



How will District Cooling Evolve in the GCC?

Presented by **Fouad Younan**
CEO & MD of DC PRO Engineering

GCC District Cooling Market Estimate (2011)

	KSA	UAE	Kuwait	Qatar	Oman	Bahrain	Total GCC
Estimated Population - Millions	28.10	7.90	2.80	1.90	2.80	1.30	44.80
Peak Electric load - MW	48,367	18,601	11,220	5,375	3,900	2,812	90,275
Peak Electric load - KW / Capita	1.72	2.35	4.01	2.83	1.39	2.16	2.02
Produced power GWH / Year	219,662	101,602	59,080	30,730	18,500	13,826	443,400
Produced power kwh / kw	4,542	5,462	5,266	5,717	4,744	4,917	4,912
kWh / Capita / Year	7,817	12,861	21,100	16,174	6,607	10,635	9,897
Estimated Peak cooling Load - Ton	22,456,100	8,636,200	5,209,300	2,495,500	1,810,700	1,305,600	41,913,400
District Cooling Est. Peak Load - Ton	600,000	1,000,000	90,000	200,000	70,000	45,000	2,005,000
District Cooling Penetration Rate - %	2.7%	11.6%	1.7%	8.0%	3.9%	3.4%	4.8%

GCC District Cooling Market Estimate (2015)

	KSA	UAE	Kuwait	Qatar	Oman	Bahrain	Total GCC
Estimated Population - Millions	31.54	9.16	3.89	2.05	4.49	1.37	52.50
Peak Electric load - MW	62,260	21,387	13,310	8,200	4,982	3,355	113,494
Peak Electric load - KW / Capita	1.97	2.34	3.42	4.00	1.11	2.44	2.16
Produced power Gwh / Year	330,367	121,775.0	70,011	41,405	25,760	16,745	606,062
Produced power kwh / kw	5,306.2	5,693.9	5,260.0	5,049.4	5,170.6	4,990.9	5,340.0
kWh / Capita / Year	10,475	13,299	17,988	20,197	5,737	12,201	11,544
Estimated Peak cooling Load - Ton	28,906,400	9,929,700	6,179,600	3,807,100	2,313,100	1,557,700	52,693,600
District Cooling Est. Peak Load - Ton	900,000	1,500,000	90,000	200,000	85,000	45,000	2,820,000
District Cooling Penetration Rate - %	3.1%	15.1%	1.5%	5.3%	3.7%	2.9%	5.4%

