KAHRAMAA
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المؤسسة العامة القطرية للكهرباء والماء
Qatar General Electricity & Water Corporation

District Cooling Workshop

Wednesday 18/6/2014

Towards Cooperative District Cooling Society

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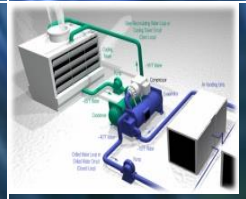
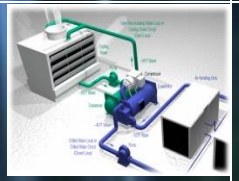
better living لحيـاة أفضـل



KAHRAMAA DC workshop
Doha, June 2014



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DC Industry - TSE utilization concepts

What to consider during implementation?

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Treated Sewage Effluent - TSE

T S E

SUSTAINABLE Solution !!!

- **Readily available**
- **Most Sustainable water resource**
- **Least Environmental affecting overall Solution**
- **Cultural considerations**
- **BUT ….. is a NEW Approach**
  requiring Engineers to think differently
  about Past & Future water use and plant operation

Water utilisation in DC - GCC sitation in 2014

- **QATAR Doha –** Municipal water use restricted by Ministerial directive
  - Alternative water/TSE mandate to DC industry introduced by Kahramaa
  - mandatory since Jan 2014 onwards
  - ASHGHAL – MoE discharge limits currently reviewed and in final conclusion
- **UAE – Dubai –** driven by financial gains (high DEWA water cost)
  - TSE soft directive issues in 2010 - Conversion period target for 2013/14
  - Discharge limits for sewer adopted for TSE in 2012 to 6000 ppm TDS
  - some DC companies started changing because of cost savings
  - Abu Dhabi lacking behind as water cost is low (subsidized)
- **SAUDI ARABIA** – water shortage driven
  - TSE strategic use concept presented by NWC in 2010/11
  - No deadline by legislation, most projects government controlled
  - Water shortage drives projects towards TSE use – KKIA, KAFD, Jabal Omar, Jeddah
- **Other GCC –** mixed approach not driven by legislation yet

TSE as Makeup in DC – The PRO & CONs

Advantages

- Availability
  - Domestic TSE water generation
  - Cooling need in regions with water scarcity
- TCO - Total Co$t reduction
  - Municipal to **TSE 20-80% reduction**
- Sustainable solution
  protects Environment and Energy resources
- Legislation compliance
  calling for alternative water use

Disadvantages

- **TSE Water quality & fluctuation**
  make your system accepting variability NOT adopt TSE to system requirements
- **TSE supply issue** – no storage
- **Discharge situation**
- DC operational adaption
  stagnancy needs to be addressed for both TSE use concepts
- Need better control/monitoring
- CAPEX – OPEX - Reliability
  Space – **high CAPEX/**RO plant reliability increased OPEX

TSE as Makeup – How to use it

2 Ways to utilize TSE as makeup – example 10 KTR (55 m3/h evaporation)

Polished TSE

- **Polishing plant – max 70% Recovery**
  Membrane process (UF) + RO need footprint
- **needs 102 m3 TSE/10 KTR**
- **COC 10-11** >> means 5,5 m3/h BD
- CT feed water quality is desal
  so of very aggressive nature
- Operational Risks
  High on RO polishing plant
  Low on CT
- **TCO (W+WT): 12-21 QAR/1000 TR**
- **Saves 50 %** to Municipal water

Direct TSE

- **Used direct as CT-makeup**
  less footprint, no CAPEX, min. adaption
- **needs 83 m3 TSE/10 KTR**
- **COC 3** >> means 27,5 m3/h BD
- CT feed quality varies
  needs Scale/corrosion & microbio control
- **no pre-treatment - elevated on CT**
  needs good treatment, is compensated by good monitoring
- **9 QAR/1000 TR**
- **Saves 76 %** to Municipal water

TSE implementation DOHA – The Financials

TSE is free of cost – Polishing cost range 1,5 - 3,5 QAR/m3 (size dependent)

