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Qatar Environment & Energy
Research Institute

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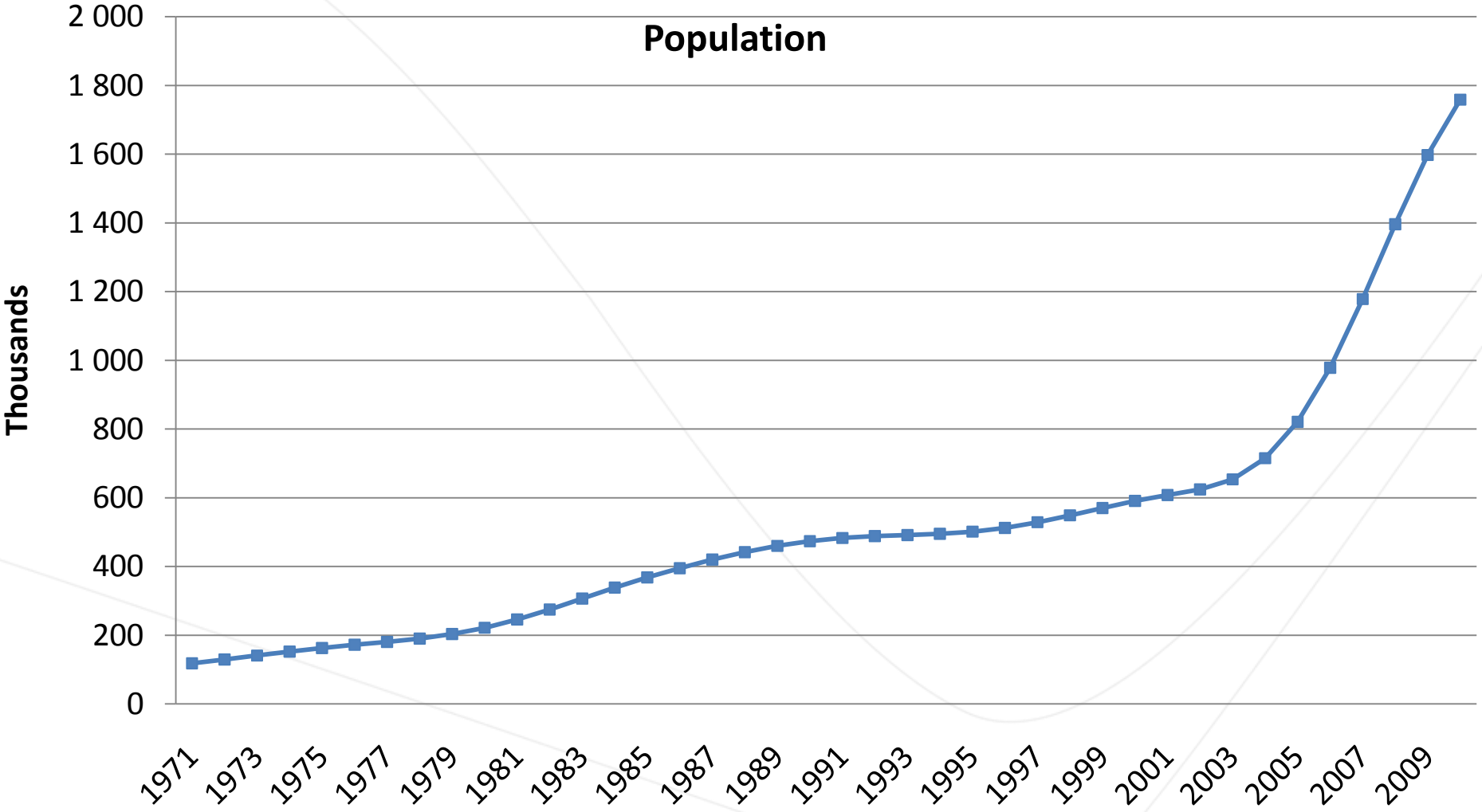
QATAR WATER CHALLENGES

Dr.Rabi Mohtar
Dr.Mohamed A.Darwish

Presented by:
Dr. Fedaa S. M. Ali

Qatar population growth rate against years



0.744 M in 2000 to 1.7 M in 2010 ➡ 2.28 times increase in 10 years

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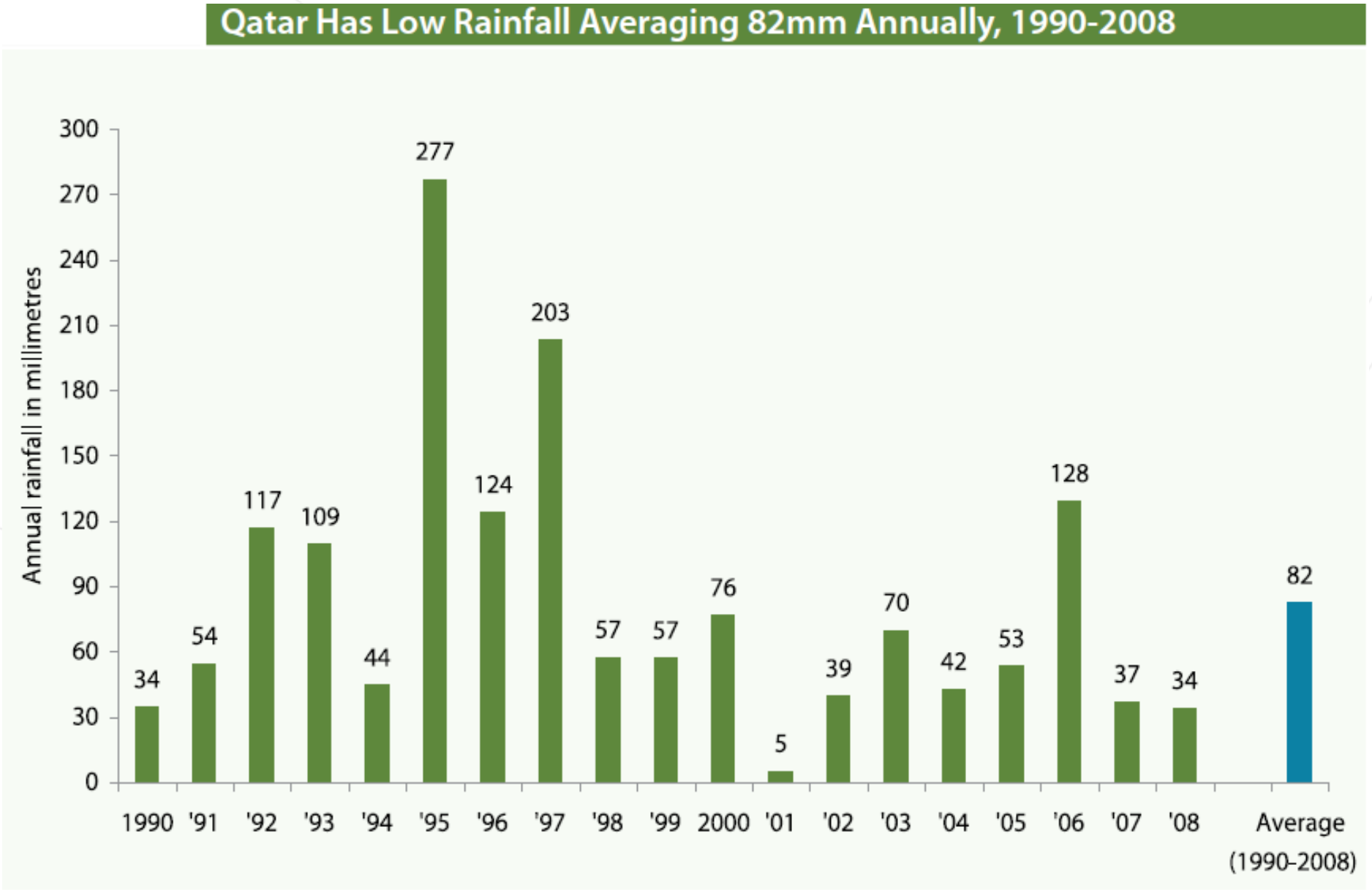
Year	Population
1908 est.	22,000
1939 est.	28,000
Late 1960s	70,000
1986	369,079
1997	522,023
2000	744,483
2001	769,152
2002	793,341
2003	817,052
2004	840,290
2005	863,051
2006	885,359
2007	1,207,229
2008	1,524,789
2009	1,309,000
2010	1,696,563
2011	1,692,262