GCC District Cooling Market Assessment

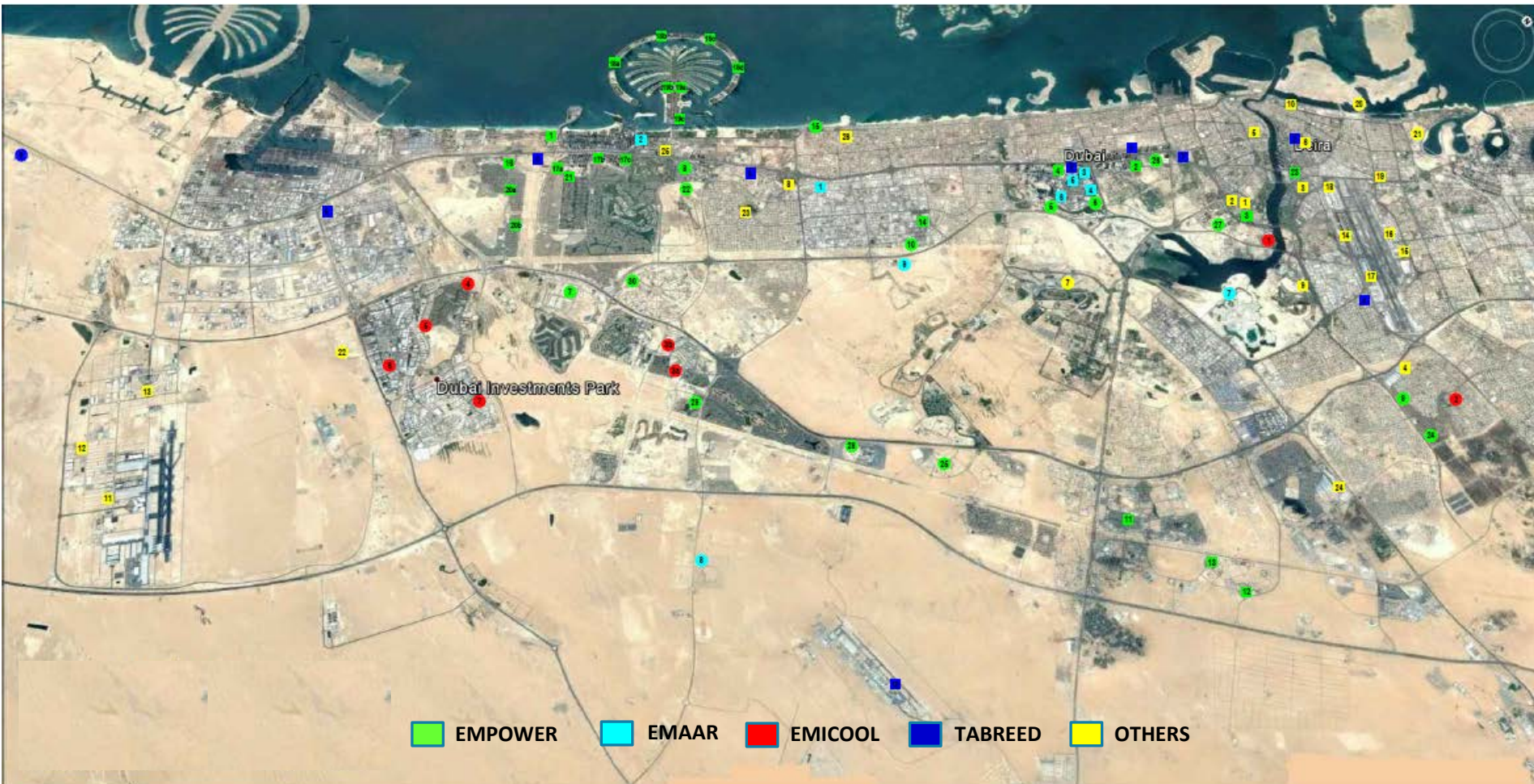
- Although there were substantial growth from 2011 (2.0 Million Ton) to 2015 (2.82 Million Ton) in District Cooling the market penetration increased slightly (4.8% to 5.3%) due to growth of traditional A/C systems as well.
- The UAE has the largest DC market (1.5 Million Ton) followed by KSA (900,000 Ton) and Qatar (200,000 Ton)
- Installed Capacity is over 5.5 Million Ton while utilized capacity is around 50% or 2.85 Million Ton.
- Tri-Generation & Distributed Generation is around 150,000 Ton of installed capacity or around 3% of the DC market.
- Over 10,000 Km of distribution chilled water networks and over 500,000 BTU meters installed in GCC.

GCC District Cooling Market Trends

- UAE, Qatar and KSA are planning substantial increase in DC Capacity of 500,000 Ton / year with several laws encouraging DC (ECRA recent DC regulations mandating all Government projects over 15,000 Ton to have DC).
- Thermal Storage is becoming dominant by Government mandate (Dubai) and customers preference to reduce both Capex (-12%) and Opex (-8%).
- Market is split between 60% DC utilities and 40% Government or large single customer owned utility.
- Continued consolidation in DC utilities lead by Empower, Tabreed, Emaar, Emicool, Pal tech., Marafiq, Enova(Dalkia), City Cool, DFC, etc.
- Struggling to utilize spare capacity (2.65 Million Ton with est. Value of US \$ 6 Billion) with few exceptions such as Motor City exporting DC to Sport City & Akoya and added capacity next to existing networks of several DC systems.
- Renewables are not yet seriously considered by the DC Industry.

Dubai Specific DC Market Trends

The largest single City DC Market + Highest DC Penetration in the world



Dubai Specific DC Market Trends

Total DC Plants	105	
Total DC Planned Capacity - TR	3,285,310	
Total DC Installed Capacity - TR	1,981,150	100%
Total DC Utilized Capacity - TR	792,460	40%
Total Installed DC Capacity With Thermal Storage Tank - TR	746,450	38%
Available DC Capacity Without Thermal Storage Tank - TR	1,234,700	62%

- Dubai is planning for **800 MW** of CSP that would cost **US\$ 4 Billion**
- If we use **Solar PV (800 MW @ \$ 0.8 B)** with DC & oversized (200%) Thermal Energy Storage (**1.2 MTR @ \$ 1 B**) we can save **US \$ 2.2 Billion of CAPEX** while achieving same objective.

