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Desalination – The Cyprus Experience

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Renewable Energy Sources and Energy Efficiency
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Presentation Overview

The water shortage problem in Cyprus

The Cyprus experience from using Desalination Technology

Conclusions

The Water Shortage Problem in Cyprus 1/2

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- The increasing water demand for both irrigation and human consumption, during the past century, has let to the development of large infrastructure projects such as dams, water treatment plants, large conveyors and reservoirs, to store, process and transfer water throughout the island.
- The highlights of the infrastructure projects are:
  - The construction of 108 dams with total storage capacity of 332 million cubic meters of water
  - The southern conveyor project
  - Six water treatments plants

DAMS OF CYPRUS

SOUTHERN CONVEYOR PROJECT

SOUTHERN CONVEYOR PROJECT


CATERPILLAR

The Water Shortage Problem in Cyprus 2/2

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- Despite the impressive development of the conventional surface water sources, Cyprus still faced an acute water shortage problem. Prolonged droughts had drastically reduced the water reserves of the surface and underground reservoirs and had created problems in all fields of activities.
- Therefore, in order to eliminate the dependency of the towns and tourist centers on annual rainfall and in view of the increasing water demand, the Government decided to proceed with the construction of sea water desalination plants.

Description of the main parts of a Desalination Plant

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- Sub-sea conveyors for sea water collection (500m at Dhekelia and 1km at Larnaca) and sub-sea conveyors for brine rejection(500m at Dhekelia and 1.3km at Larnaca).
- Sea water pumping station.
- Ground conveyors to transfer sea water to the desalination plant and reject brine to the sea.
- Desalination Plant
  - Pre-treatment
  - Reverse osmosis
  - Post-treatment
- Treated / desalinated water reservoir
- Treated / desalinated water pumping station

Existing Desalination Plants 1/3

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	DHEKELIA	LARNACA	DHEKELIA REFURBISHMENT	DHEKELIA EXTENTION
CONTRACT TYPE	BOT	BOT	BOT	BOT
START OF PRODUCTION	1st April 1997	12th July 2001	20th May 2007	18th July 2008
PERIOD	10 Years	10 Years	20 Years	
CAPACITY	40.000 m^3/day	52.000 m^3/day	40.000 m^3/day	50.000 m^3/day
MINIMUM DAILY PRODUCTION (m^3)	-	46.500 m^3	36.000 m^3	45.000 m^3
MINIMUM YEARLY PRODUCTION (m^3)	-	**16.972.500 m^3**	**13.140.000 m^3**	**16.425.000 m^3**
CONTRACT PRICE	€0.92/m^3	€0.68/m^3	€0.64/m^3	€0.82/m^3 *
ADJUSTED PRICE (ELECTRICITY TARRIFF AND LABOR INDEX)	-	-	€1.31/m^3	

* For the extra 10.000 m3/day

Existing Desalination Plants 2/3

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	MONI	GARYLLIS	PAFOS	LIMASSOL
CONTRACT TYPE	BOOR	BOT	BOOR	BOT
START OF PRODUCTION	22nd December 2008	2009	22nd November 2010	1st July 2012
PERIOD	3 Years	5 Years	3 Years	20 Years
CAPACITY	20.000 m^3/day	13.000 m^3/day	30.000 m^3/day	40.000 m^3/day
MINIMUM DAILY PRODUCTION (m^3)	18.000 m^3/day	11.700 m^3	27.000 m^3/day	36.000 m^3
MINIMUM YEARLY PRODUCTION (m^3)	**6.570.000 m^3**	**3.482.592 m^3**	**9.855.000 m^3**	**1.140.000 m^3**
CONTRACT PRICE	€1.39/m^3	€0.29/m^3	€1.219/m^3	€0.8725/m^3
ADJUSTED PRICE (ELECTRICITY TARRIFF AND LABOR INDEX)	-	€0.35/m^3	€1.70/m^3	€1.27/m^3