Main Water Resources

1. Rain Fall

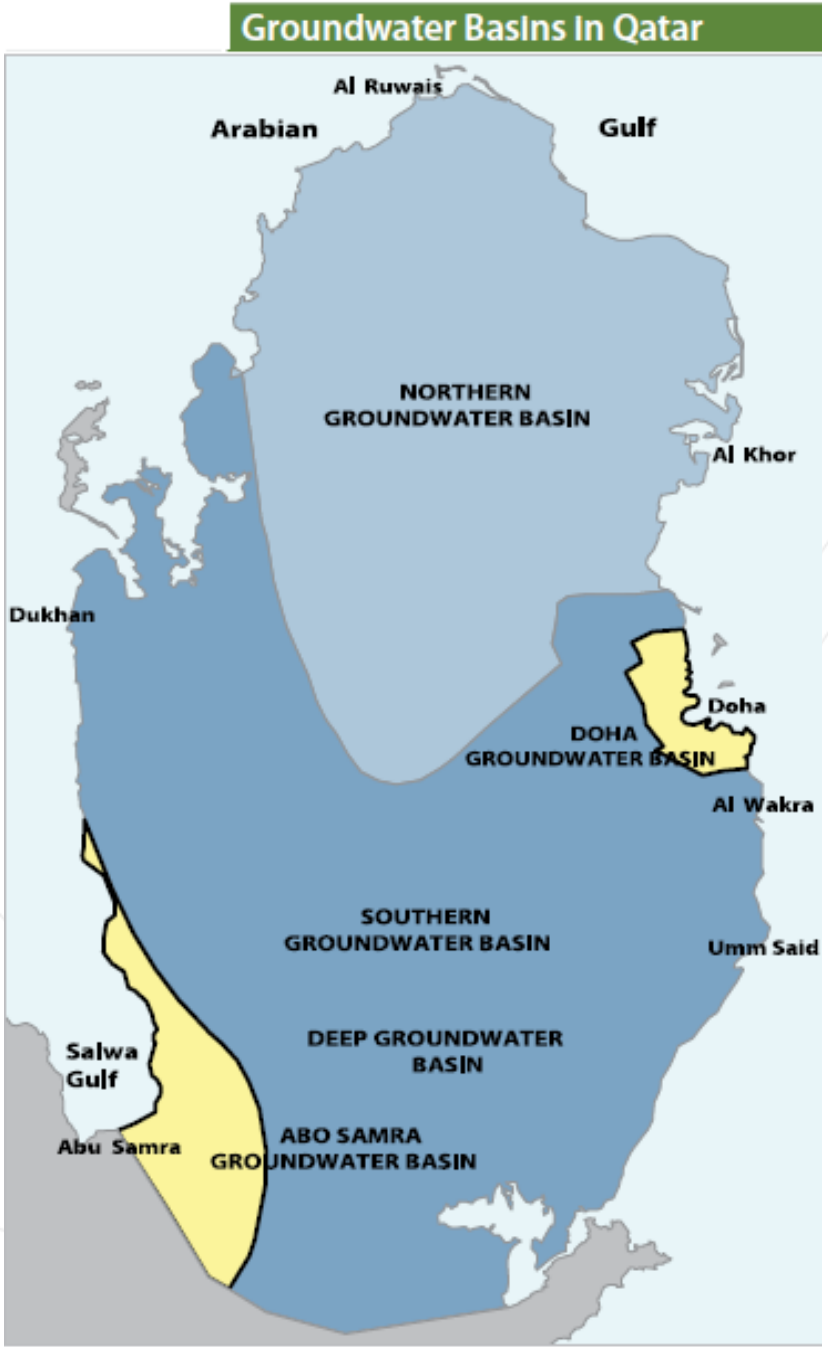

Qatar Has Low Rainfall Averaging 82mm Annually, 1990-2008
Annual rainfall in millimetres
300
270
240
210
180
150
120
90
60
30
0
34
54
117
109
44
277
124
203
57
57
76
5
39
70
42
53
128
37
34
82
1990
'91
'92
'93
'94
'95
'96
'97
'98
'99
2000
'01
'02
'03
'04
'05
'06
'07
'08
Average
(1990-2008)

Groundwater GW

1- Northern GW (NGW) basin
Salinity (S) 500 - 3000 ppm and up to 10 000 ppm near coasts by SW,
covers ≅ 19% of Qatar at 10 - 40m water depth ground

2- Southern GW (SGW) Basins, S (3,000-6,000 ppm)
Cover ½ Qatar land, not suitable for agriculture

3- Three secondary basins called :
Abu Samra, depth 22 - 80 m below ground
Doha and Aruma deep GW basins SW of country, S ≅ 4 000 ppm, at deep depths of 450-650 m



Source: Redrawn from Amer and Abdel-Wahab, 2009, derived from FAO Studies Project, 1981

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Groundwater GW

- GW average recharge/y from rainfall ≅ 55.9 Mm^3/y.
- GW inflow of GW from SA ≅ 2.2 Mm^3/y,
- Total renewable GW ≅ 58.1 Mm^3/year for the period 1972-2005.
- GW extraction from NGW and SGW ≅ 220.2 Mm^3 in 2004-2005
- Water abstraction many times natural GW recharge rate.
- Continued over-exploitation of fossil GW reserves threatens the remaining reserves from saltwater intrusion, while overuse of GW for agriculture is resulting in soil salinization and desertification

Number of wells and water abstraction in Qatar

Figure 2.4 Number of Wells and Water Abstraction in Qatar Stabilising

Source of data: Amer and Abdul-Wahab, 2009, derived from the Agricultural and Aquatic Research Department, Ministry of Municipality and Urban Planning