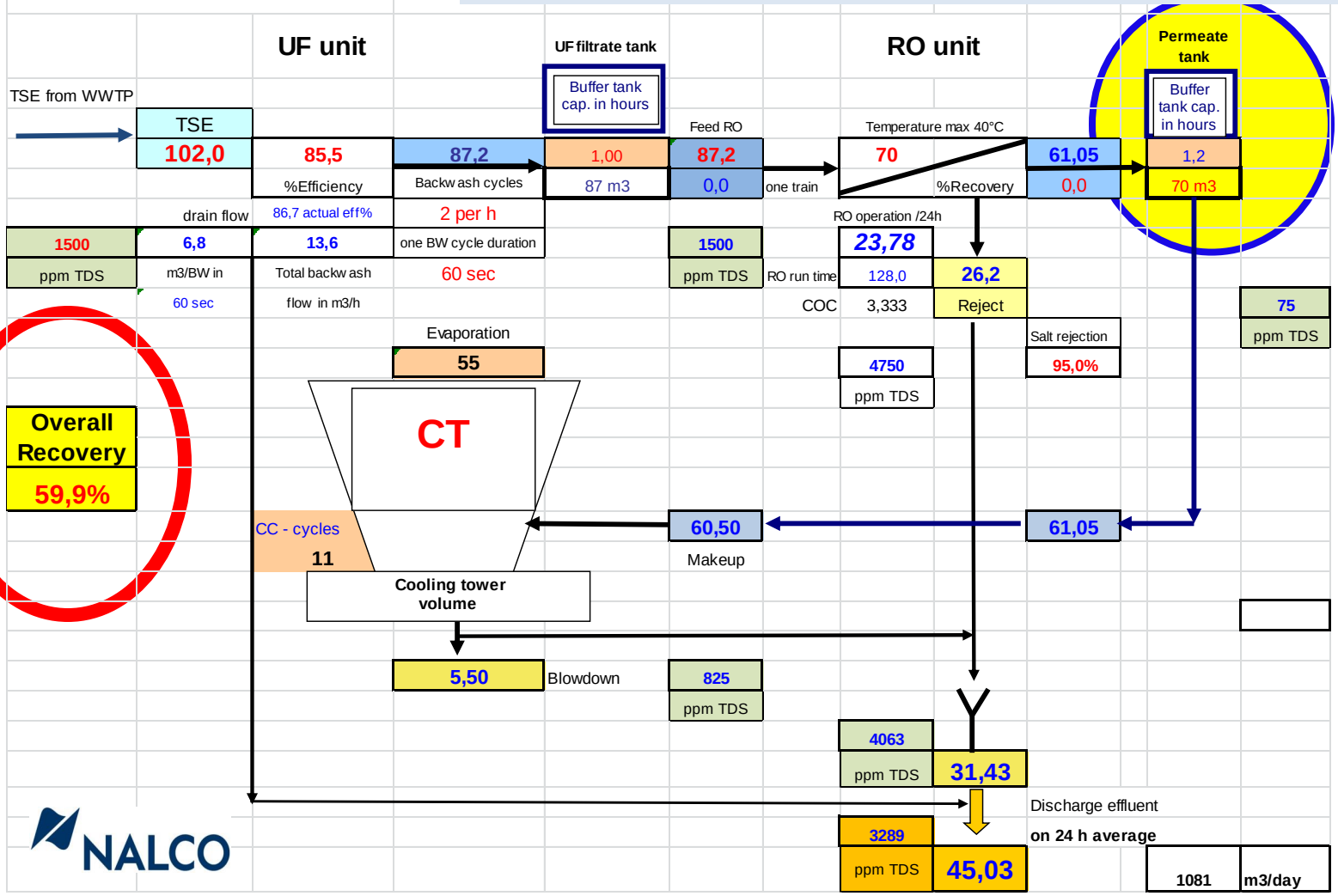
Calculation utilizing TSE

					TSE cost:	0,000	QAR/m3	Polished TSE cost	2,5	QAR/m3
The study did not take into consideration the availability of TSE on all sites								Municipal water	5,20	QAR/m3
We did not take into consideration the location of polishing plant for supply for all plants										
									Water treatment cost QAR/TR	
COC	7	11	3		Water cost QAR/TR			0,0035	0,003	0,009
System	I/TR with Municipal	I/TR for Polished TSE	I/TR for Direct TSE	Total PRODUCTION TR	QAR/TR for Municipal	QAR/TR for Polished TSE	QAR/TR for Direct TSE	TCO QAR for Municipal	TCO QAR for Polished TSE	TCO QAR for Direct TSE
DC sytem	6,41	6,05	8,25	87.600.000	0,0333	0,0151	0,0000	3.226.483	1.587.750	788.400
		10,15 on TSE		m3/h water demand	64,1 m3/h	60,5 m3/h	82,5 m3/h			
					full TSE need	102 m3/h	Total TCO:	3.226.483	1.587.750	788.400
									1.638.733	2.438.083
		annual load						COST TO:		
	TR plant	50,00%						Municipal	49%	24%
	20.000,00	87.600.000						Polished TSE		50%
							QAR/TR	0,037	0,018	0,009

