deficit in water supply must also be sought on the other side of the equation,[8] that is, **by reducing demand**.

Alternatives to Desalinization

2. Management of Demand and Conservation of Water

Currently, the average Israeli consumes about 90 cubic meters of fresh water per year, which is 247 liters per day, for domestic consumption alone. Along with the agricultural consumption of fresh water (about 500 million cubic meters per year), we reach a total consumption of 311 liters per person per day. Less than 5% of this water is consumed directly for drinking and cooking (about 15 liters per person per day). The rest is consumed through the supply of fresh food, bathing, dishwashing, toilet flushing, and gardening. These services can be supplied in various ways that do not require an accumulated consumption of fresh water (drinking water).

There are various and varied means that can be applied through a water conservation approach that are not sufficiently utilized, even in Israel.

a. Prevention of loss, mainly the reduction **of water and sewage** leakage and the reduction of evaporation from water reservoirs.

b. **Purification and additional reuse of water:** the purification and recycling of the 160 million cubic meters of sewage water currently not utilized for reuse in agricultural irrigation, "reclamation of wells" – the purification of contaminated water sources and the reuse of grey water. [9]

c. **Landscaping and agriculture adapted to the local climate**. It is possible to achieve a reduction of 50% in water consumption for municipal and domestic gardens without affecting the quality or the designation of the gardens. Although the agricultural sector in Israel is one of the most efficient in the world regarding water consumption, there is still room for savings. Special water tariffs, the types of crops, and the scope of irrigated land should be examined and, through reforms in conjunction with farmers, the consumption of water in the agricultural sector could be substantially reduced.

d. **Education and guidance** as a fixed policy starting from a young age, **with the objective of long-term changes in water consumption habits**. Educational campaigns should refrain from presentations using dual

[8] To increase the supply of fresh water, there are other solutions that have not been sufficiently investigated and will not discussed here. For example, importing water from the Adriatic coast in floating tanks and increasing rainfall using new methods.

[9] Enables the double recycling of bathroom water: 1. Flushing the toilets with grey water after treatment at home. 2. Third-time use for irrigation of public gardens or agricultural fields, after additional purification at a purification plant.

connotation messages, such as the latest campaign that hinted that soon there will be no need to save water thanks to desalination.

e. **Enforcment of the regulations** that prohibit wasting water, such as the regulations against washing cars and sidewalks and restrictions on irrigation. This, along with subsidies for water saving and recycling measures, (installation of water saving devices, pressure valves, irrigation controllers, etc.).

f. "**Water Sensitivity Planning**" that reduces the municipal storm water surplus to a minimum and increases the introduction of water into the ground water table. Such a plan has been approved in National Master Plan 35/b, but has not been implemented properly due to a lack of training and enforcement.

g. **Managing demand by means of full and staggered tariffs** according to the level of consumption per person,[10] beginning with a subsidized tariff for vital basic consumption, and steeply rising tariff levels relative to the amount of consumption. Such costing will bring about a substantial reduction in unnecessary consumption without burdening the weaker socio-economic population or the middle class.

The majority of the above stated means of the "water conservation economy" are cheaper than the cost of desalination. It was found that adopting some of the above stated means (those whose costs are less than desalination), can save some 500 mcm of water annually in 2020 compared to the 2007 BAU forecast, at a lower cost than desalination.[11] In the joint document of the Environmental Organizations[12] it was found that it is possible to reduce the need for desalination in the target year, 2030, to 660 mcm. The cost of the environmental balance to the economy is lower by NIS 2 billion per annum.

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[10] We suggest three levels that include a cross subsidy: 1. Under 2 cubic meters per person, per month: a subsidized tariff. 2. From 2 to 4 cubic meters.: full tariff (that covers all the direct and indirect costs that can be priced). 3. Over 4 cubic meters. per person: a high and deterring price (at least NIS 20) aimed at reducing excess consumption.

[11] Even if we calculate only the direct costs and even more so if we also include the external costs of desalination (that is: air pollution, the greenhouse gas emissions, etc.), see for example, Rosenthal & Katz (2010):
http://foeme.org/uploads/JR_Economic_Analysis_of_Policy_Options_for_Water_Conservation_in_Israel_HEBREW_August_2010.pdf .
According to the Ministry for Environmental Protection, the potential of these and other means stands at 370 mcm per annum (quoted from the National Commission of Inquiry for the Management of the Water Economy in Israel, pp 270–271, March 2010).

[12] Gadi Rosenthal, Rami Erez, and the Environmental organizations (2010) – "Environmental Policy for Water Economy Management". The overall environmental balance includes the reduction in the domestic–municipal consumption to 83cubic meters per person, a reduction in the allocation of fresh water to agriculture to 300 mcm. per annum, and the increase of the allocation of water to nature from 50 to 180 mcm per annum. http://www.teva.org.il/?CategoryID=869&ArticleID=5091

Furthermore, the water conservation economy has additional advantages compared to desalination, in employment potential in the Israeli market and the potential to encourage exports and "green growth" in the technological industries and services.[13] The implementation of the above-mentioned steps, including the reduction in demand through education and presentations, the replacement of gardens, the prevention of leaks, and grey water recycling, will **add 316 mcm per year to the water economy in 2020, while creating 5,200 "green" jobs per year.** Desalination is a capital-intensive technology with a low potential for employment compared with the implementation of a water conservation economy. **The promotion of these measures in Israel will increase the export potential of Israeli companies specializing in water conservation by about NIS 2 billion per annum in 2020 and the employment potential to about 10,000 additional jobs.**