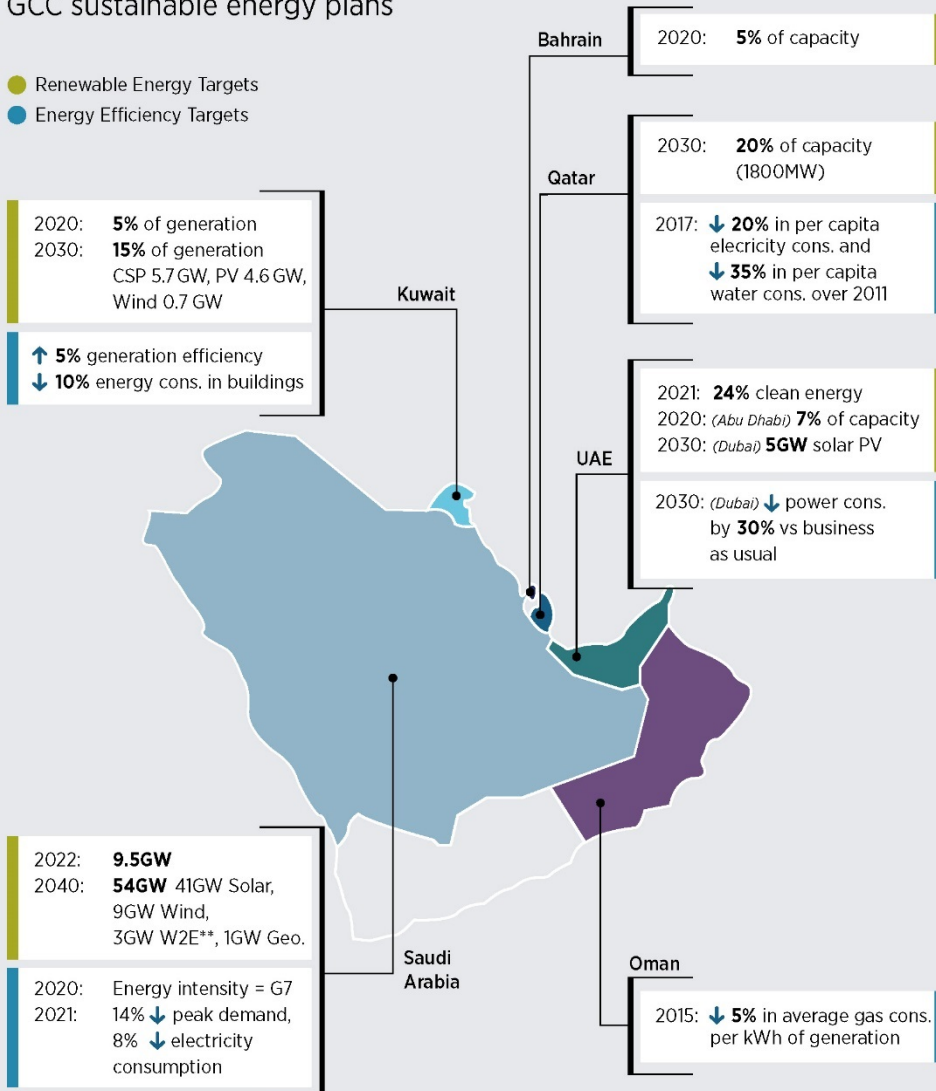
The GCC Solar PV Boom

- Abu Dhabi initiated the Market with 10 MW Solar PV (Masdar City) and Concentrated Solar 100 MW Shams 1. 350 MW Solar PV is currently in the bidding stage in Abu Dhabi.
- Dubai Followed by 10 MW, 200 MW and 800 MW solar PV (Mohammed bin Rashid Al Maktoum Solar Park) with world record low cost of US ¢ 2.99 / kwh.
- Dubai Planning a much more expensive Concentrated Solar (Thermal) of 1,000 MW and many distributed PV under Shams Dubai Initiative allowing grid connections.
- Taqnia Energy initiated 50 MW Solar PV in KSA.
- Kuwait & Oman has several multi MW installations
- Qatar QWEC / QP JV planning a 200 MW Solar PV tender soon.