Existing Desalination Plants 3/3

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	LARNACA REFURBISHMENT	VASSILIKOS
CONTRACT TYPE	BOT	Purchase contract
START OF PRODUCTION	Summer 2014	Summer 2013
PERIOD	25 Years	20 Years
CAPACITY	60.000 m^3/day	60.000 m^3/day
MINIMUM DAILY PRODUCTION (m^3)	54.000 m^3/day	54.000 m^3/day
MINIMUM YEARLY PRODUCTION (m^3)	**19.710.000 m^3**	**19.710.000 m^3**
CONTRACT PRICE	€0.59/m^3	€0.813/m^3
ADJUSTED PRICE (ELECTRICITY TARRIFF AND LABOR INDEX	€0.82/m^3	€1.10/m^3

Contribution to the Water Balance

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In years of drought, the water demand for the provinces of Nicosia, Larnaca and Famagusta together is: **44.000.000 m³/year**

Desalination contributes :

33.000.000 m³/year (minimum yearly production) to

37.000.000 m³/year (maximum yearly production)

Therefore, the Dhekelia and Larnaca Desalination Plants contribute to the Water Balance 84% of the total demand in drinking water.

However, the unusually high rainfall of the past few years allowed the WDD to switch all Desalination Plants into stand-by mode and shift the production of drinking water to Water Treatment Plants.

Environmental Aspect

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- Desalination is a Power Hungry Process - Emission of Greenhouse Gases.
- Slight Impact on the Marine Environment – Increased Salinity at the point of Brine Rejection
- Very High Sound Levels Inside the Plant

Power Consumption 1/4

DHEKELIA DESALINATION PLANT - POWER CONSUMPTION

YEAR	DESALINATED WATER (m^3)	POWER CONSUMPTION (GWh)	TOTAL EAC * POWER GENERATION (GWh)	PERCENT OF TOTAL POWER GENERATION (%)
1997	5.221.110	27	2700	1,02
1998	10.007.770	53	2950	1,80
1999	13.677.259	72	3150	2,30
2000	13.634.718	72	3370	2,16
2001	13.101.302	69	3550	1,95
2002	12.715.536	67	3780	1,77
2003	13.172.442	70	4040	1,72
2004	12.736.485	67	4176	1,60
2005	12.547.762	70	4350	1,59
2006 * *	7.962.682	46	4618	0,99
2007 * *	8.208.256	47	4786	0,98

* EAC is the Electricity Authority of Cyprus * * Low production due to refurbishment and extension

Power Consumption 2/4

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DHEKELIA DESALINATION PLANT - POWER CONSUMPTION				
YEAR	DESALINATED WATER (m^3)	POWER CONSUMPTION (GWh)	TOTAL EAC * POWER GENERATION (GWh)	PERCENT OF TOTAL POWER GENERATION (%)
2008	14.797.799	81	4800**	1,69
2009	19.621.180	104	4853	2,14
2010	21.858.428	115	4935	2,33
2011	19.383.351	103	4727	2,18

* EAC is the Electricity Authority of Cyprus
* * Estimated

Power Consumption 3/4

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LARNACA DESALINATION PLANT POWER CONSUMPTION				
YEAR	DESALINATED WATER (m^3)	POWER CONSUMPTION Gwh	TOTAL EAC POWER GENERATION Gwh	PERCENT OF TOTAL POWER GENERATION %
2001	7.364.628	34	3550	1,00
2002	16.897.540	77	3780	2,00
2003	16.881.637	76	4040	1,88
2004	16.355.121	73	4176	1,76
2005	18.093.453	79	4350	1.86
2006	18.302.262	81	4618	1,75
2007	18.188.714	81	4786	1,69
2008	18.012.556	79	4800*	1,65
2009	20.655.909	88	4853	1,81
2010	19.879.880	86	4935	1,74
2011	18.872.790	83	4727	1,76

