Garden DCP3 Plant Optimization

Emirates Central Cooling Systems Corporation
(EMPOWER)

Presented By: Tariq Al Yasi

Purpose

- Improved plant efficiency
- Improved plant capacity generation

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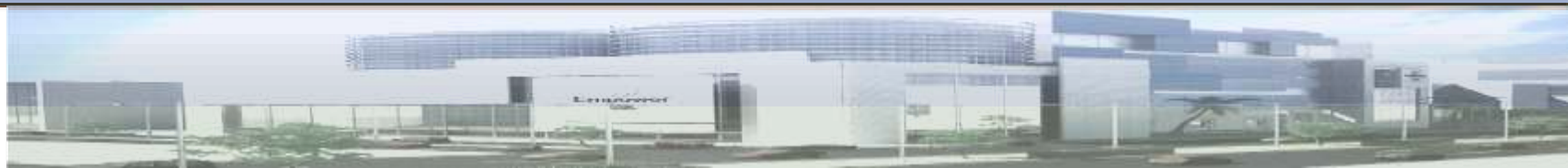
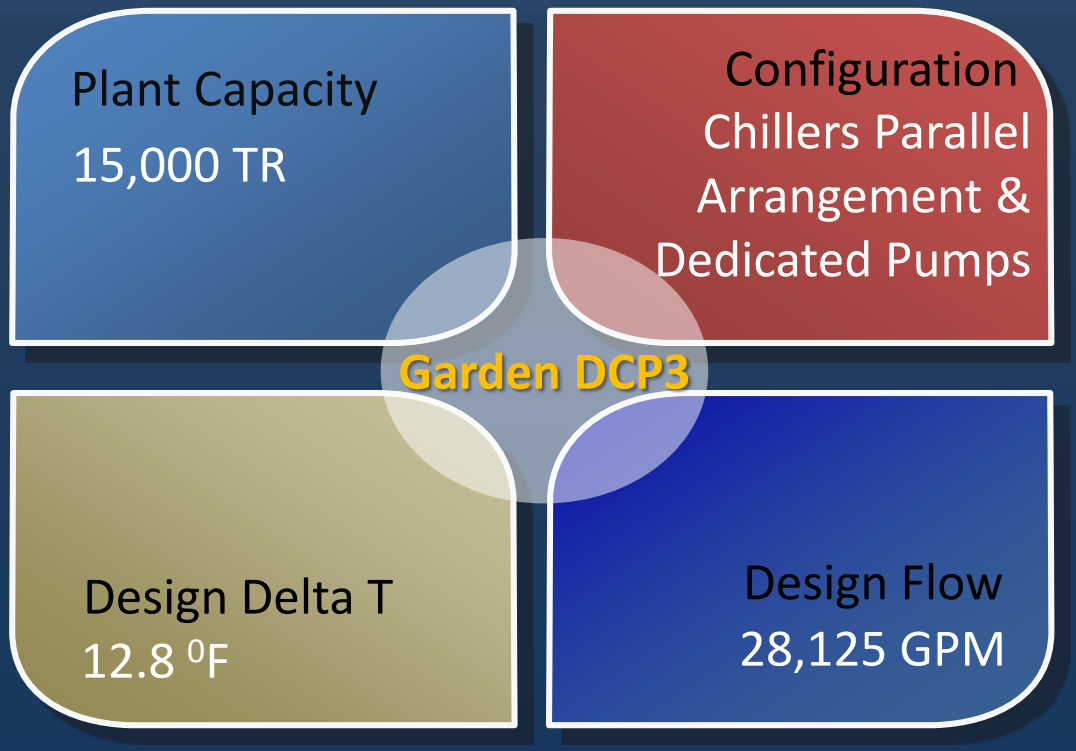
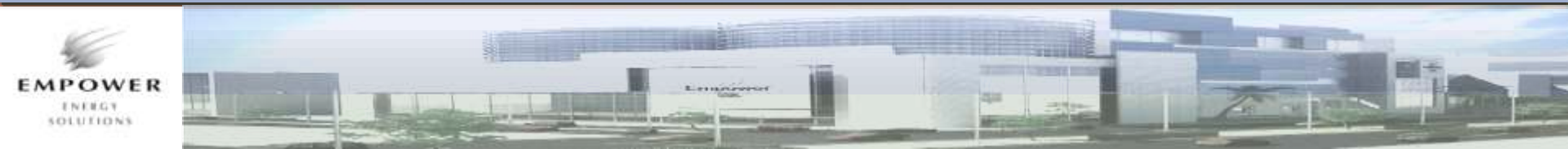
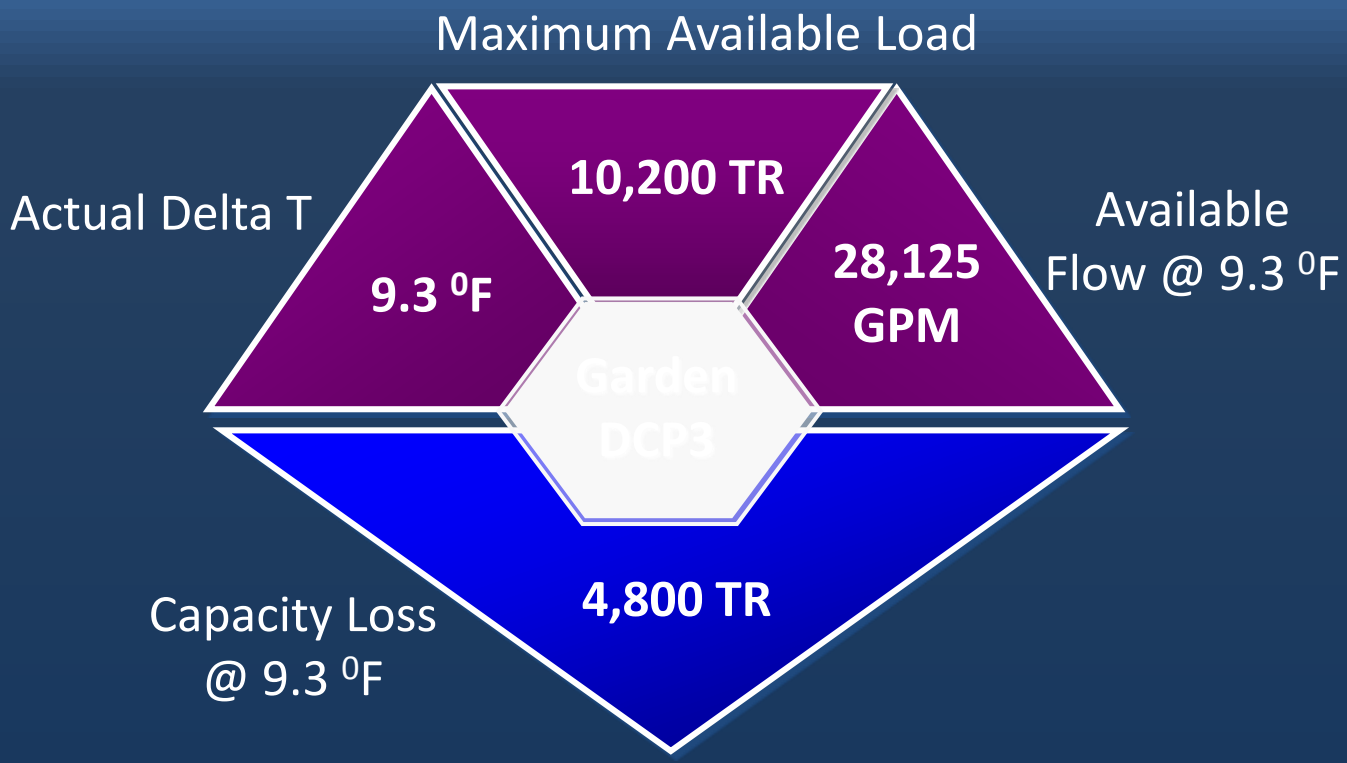