The GCC Renewables' Boom - IRENA

GCC sustainable energy plans

- Renewable Energy Targets
- Energy Efficiency Targets



Country	2017-2022 MW	2030-2040 MW
KSA	9,500	41,000
UAE	1,400	7,000
KUWAIT	700	3,000
QATAR	200	1,800
OMAN	200	500
BAHRAIN	70	200
GCC	11,970	53,500

The GCC Renewables' Boom - IRENA

Figure ES.4 Fossil fuel savings from GCC renewable energy targets by year and by country

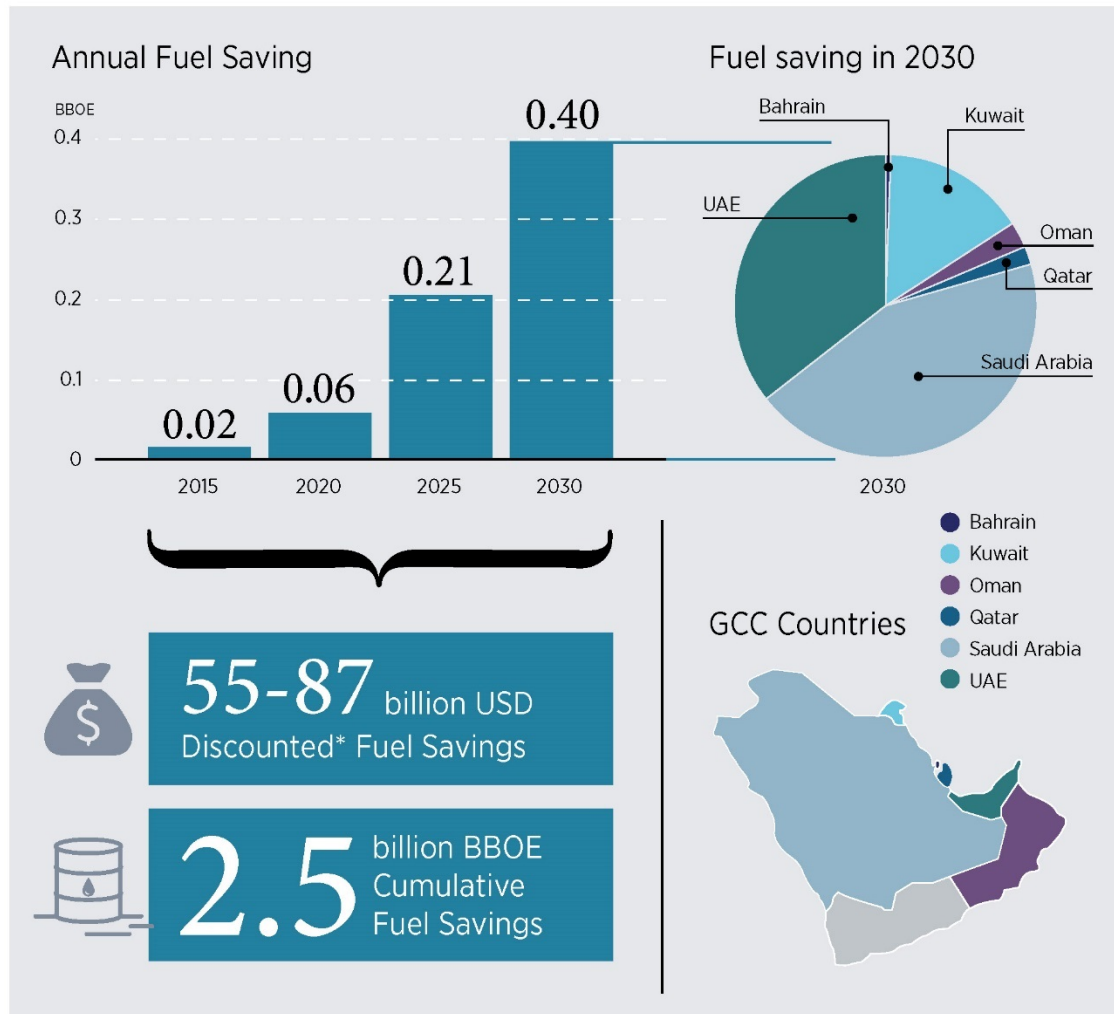


Figure ES.5 Emission savings due to renewable energy deployment plans (MtCO₂)