Polished TSE - 10.000 TR plant

TSE Polishing Concept

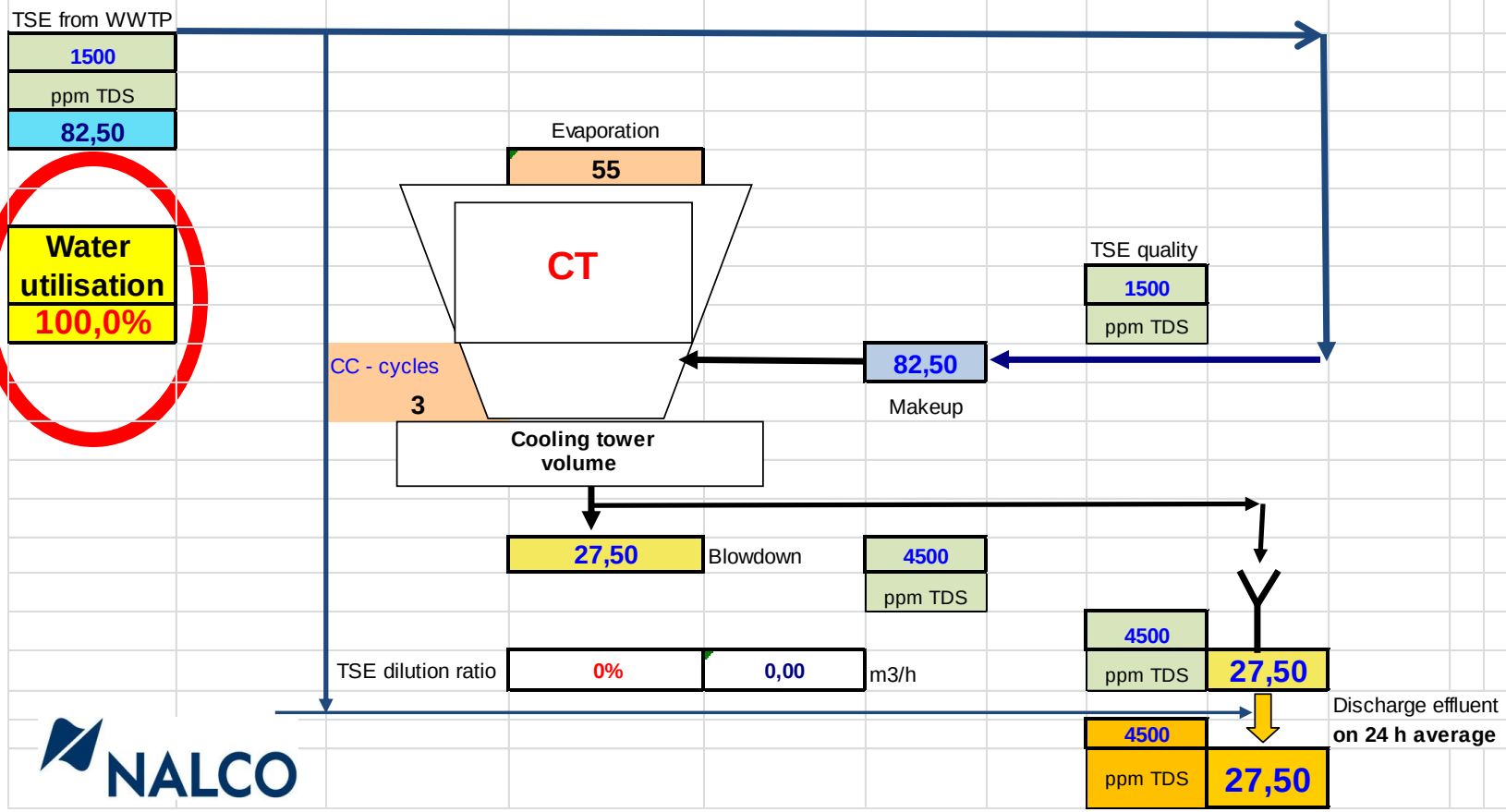
Polishing TSE via UF/RO – 55-60% utilisation