Notice the decline of GW output since 2002

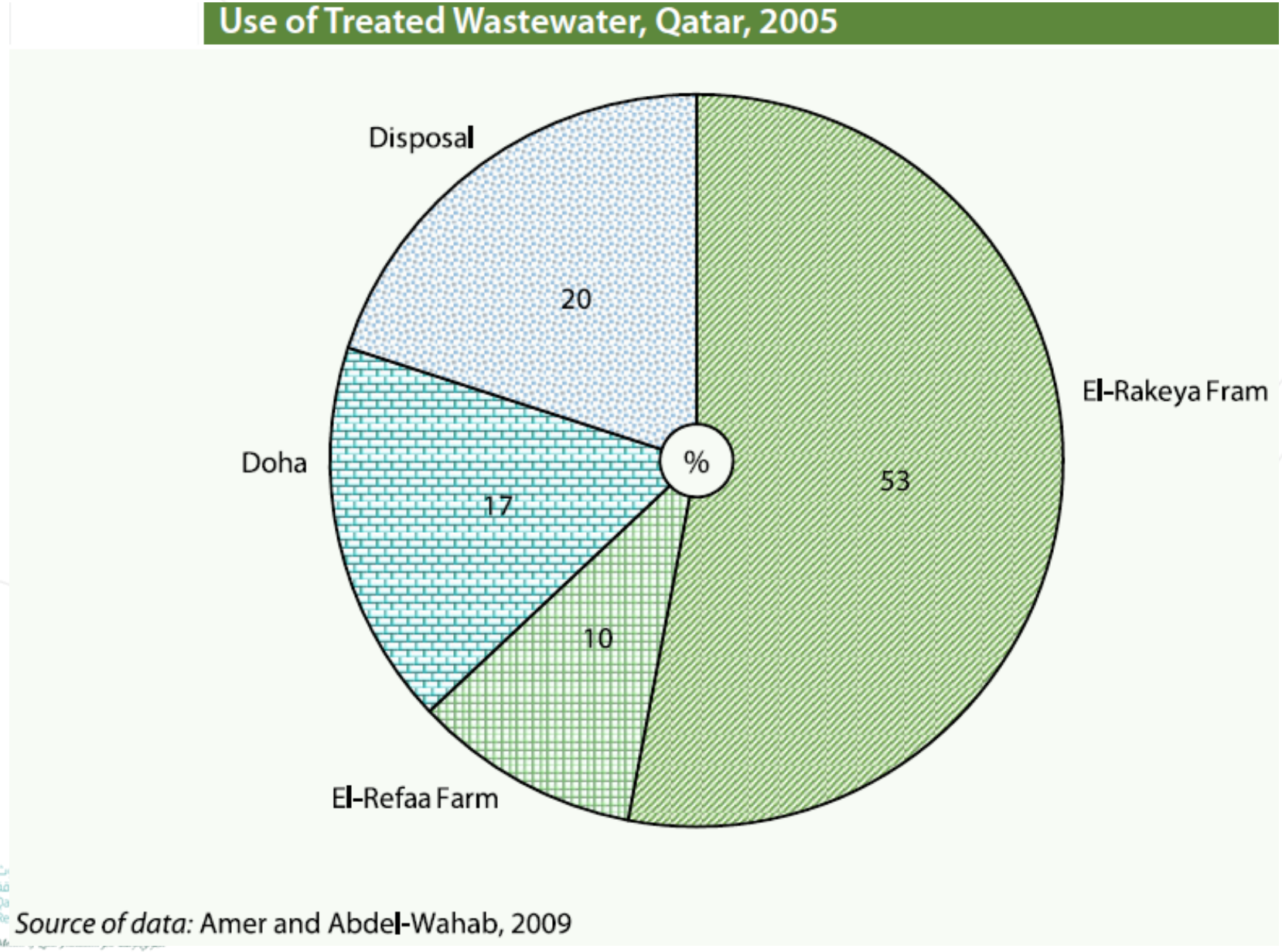
3. Wastewater

- All population have clean drinking water acess
- 68% of all Qatar's building connected to sewage network (95% of Doha bldg connected
- One-third of municipal (WW) is treated and recycled.
- Balance is lost as leakage or from buildings not connected to the sewer system
- Most of supplied water has potable quality, misused in services that do not need high quality, e.g. garden irrigation, car washing, toilet flushing, and others.

Treated Waste Water Capacity

- Treated effluent from the two main (TWW) plants in Doha ≅140,000 and 150,000 m^3/day in 2005.
- The two main sewage TWW use tertiary treatment (96% of TWW influent)
- The known TWW plants and their capacities in (m^3/d) are:
- Doha West known as Sailiyyah (135,000),
- Doha South known as Nuaija (112,000),
- Doha North known as Lusil (60,000),
- Doha Industrial area (12,000), Al-Khor (4,860), and
- Al Thakhira known as Dakheri (30,000).
- So, TWW total capacity ≅ 354,000 m^3/d.
- Another WWT plant of 28,700 m^3/d capacity started to be built in 2009 at the site of the new airport for its landscape irrigation.
- Total WWT plants is expected to increase to 129.4 Mm^3/y.

Use of Treated Waste Water in 2005

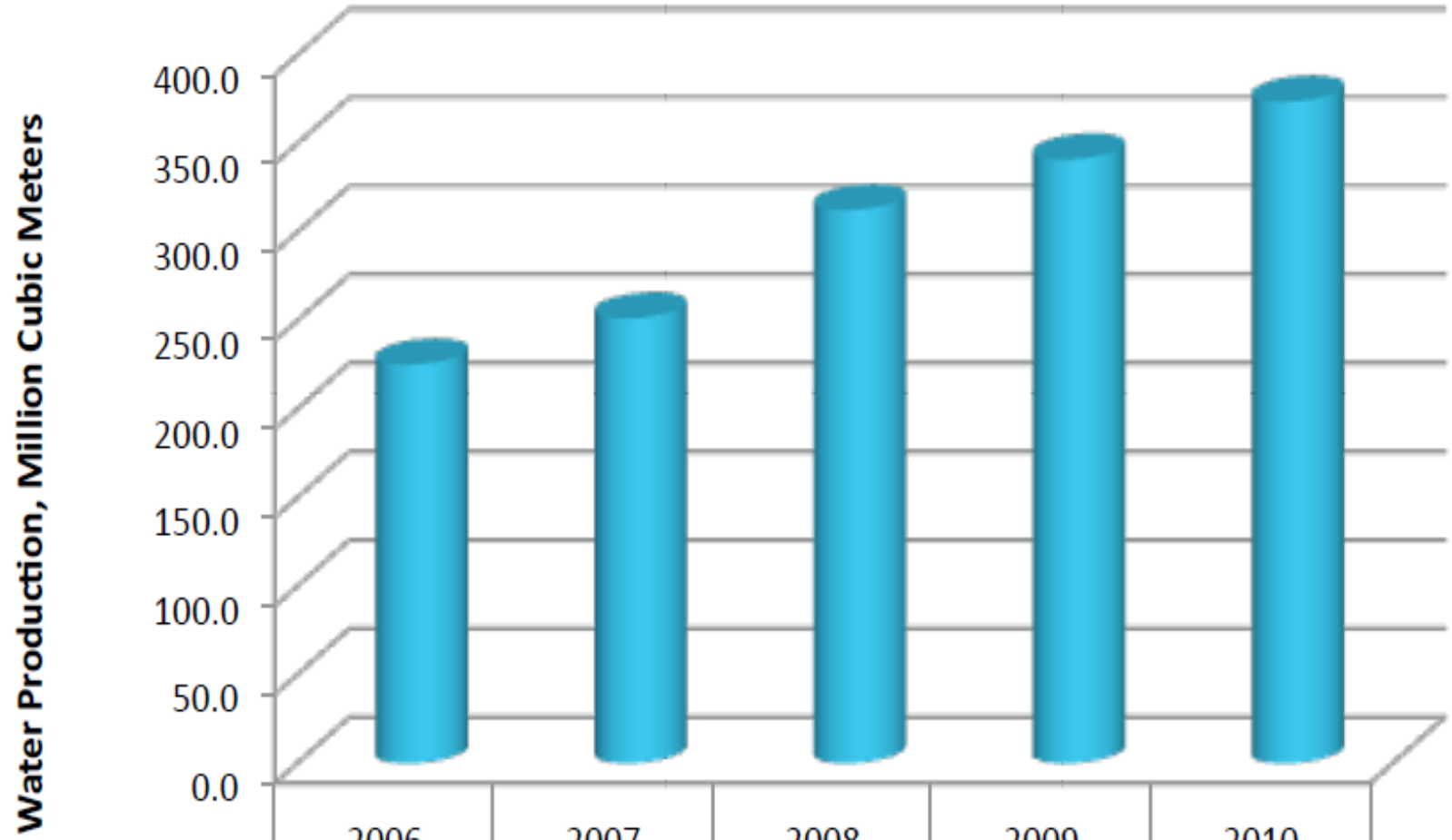


4. Desalted seawater DW

- DWQatar's first plant in 1953, and had 680 m^3/d
- More plants were added later, and capacity now 1.49 Mm^3/d in 2011
- Large capacity DP combined with GT and GTCC Power Plants (PP),
- Called Cogeneration Power Desalting plants (CPDP).
- Next table gives names and capacity of DP