* Discount rate 5%; Low price scenario (Oil: USD 40/barrel; Gas: USD 8/MMBtu); High price scenario (Oil: USD 80/barrel; Gas: USD 11/MMBtu)

District Cooling & Renewables

DC & Renewables share common goals:

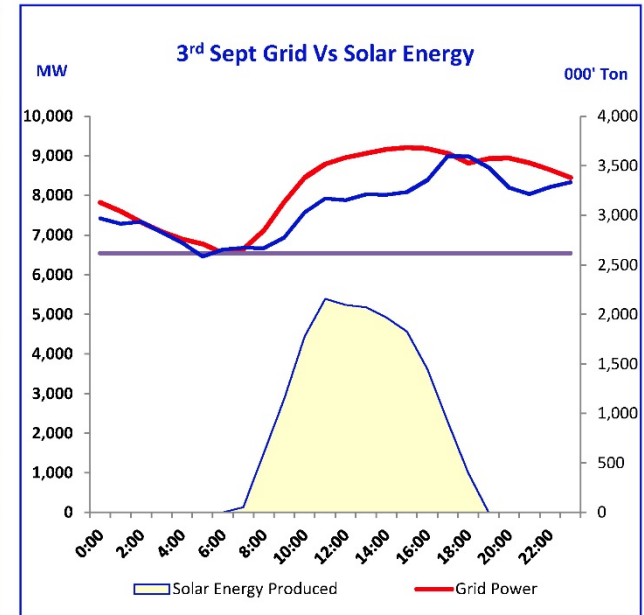
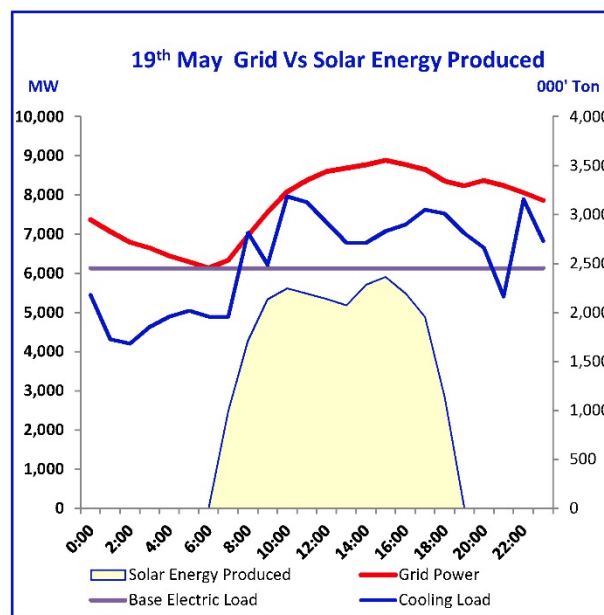
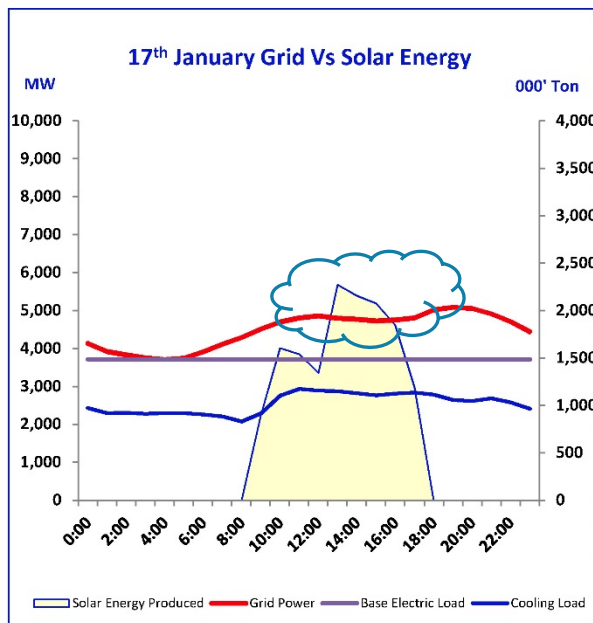
- Reduce fuel consumption & greenhouse emissions and improve country competitiveness.
- Both are looking for energy storage; District Energy to level the load and reduce the investment and the second trying to supply continuous renewables day & night.
- Improve people's quality of life:
 - Through distributed & more reliable power generation and cooling sources.
 - Better outdoor and Indoor air quality.
- Conserve fuel consumption for future generations, export revenues and prosperity.
- Improve the GCC countries' image from very high polluters to very high preservers.