* Estimated

Power Consumption 4/4

TOTAL DESALINATION (%) OF THE TOTAL EAC POWER GENERATION			
YEAR	DHEKELIA %	LARNACA %	COMBINED %
1997	1,02		1,02
1998	1,80		1,80
1999	2,30		2,30
2000	2,16		2,16
2001	1,95	1,00	2,95
2002	1,77	2,00	3,77
2003	1,72	1,88	3,60
2004	1,60	1,76	3,36
2005	1,59	1,86	3,45
2006	0,99*	1,75	2,74
2007	0,98*	1,69	2,67
2008	1,69	1,65	3,34
2009	2,14	1,81	3,95
2010	2,33	1,74	4,07
2011	2,18	1,76	3,94

* Low production due to refurbishment and extension

Financial Aspect 1/3

YEAR	DESALINATED WATER PRODUCTION			DESALINATED WATER COST		
	DHEKELIA (m^3)	LARNACA (m^3)	TOTAL (m^3)	DHEKELIA (€)	LARNACA (€)	TOTAL COST (€)
1997	5.221.110	-	5.221.110	4.886.131	-	4.886.131
1998	10.007.770	-	10.007.770	10.252.032	-	10.252.032
1999	13.677.259	-	13.677.259	13.170.070	-	13.170.070
2000	13.634.718	-	13.634.718	18.058.375	-	18.058.375
2001	13.101.302	7.364.628	20.465.930	16.940.781	6.146.448	23.087.229
2002	12.715.536	16.897.540	29.613.076	15.191.451	13.670.556	28.862.008
2003	13.172.442	16.881.637	30.054.079	16.369.840	13.828.036	30.197.877
2004	12.736.485	16.355.121	29.091.606	14.817.126	12.932.340	27.749.467
2005	12.547.762	18.093.453	30.641.215	15.111.005	14.876.476	29.987.481
2006	7.962.682	18.302.262	25.994.944	13.015.355	18.742.575	27.055.098
2007	8.208.256	18.188.714	26.396.970	11.978.700	16.464.914	31.757.930
TOTAL	**122.985.322**	**112.083.355**	**234.798.677**	**137.812.166**	**80.196.431**	**218.008.597**

Financial Aspect 2/3

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DESALINATED WATER PRODUCTION		
DHEKELIA (1997-2007) (m^3)	LARNACA (2001-2007) (m^3)	TOTAL (m^3)
122.985.322	112.083.355	234.798.677

DESALINATED WATER COST		
DHEKELIA (1997-2007) (€)	LARNACA (2001-2007) (€)	TOTAL COST (€)
137.812.166	80.196.431	218.008.597

Financial Aspect 3/3

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Summarized:

- Power Consumption:

  4.52 kWh /m³

  or

  135.000.000 kWh/year
  approximately for both
  Desalination plants

- Energy Cost: €11.500.000/year

Conclusions 1/2

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- The inevitable choice to built Desalination Plants in Cyprus has proved particularly beneficial for the agriculture and salvation for the water supply of urban areas.
- Nevertheless building Desalination Plants is not panacea.
- The environmental impact, mainly because of the emission of greenhouse gases, should not leaves us indifferent at times where our planet struggles for survival.
- Furthermore the production cost, which is not recovered, at times where the oil price is unstable and just recently it marked a record high should have us seriously concerned.

Conclusions 2/2

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- It is therefore imperative to continuously seek of ways to increase the efficiency of the existing desalination technologies in such a way so as to reduce the energy consumption, and
- To seek for new methods to produce drinking water by utilizing renewable energy sources.
- Based on the above, the WDD is proud to participate in a promising project such us the “Solar Thermal Production of Electricity and Water (STEP-EW)” that aim to harness the power of the sun to produce both electricity and water.

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Thank You

www.moa.gov.cy/wdd

www.step-ew.eu

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Ηλιοθερμική Παραγωγή Ηλεκτρισμού & Νερού