3. Operative Proposals for a Balanced Desalination Policy:

a. Changing the government's current approach and reducing the desalination target for 2020 to 400 mcm. This target will secure about 50% of the municipal consumption as well as the preservation of a minimal allocation to nature that will prevent drying up of natural sources even during periods of extended drought that require drastic pumping restrictions.

b. The adoption of all the steps required for the water conservation economy and the management of demand (see section 2 and the attached documents).

c. **Policy to return water back to nature as desalination increases.** A special legislation should be established that determines a certain percentage of desalinated water (10–20%) to be used as an alternative to pumping from natural water sources, in order to raise the water level of natural water resources and reinstate, in a gradual manner and where possible, the natural water flow into the streams, the Jordan River, the Sea of Galilee, and the Dead Sea. This proposal has a number of advantages to the water economy:

- **Water Security**. Raising the level of the water table in the aquifers and in the Sea of Galilee will bring about an increase in the water reservoirs and an improvement in the water quality.

- **Restoration of some of the natural abundance.** High water levels will increase flows that have been severely thinned out over the past few years. For example, in work that FoEME carried out recently in conjunction with DHV, it was found that the expected reduction in pumping in the National Water Carrier in addition to a number of steps to reduce water use from the Jordan River will

[13] Sinclair et al. (2011): "The Potential of Green Jobs and Green Growth": http://foeme.org/uploads/13148607690~%5E$%5E~Promoting_Green_Jobs_and_Exports_in_a_Green_Water_Economy.pdf

enable the restoration of the level of the Sea of Galilee and the controlled release of some 150 mcm of water annually over and above the current existing flow into the Lower Jordan River.[14]

- **Including some of the external costs due to excessive pumping** (damage to the environment and to future generations) **in the price of water**. The relatively high cost of desalinated water reflects part of the external costs caused by excessive pumping [15] and will encourage lower demand and savings on the part of the public.

The provision that the recycling of water into streams be conditional with the progress of desalination is tantamount to environmental justice, as all the consumers benefit from desalinated water – the municipal sector, the industrial sector, and the agricultural sector. Thus, it is only fair that nature, which is the main victim of the water shortage, will benefit from the increase in supply as a result of desalination. We will all benefit from the restoration of nature and the streams and rivers.

d. **Carrying out research on the environmental impact and damage caused by desalination facilities**, specifically: the accumulative damage of discharge into the marine environment; the accumulative effect of prolonged consumption of desalinated water on human health, and an economic evaluation of the prevention/reduction in possible health damage from the above stated. The Ministry of Environmental Protection should issue tenders to carry out these studies.

e. Feasibility studies and the implementation of innovative technologies to reduce the energy consumption of desalination facilities, such as combining direct osmosis to dilute seawater in desalination plants.

Conclusions: Desalination is often the more expensive approach to resolving the water supply challenges both to the economy as whole and to the consumer, with profits from the high costs going to the wealthy, the manufacturers of membranes in Germany and the construction of the facilities (temporary contract workers, not necessarily Israelis). A water economy based on conservation and demand management will reinstate a greater portion of the water resource to public ownership and expand the responsibility and ownership of each and every one of us to conserve water. Apart from that, technologies that enable more efficient use

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[14] Gilad Sapir, DHV-MED and Friends of the Earth Middle East, 2001. Road map for the restoration of the lower Jordan River.

[15] These, however, do not fully reflect the external costs resulting from the desalination itself – the high energy consumption, the emission of pollutants and greenhouse gases, and damage to the coastal and marine environment – but it is an initial step in the direction of internalizing the external costs.

of water are constantly improving[16] which can reduce consumption, reduce water losses, or enable the re-use of water, without affecting the level of water services to which we have become accustomed. **The solution to the water crisis lies in the correct policy of both sides of the equation – in increasing supply as well as reducing demand.**

The setting up of more and more desalination plants in order to keep up with the increased demand in water reminds one of the well-known vicious circle of "policies" in response to the traffic congestion on the roads. Building more roads that encourage more suburbs and more shopping centers that are aimed at vehicle owners, a process that leads to the purchase of more vehicles and further congestion on the roads and so on and so forth.

"Protecting the Environment" means to change our global perception: to change from a culture (and policy) that enables and even encourages excess consumerism that creates more and more system-wide problems and consumes natural resources, to a culture (and policy) based on wise consumption and maximum efficiency, that will improve the quality of life of the consumers and not only the volume of consumption. This applies especially to the policy regarding the water resource in our region that must be managed in a sustainable manner for current and future generations.

For additional information regarding the Friends of the Earth Middle East and to download the Organization's publications, please visit our website: www.foeme.org

EcoPeace/ Friends of the Earth Middle East (FoEME) is a unique organization at the forefront of the environmental peacemaking movement. As a tri-lateral organization that brings together Jordanian, Palestinian, and Israeli environmentalists, our primary objective is the promotion of cooperative efforts to protect our shared environmental heritage. In so doing, we seek to advance both sustainable regional development and the creation of necessary conditions for lasting peace in our region. FoEME has offices in Amman, Bethlehem, and Tel-Aviv. FoEME is a member Friends of the Earth International, the largest grassroots environmental organization in the world.

Supported by the Swedish International Development Cooperation Agency (SIDA), the Goldman Fund, the Global Nature Fund/Ursula Merz Fund, the Green Environment Fund and the Osprey Foundation.

[16] For example, flushing the toilet using negative pressure and minimum rinsing = 15% of the amount of water that we currently use to flush toilets: http://foeme.org/uploads/WWDM_Report_Heb_290309.pdf