Direct TSE - 10.000 TR plant

Direct TSE into CT – 100% utilisation

TSE Direct use Concept



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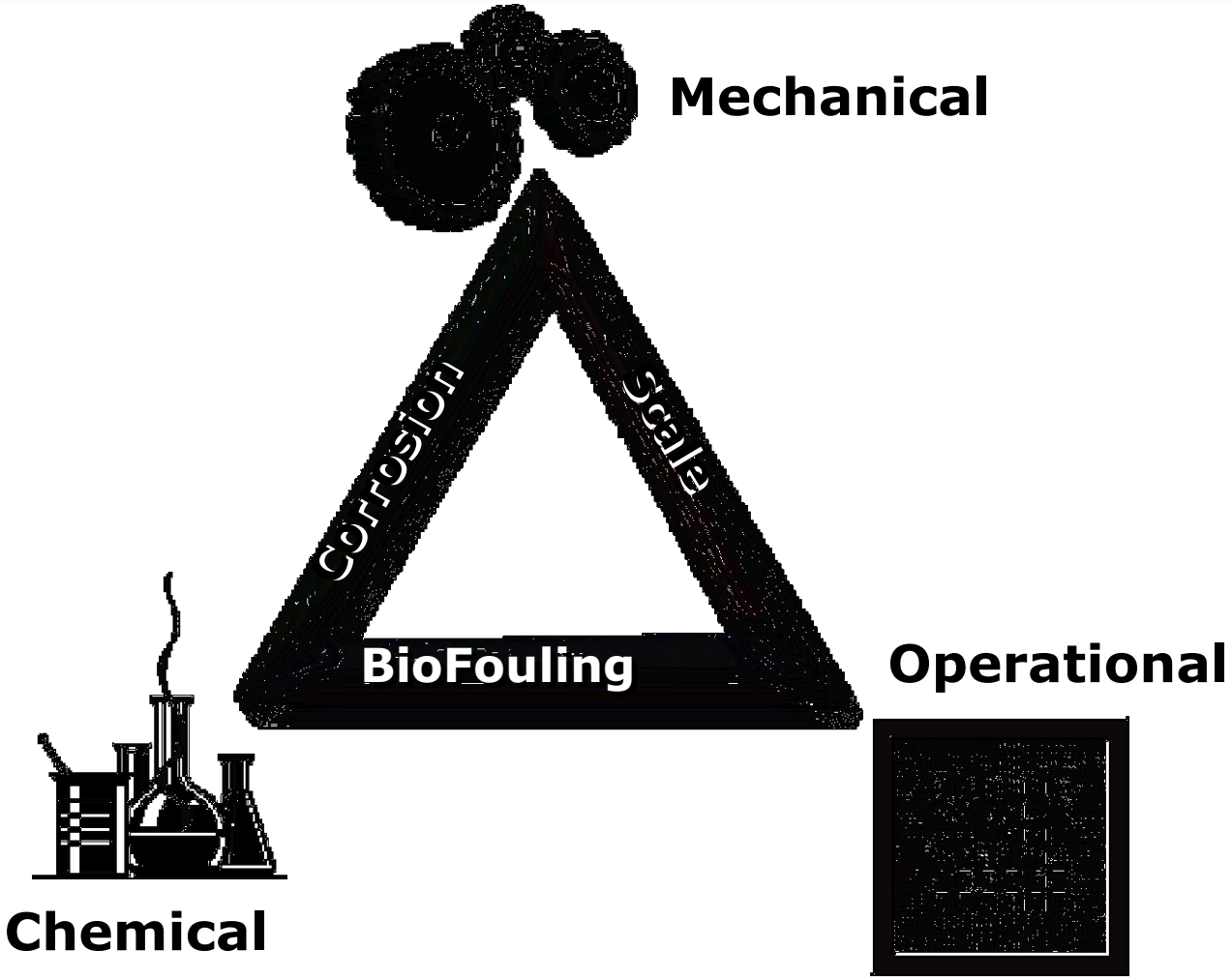
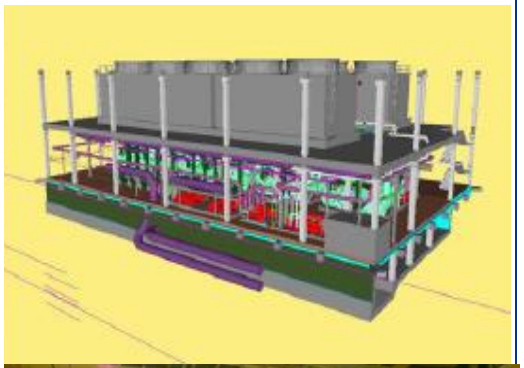
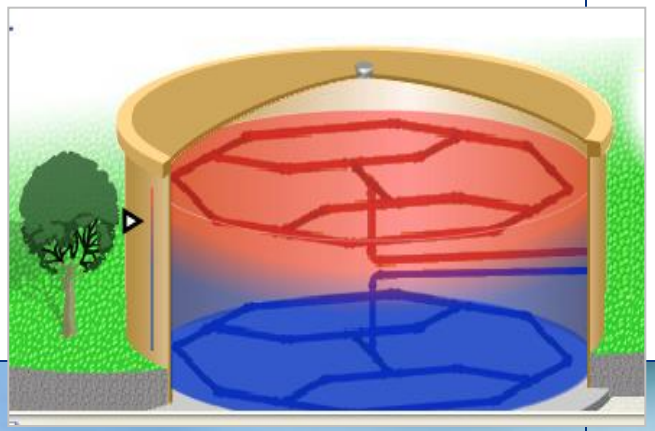
MOC Issues using TSE in Cooling Systems