Total Water Production from 2006-2010

Total Water Production from 2006 to 2010

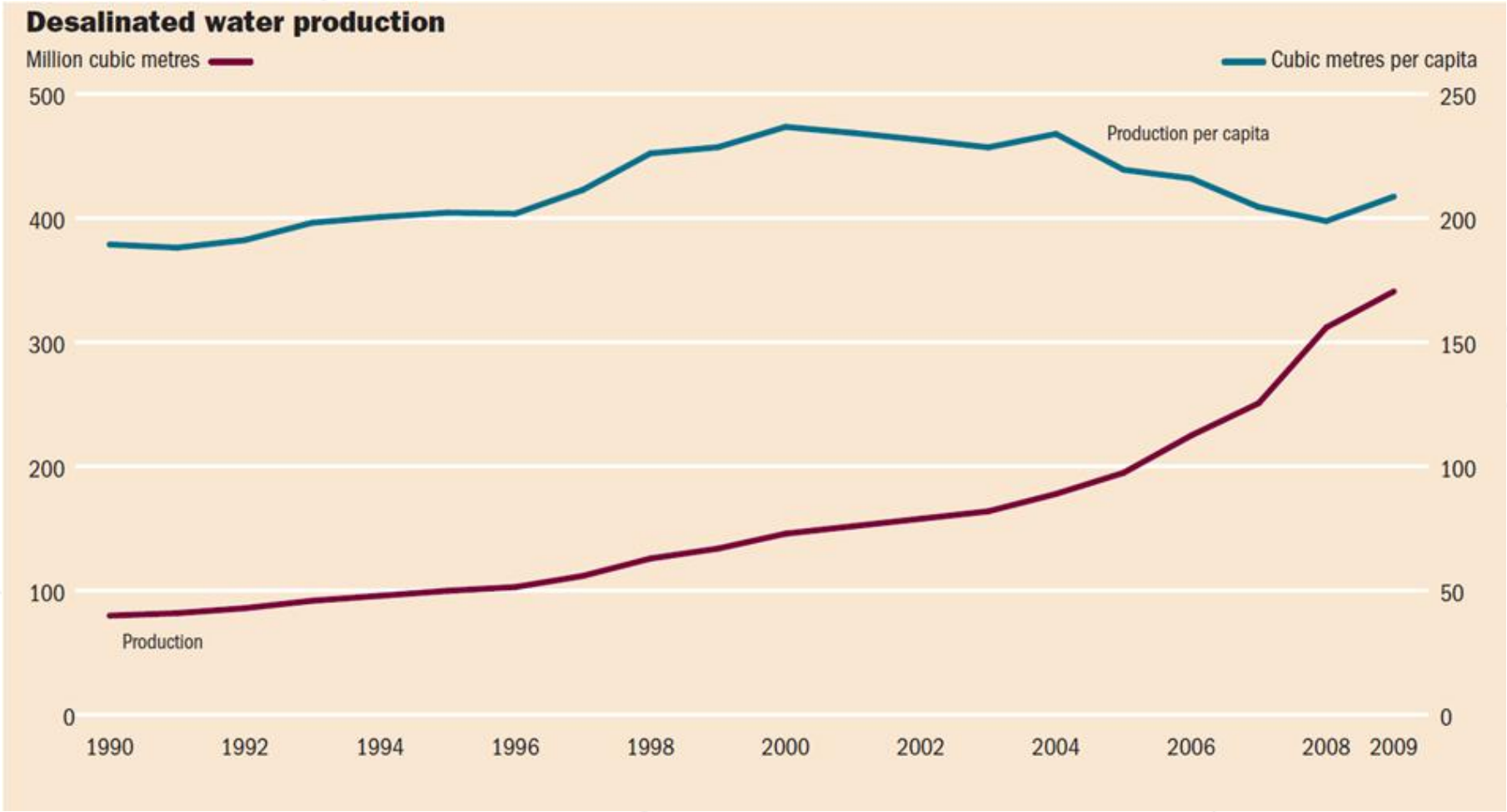


	2006	2007	2008	2009	2010
Water Production, MM3	225.1	251.2	312.4	341.0	373.6

Desalination Plant in Qatar

Desalination Plant	Power plant capacity, MW	Total Capacity m3/d	Total capacity, (MIGD	Starting date
Ras Abu Aboud				
Ras Abu Fontas A	497	318,226	70	1980
Ras Abu Fontas B	609	150,000	33	1995
Ras Abu Fontas B1	377	240,000	53	2002
Ras Abu Fontas B2	567	136,000	30	
Ras Laffan A	756	181,843	40	2003
Ras Laffan B	1025	272760	60	2006
Meisieed	2007			2009
Ras Girtas	2730	286,400	63	2010
Satelites	184			1983
Total	8752	1,450,229	349	

Desalination Water Production



Production of desalinated water has increased massively but has barely kept pace with population growth

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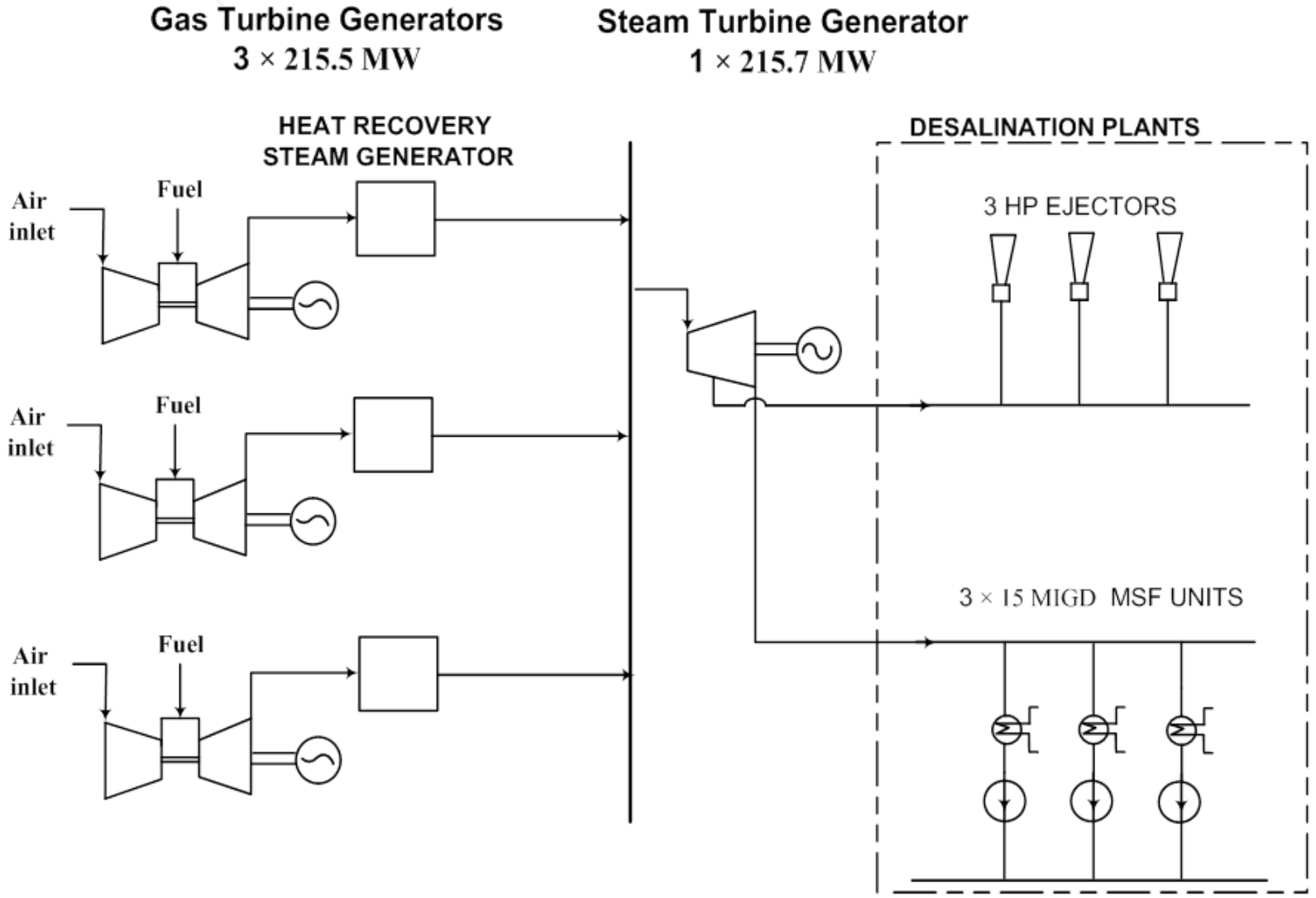
Desalination energy Consumption & CO_2 emission