How should the GCC DC industry react to the renewables' boom?

- The Renewable industry is looking at the most expensive methods to store energy. Concentrated Solar system (CSP) would increase cost by six folds from US ¢ 3 to 4 / kwh to around US ¢ 18 to 20 / kwh).
- GCC countries are planning 8 GW of CSP costing around US \$ 32 Billion higher than solar PV.
- 50% of GCC annual electric usage and around 65% of peak demand is for air conditioning application.
- District Cooling could reduce the CSP need by half saving the GCC countries a whopping US \$ 16 Billion in future Investment.
- District cooling can increase both chillers capacity and thermal storage to charge during the day and discharge during the night.

Electric Load, Cooling Load and Solar Generation profile in GCC for typical winter, Mid-season and summer day

- We have assumed that 50% of GCC peak demand will be covered by Solar Energy.
- In Winter there will be a need to abort part of the solar energy produce.
- In Mid season a big interference during mid day for base power generation (Combined cycle, clean coal or Nuclear)



How should future DC plant designed in response to the renewables' boom?

- If District cooling was powered by 100% solar PV then it need to **oversize** the **chillers capacity by 300%** and the **thermal storage capacity by 200%** to supply the majority of cooling need as extracted from the load profiles. The **Additional Cost** is estimated to be **US \$ 4,000 / Ton**.
- We will assume that District Cooling will achieve 25% penetration rate by 2030 and if the cooling need is increasing at an average of 3% annually that would translate to 20 Million Ton of DC capacity in 2030.
- If 50% of CSP or 4,000 MW will be replaced by DC + Thermal Storage strategy that would requires around 4 Million Ton to be designed with a solar energy storage strategy in mind or 20% of the Total TC industry.
- The Additional Chilled water and thermal storage would cost the DC industry $4,000,000 \text{ Ton} \times \text{US\$ } 4,000 / \text{Ton} = \text{US } 16 \text{ \$ Billion}$ or half the Concentrated Solar cost.

How should future DC plant designed in response to the renewables' boom?

- DC industry will have lot of spare capacity and may not need to invest the entire US \$ 16 billion. If the industry will have 20% spare capacity or 4 Million Ton then the additional Investment would be US \$ 8 Billion.
- Tri-generation synchronized with renewable could avoid increasing chillers capacity and thermal storage at night. A 4 Million Ton would require 3,000 MW of Tri-gen at a cost of US \$ 3.6 Billion.

How should the Electric Industry or Higher Government Planning authority benefit from DC Industry?

- Integrate the electric strategy with the DC Strategy.
- The US \$16 Billion planned for CSP should be funneled partially to the DC industry through joint investment in Tri-Gen.
- Supply preferential electric power tariffs and capital investment rebate for the DC Utility that is willing to design its plant for solar strategy.
- Facilitate Natural Gas supply or Diesel or bio diesel for the Tri-Gen Plants.
- Develop national strategy for thermal grid networks in major cities to increase the utilization of all DC spare capacity.

The Current parallel unrelated approach of Electric Power & DC is hurting the GCC national Economy and the environment!

- Is it about time that the DC Cooling Industry and the Electric Power Industry should change from current practice into one that embraces the Future??
- Isn't the future made by visionaries from both industries today?
- Optimized approach for both industries (Solar & DC) can save a minimum of US \$ 11.4 Billion and a maximum of US \$ 20 Billion.

Thank you

www.dcproug.com

email: gberbari@dcproug.com