Mechanical Challenges - TSE

- **System Design**
  - > no real changes needed from Municipal feed
  - > more constant operation is beneficial
  - > Polished & Direct TSE is more corrosive than Municipal water if stagnant
    - **Prevent longer stagnancy in flow**
      - Common header vs. Modular
      - GRP piping is more suitable from corrosion point
      - CT designs: better adopted but no special design
    - **Implement lay-up procedures** for chillers not in service for more than a week
      - empty water boxes , flush them if out of service
      - **Condenser water box/tube sheet coated**
    - **TES is best suitable for utilizing TSE** as it allows more continuous operation with better load management





Operational Challenges - TSE

- **System Operation** – out of service chillers - stagnant flow/
  - Chiller isolation/flushing procedures – lay-up - flushing
  - CT basin maintenance – biocide lay-up

- **Polishing plant** – an **UF-RO is best practice**
  - Needs tank capacity for inter mediate storage
  - **UF/RO** - requires monitoring for maintenance planning
  - **CONTINOUS operation** important – (preservation procedures needed)

- **CT operation monitoring & control**
  - Blowdown control
  - Proper dosing control of treatment and biocides
  - Monitoring of Perfomance Indicators – On-line >>> no Surprise
  - Operator involvent and training

TSE - How to meet the Discharge Limits

Discharge the Blowdown to the**:**

- **MunicipalSewer system**
- **Surface/storm water system to the sea or deep well**

The Key Limiting Parameters for Discharge			
1.	Conductivity: 4500	µS/cm	
2.	TDS:	3000	ppm
3.	Sulfate:	500	ppm as SO_4
4.	Phosphate:	30	ppm as PO_4
5.	Zinc:	0.5	ppm as Zn

Dubai municipality changed to 6000 ppm

BD quality: Polished 3300 ppm vs. Direct 4500 ppm

lower COC with Direct TSE

- Costly chemical program.
- High TSE Demand at 2 cycles 33 % more make up compared to cycles 3
- Meets current discharge limits

Dilute the Effluent

- Operating at maximum COC
- Most cost balanced choice
- Requires 20-50% Dilution water from original needs.
- ***use TSE for dilution*** *(best practice)*