- In 2010, produced EP =28144 GWh and of DW= 373 Mm^3 (1.022 Mm^3/d).
- Consumed fuel energy and its CO_2 emission are calculated here.
- Equivalent consumed EP per m^3 of DW by MSF ≅ 20-kWh/m^3.
- Consumed equivalent EP to desalt 1.022 Mm^3/d = 20.44 GWh/d, and 7461 GWh/y.
- Total equivalent EP output for electricity and DW (28144 + 7461)=35605 GWh
- DW share of 21%.
- For 35% average efficiency, consumed fuel energy = 366.3 MGJ. (equivalent to 61.03 Mbbl, or 348.9 BCF of NG.
- Qatar produced NG in 2009 3154 BCF of NG in 2009, while consumed 745 BCF.
- CPDP consumed NG about 11% of total produced NG in 2009, and about 40% of total NG consumption.

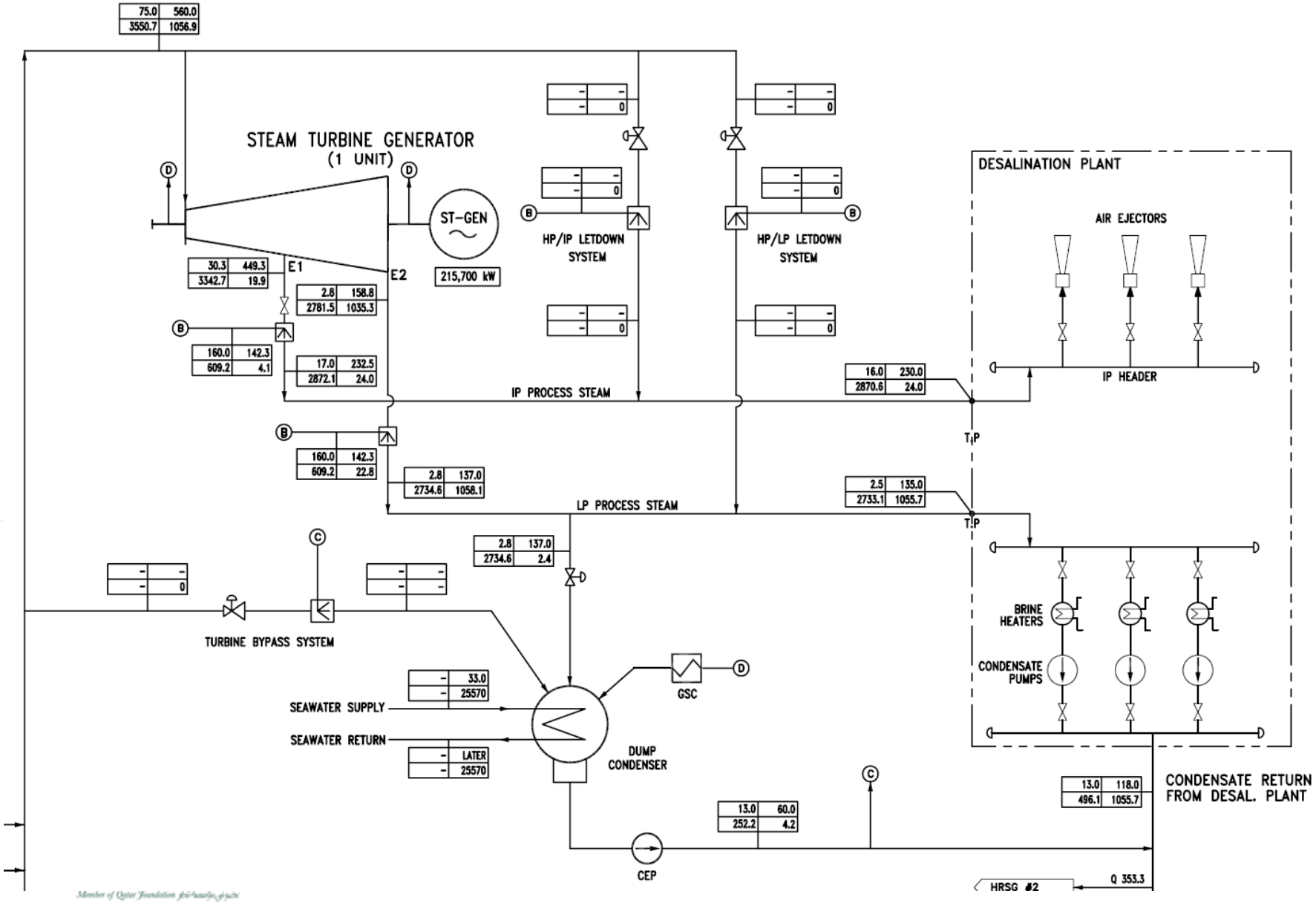
Cont.

- NG burned in CPDP =366.2 BCF = = 7.602 M ton, 1.6 Mton by DW.
- CO_2 emission due to burning 7.602 M ton of NG is 20.922 M tons.
- DW contributed 11.23 kg/m^3 CO_2.
- In brief, desalting 373 Mm^3 in 2010 (1.02 Mm^3/d) causes burning 1.6 tons of NG and the emission of 4.4 million tons of CO2.
- *Choice of SWRO to can save 75% of fuel used, reduce CO2 emission.*
- *Average SWRO consumed energy with energy recovery devices is 5 kWh/m3.*
- Produced DW increased from 178 Mm^3/y in 2004 to 373 Mm^3/y in 2010, significant annual increase of 14%.

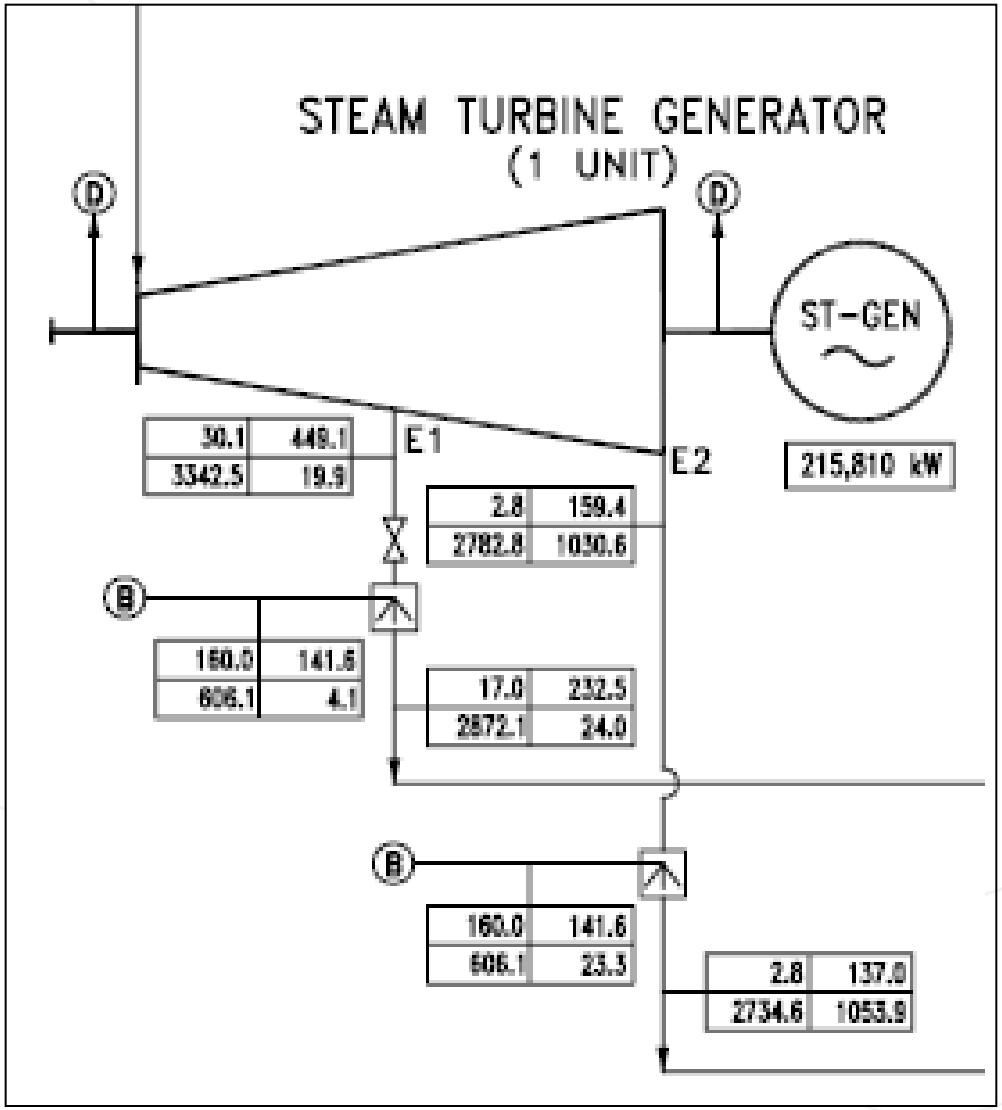
Arrangement of GT combined cycle (GTCC) with BPST



Arrangement of BPST supplying steam to 3 MSF



Steam Turbine Generator



Water Storage Capacity in Qatar-2007

Water Storage Capacity in Qatar, 2007

Storage Facility	Storage Capacity (m^3)	Percentage
Reservoir	1,927,542*	97.2
Ground Tank	25,167	1.3
Elevated Tank	2,987	0.1
Water Tower	27,640	1.4
TOTAL	**1,983,336**	**100**