Discharge Limits

Work with legislators

•adopt limits

DUBAI municipality raised TDS 6000 ppm

•Sewer discharge

no issues with municipal WWTP

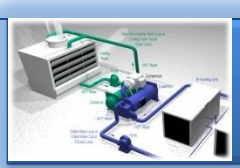
•Sea water discharge

MoE approve discharge to surface/storm water system

TSE as Makeup – Challenges vs. Facts

Comparison of both Concepts – real plant experience

Topic	***Polished TSE***	***Direct TSE***
• **TSE supply**	• multiple intermediate tanks	• 1 „day“ tank 50-100 m^3
• **Corrosion**	• 3-5MPY – within Chiller specs	• 3 MPY – above Chiller mfg. specs
• **water utilisation**	• COC 10-11 >> 102 m^3/KTR	• COC 3-5 >> 83 m^3/KTR
• **CT feed water quality**	• water quality is desalinated and stable - but more aggressive nature, limited microbio	• Fluctuating on CT makeup in TDS/chlorides/phosphates/N >> Cu/Scale/microbio protection
• **Operational Risks**	• High on UF/RO – CT risk low	• No RO - CT increased risk – dealt with by treatment/monitoring
• **Conversion needs**	• High space/CAPEX, med.OPEX	• No space/CAPEX, med.OPEX
• **TCO water/WT**	• 12-21 QAR/1000 TRh	• 9 QAR/1000 TRh
• **OP-Results Reference**	• 5 plants in GCC, less than 3 year concerns on membrane live	• 2 plants operate more than 4-6 year with proven results, 3 plants 1-2 yr



TSE Global - GCC Experience in DC

- **US -** University campuses, Hotels, (Refineries)
- **Europe** - Paris/France, etc.
- **Middle East** - UAE, SAUDI with Doha starting
  - **Dubai Festival City** (direct TSE)
  - **Riyadh Airport** (direct TSE)
  - **Empower** (use polished TSE in 2 plants)
  - **KAFD Riyadh** (direct TSE project)
  - **Jebel Omar** (direct TSE - project)
  - **EMICOOL** – DIP, Motor city (both TSE concepts)
  - **Doha Hotel** (polished TSE)
  - **DUBAI Airport** – DAFZA Freezone (both TSE concepts projects)
  - **EMAAR** – Burj Khalifa (polished TSE project)
  - **University complexes SAUDI**, etc. (both TSE concepts in project phase)

Thank You

» QUESTIONS !

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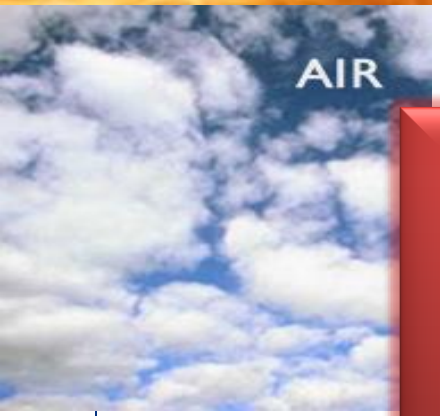
Case History 1 – Al Futtaim DFC plant

Dubai Festival City - direct TSE as

- 50.000 TR installed – 10 Packaged units
- YORK STD wall Cu enhanced tubes – SPIG towers – GRP
- **Nalco changed 2008 from DEWA water to TSE**
- **100% direct TSE as MU for > 3,5 years**
- **Eddy Current** – Cu tubes measured annually
  98,1% found at < 10% metal loss at the end of 3 years with TSE - **3 years no tubes replaced**
- **1,2 M m3 water and 6 M AED saved/year**

Savings per Cooling tower
~ 203,000 m3/Y of fresh Water
TCO reduction of ~ 1,72 million AED/Year
(full load, incl. treatment cost)
WT cost: 345,000 AED/year

Case History 2 – **Ryiadh Airport**



SAUDI Oger – KAIA with direct TSE

- **DC system – 35 m3/h max. evaporation**
- Changed from RO permeate to direct TSE water from KAIA own WWTP
- **Copper tubes – TSE 600-800 µS/cm – COC 4.5-5**
  TH: 150 ppm, Cl: 100 ppm, PO4: 0,5 ppm, NH4: 2 ppm
- Implementation started in June 2010
- **Corrosion rate 2,9 mpy – no deposits visible**
- **Approach, fouling factorr not increased**

Savings
~ 321,900 m3/Y of fresh Water
TCO reduction of 2,288,000 SAR/Year
WT cost: 850,000 SAR
from previous 305.000 SAR