* Exludes non-operating reservoir under refurbishment or maintenance

Source: KAHRAMAA, 2008

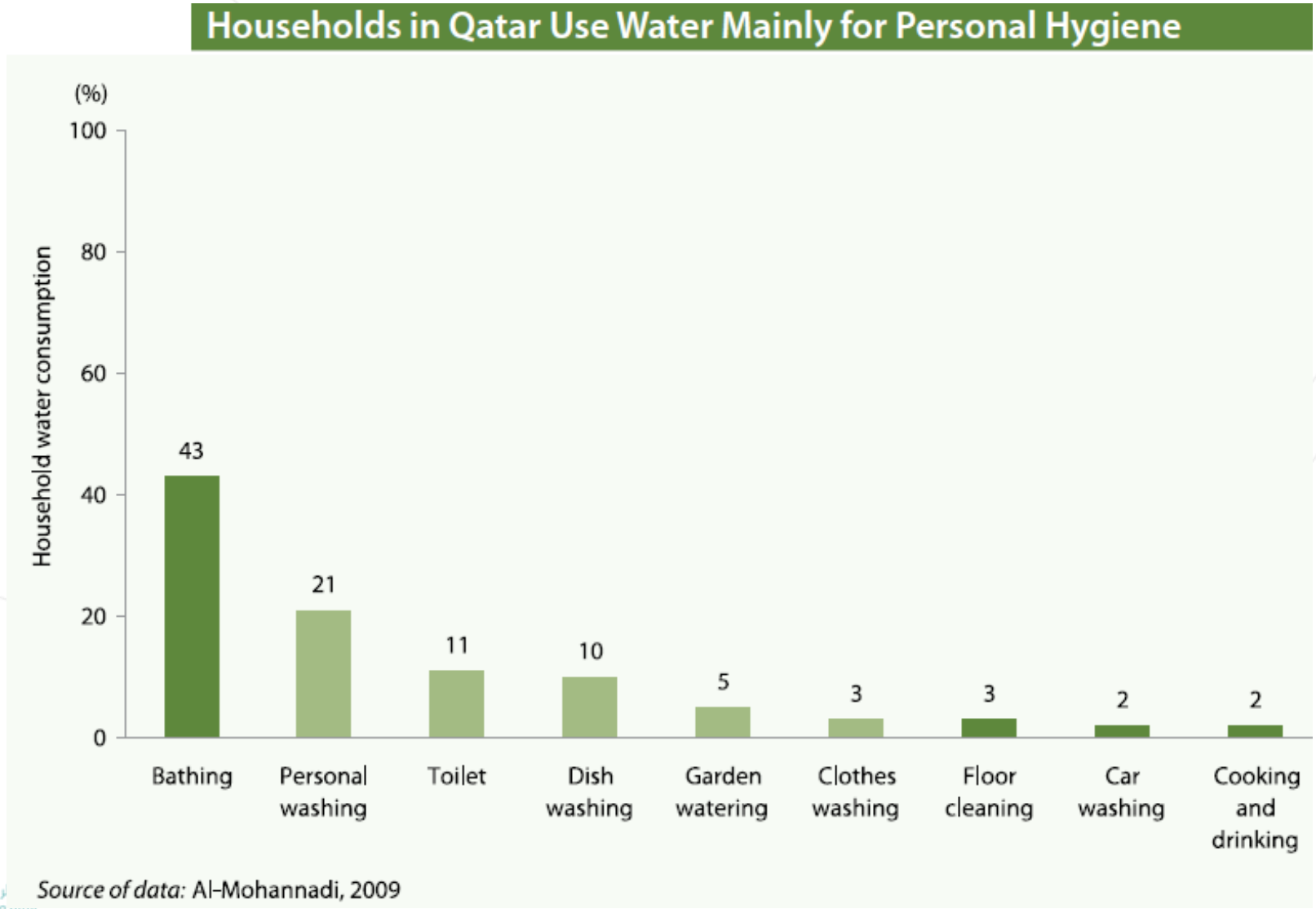
Water Use and Consumption

Water Consumption and Government Subsidy in Qatar, 2003

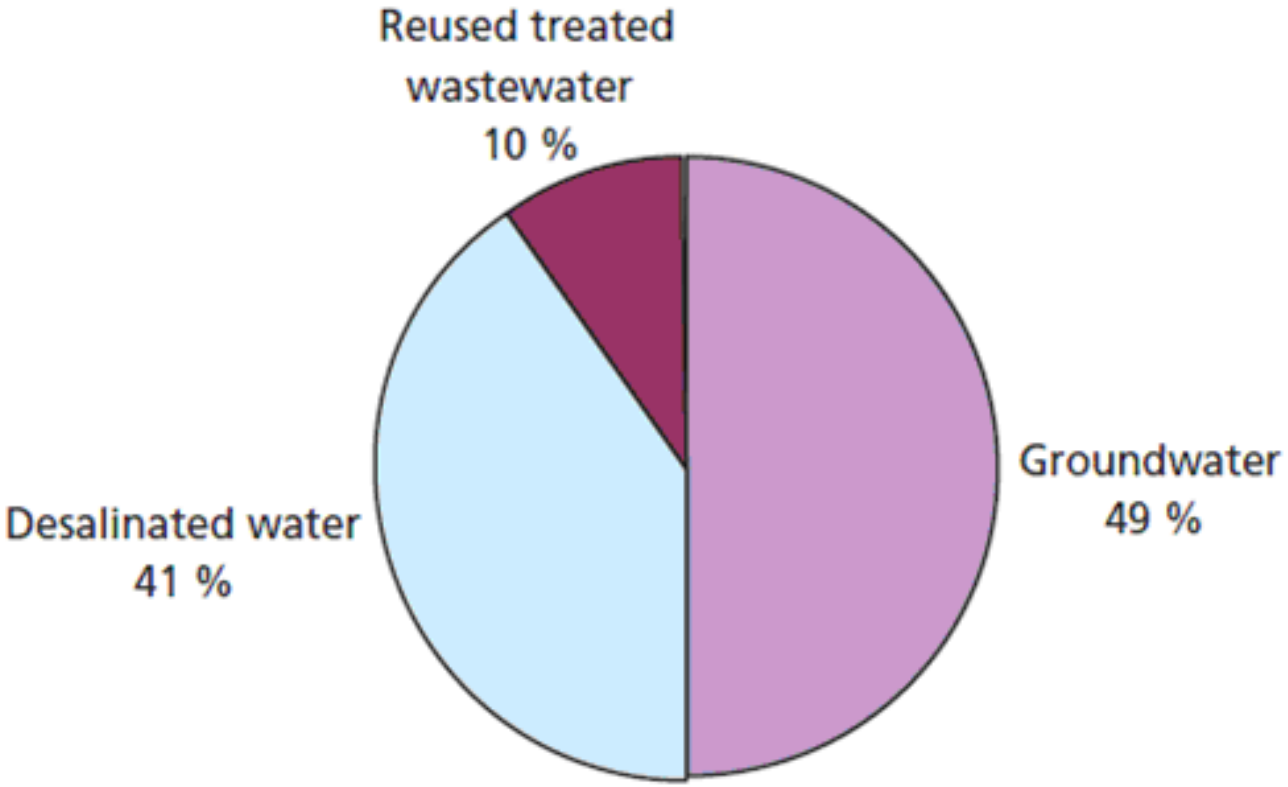
Sector	Subsidy Per Unit (QR per m^3)	Total Consumption (million m^3)	Total Subsidy (QR million)	Percentage Distribution of Subsidy
Residential (Qatari)	10	52.3	524	63
Residential (non-Qatari)	5.6	24.6	138	17
Commercial	5.6	10	56	7
Government	10	3.6	36	4
Industrial	5.6	13.4	75	9
TOTAL	**8.0**	**103.9**	**829**	**100**

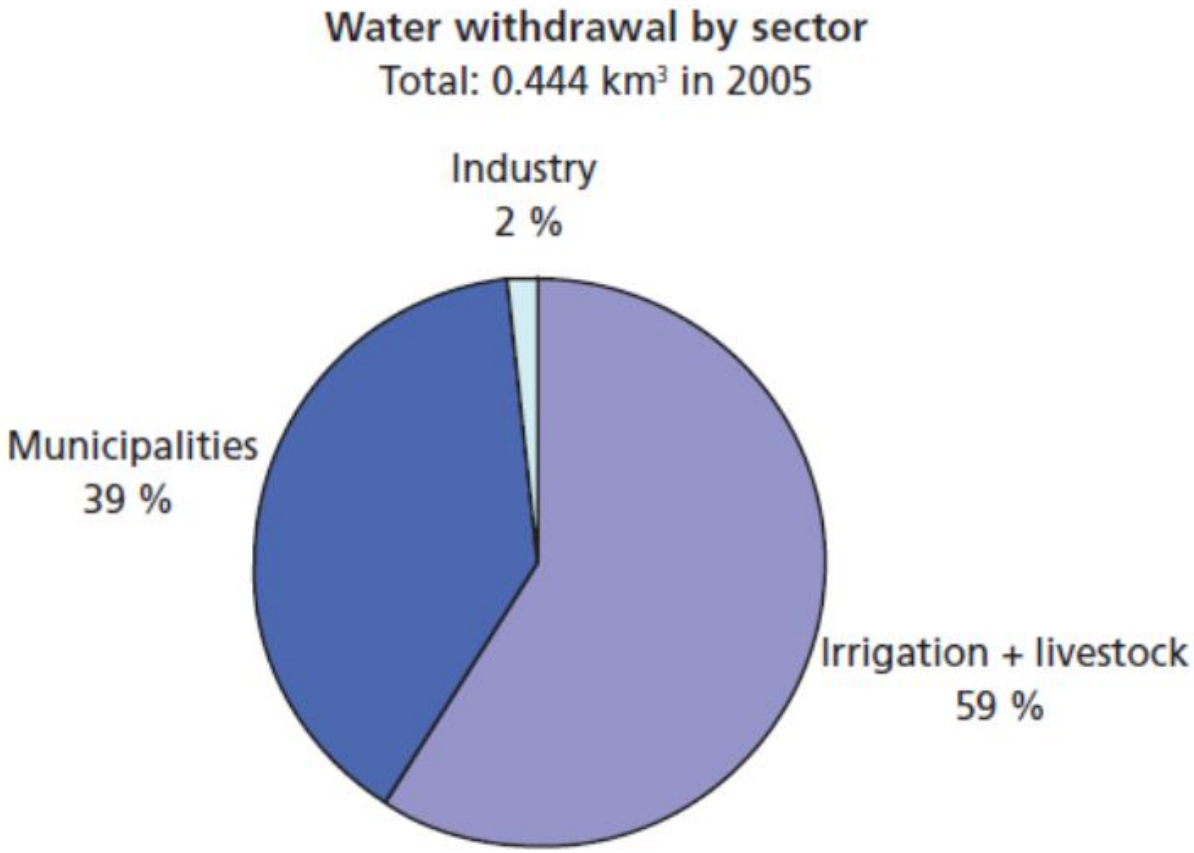
Note: Figures are independently rounded
Source: Al Mohannadi, 2009

Use of Water in Qatar-2009



Water withdrawal by source
Total: 0.444 km^3 in 2005





Water withdrawals by different sectors in Qatar (2005)

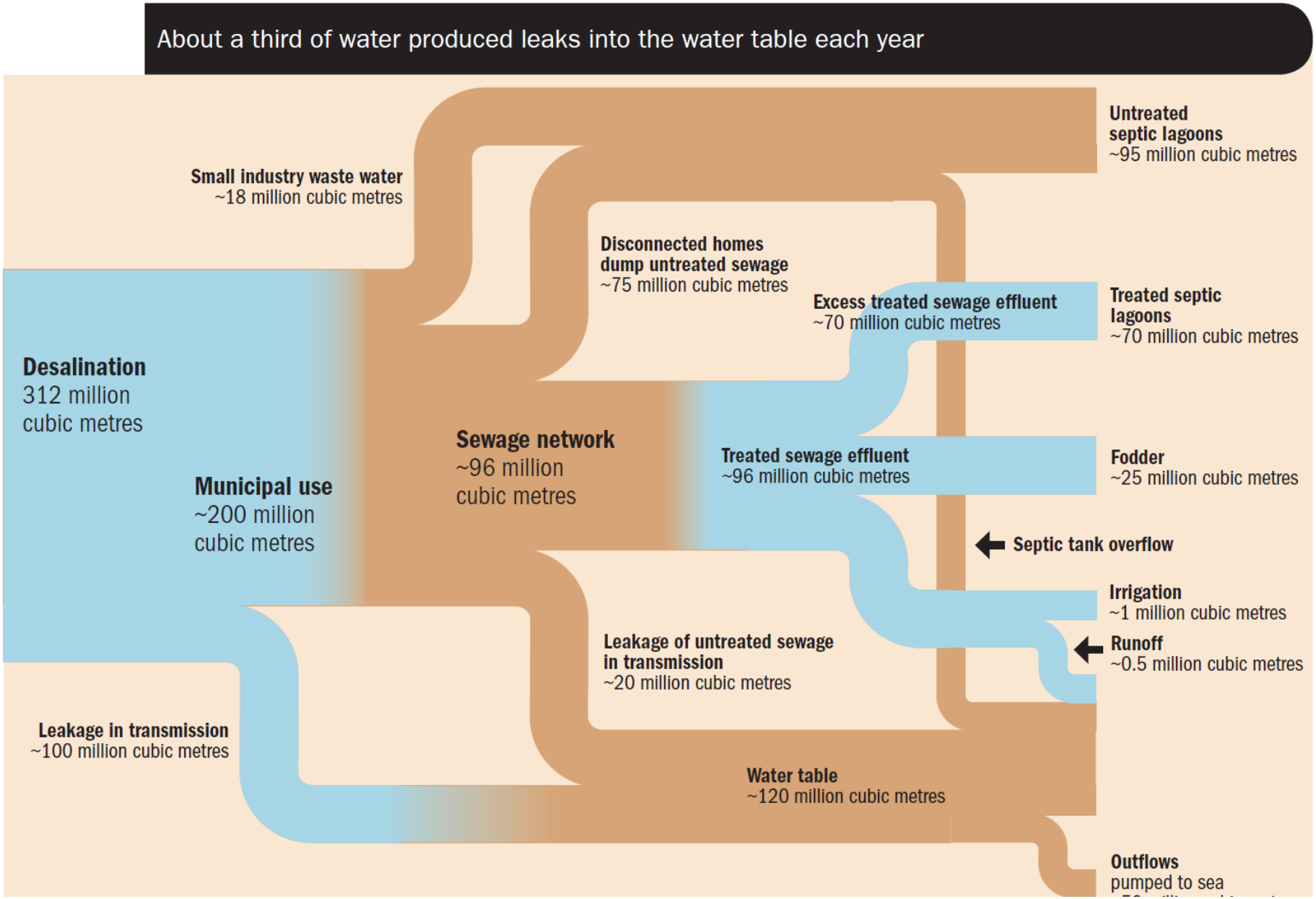
	Agriculture		Domestic		Industry		Total	
	million m³/ year	%	million m³/ year	%	million m³/ year	%	million m³/ year	%
Groundwater	218.3	83.5	2.4	1.4	-	-	220.7	49.7
Treated sewage water	43.2	16.5	-	-	-	-	43.2	9.7
Desalinated water	-	-	171.8	98.6	8.4	100.0	180.2	40.6
Total	**261.5**	**100.0**	**174.2**	**100.0**	**8.4**	**100.0**	**444.1**	**100.0**
% by sector	**58.9**	**-**	**39.2**	**-**	**1.9**	**-**	**100.0**	**-**

The picture should have been changed in 2010, as DW becomes 373 Mm^3/y (compared to 180 Mm^3/y in 2005 or 207% increase in 5 years).

Similarly TWW was increased from 43.3 Mm^3/y in 2005 to 129.4 Mm^3/y in 2009, almost 300% .

If the GW is limited to 200 Mm^3/y, then the total water withdrawal is 702.4 Mm^3/y.

The percentage water withdrawals in 2010 can be about 53.1% for DW, 18% for TWW, and 27.9% for GW.


About a third of water produced leaks into the water table each year
Small industry waste water
~18 million cubic metres
Untreated
septic lagoons
~95 million cubic metres
Disconnected homes
dump untreated sewage
~75 million cubic metres
Excess treated sewage effluent
~70 million cubic metres
Treated septic
lagoons
~70 million cubic metres
Desalination
312 million
cubic metres
Sewage network
~96 million
cubic metres
Treated sewage effluent
~96 million cubic metres
Fodder
~25 million cubic metres
Municipal use
~200 million
cubic metres
Septic tank overflow
Irrigation
~1 million cubic metres
Runoff
~0.5 million cubic metres
Leakage of untreated sewage
in transmission
~20 million cubic metres
Leakage in transmission
~100 million cubic metres
Water table
~120 million cubic metres
Outflows
pumped to sea

The sustainability of water in Qatar is at risk, where the extracted GW is several times its replenishments rate.

1- The rate of consumed renewable resource should be less than its replenishment rate. The municipal water supply depends almost completely on DW. The used desalting process is energy-intensive, and costly. The fuel consumed, NG, is finite and non-renewable.

2-The rate of consumed non-renewable resource (NG here) should be less than the rate of developing another alternative; and no alternative here. Burning fuel to produce DW emits gases, which pollutes the air, contributes to the greenhouse gases (GHG) causing climate change.

3- Polluting gases should be treated to render them unharmed to the environment; which is not the case here. The use of TWW is limited to some agriculture and landscaping, and at low rate compared to potable water consumption (about 25%). The WW is a water resource after being reclaimed, while most of it is wasted here.

Some measures to be considered:

- Most WW in Qatar is treated to the tertiary level and is used for irrigation. The dissolved organics and other contaminants limit full utilization of this valuable resource. The Quaternary treatment is producing potable water quality to meet unrestricted residential uses and industrial applications requiring ultra-pure water. Membranes of different pore sizes are usually used in this process such as micro-filtration (MF), ultrafiltration (UF), nano-filtration (NF), and hyper-filtration reverse osmosis (RO) in descending pore diameter order. The quaternary treated are used as direct potable water or recharged to aquifers for storage and then extracted for potable purposes in many parts of the world.

Continue Some measures to be considered:

- Increasing natural recharge of aquifer by drilling of wells (with a special design including a perforated casing and graded gravels) in depressions to recharge water from occasional storm through the wells to depths that reach the water bearing formations to accelerate the natural recharge of floodwater.

- Decrease the losses between municipal water supply and the treated waste water (TWW), which represents only 25% of the municipal water supply, and should be at least 60%.

- Expanding the use of Dual distribution system, one for potable quality water for drinking and cooking, and one for less quality for landscaping, toilet flushing, etc.

Thank You

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