Plant Design Parameter

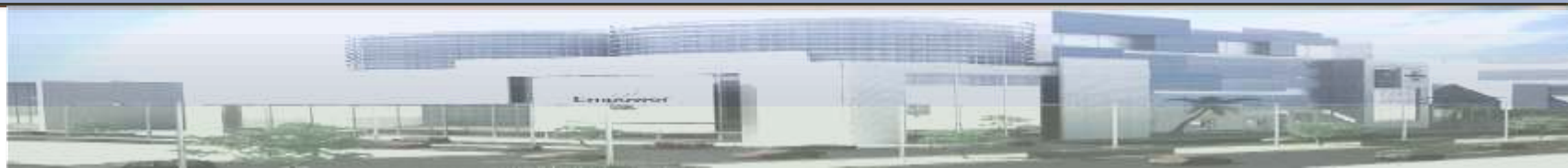




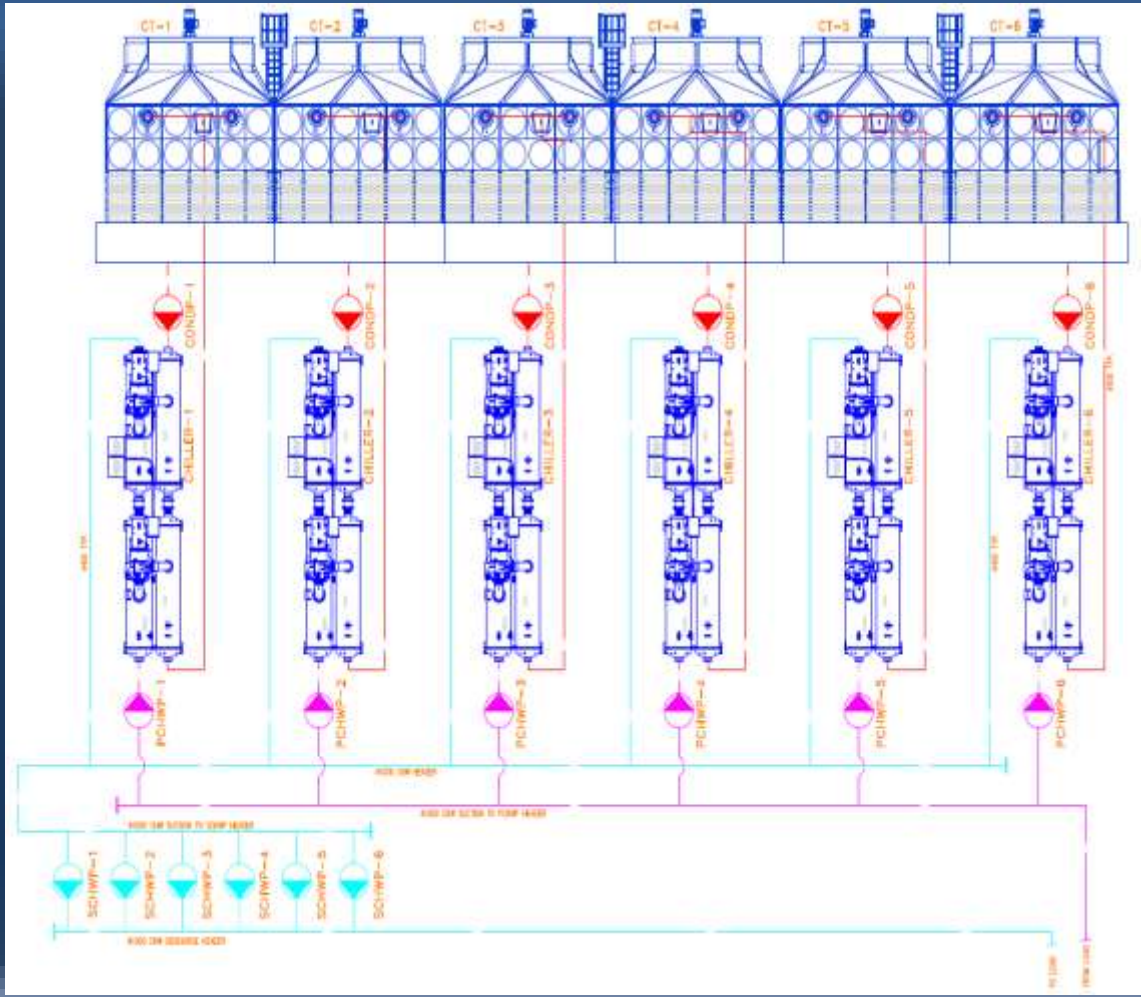
Plant Operation Parameters Before Optimization



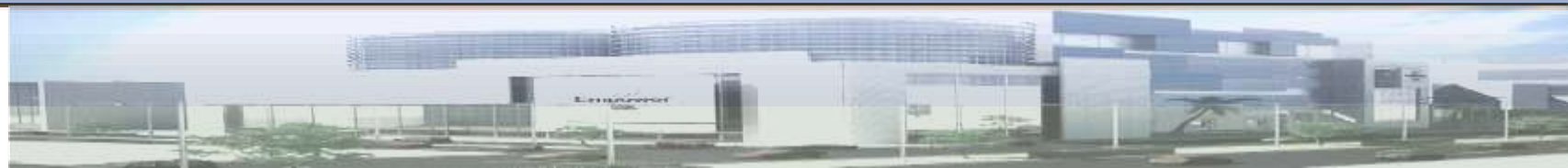
- It is confirmed from the operation data that plant was not producing design tonnage with a huge capacity loss because of low delta T.



Plant Arrangement



- Chillers arranged in series/series-counter flow, having capacity of 15,000 TR
- Dedicated arranged six nos. (6) constant flow primary chilled water pumps
- Dedicated arranged six nos. (6) constant flow condenser water pumps
- (5 Duty + 1 Standby) variable flow secondary chilled water pumps



Target

1. Run the plant at its maximum efficiency (Mitigation of low delta T Syndrome)
2. Accommodate potential new loads
3. Avoid Capex of building new plant to serve new projects in the Vicinity
4. Utilize the existing network capabilities (No Modification)

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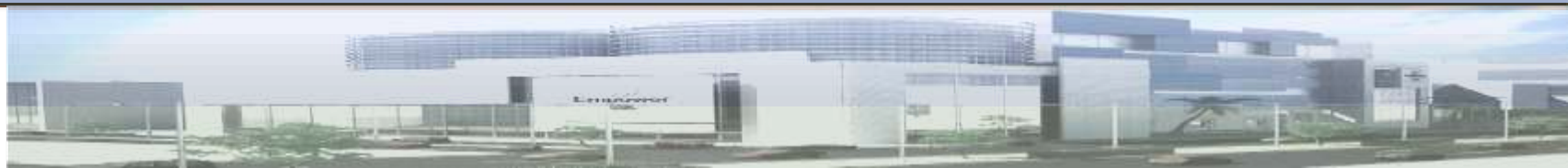

Technical Approach

- In line with past 10 years operation data, delta T correction to be implemented
- Taking advantage of diversity 15,000 TR plant can serve a demand of 20,000 TR (.75 diversity)
- Key Elements Studied:
  - ✓ Plant Layout & concept of arrangement
  - ✓ Chillers
  - ✓ Primary, condenser and secondary Pumps

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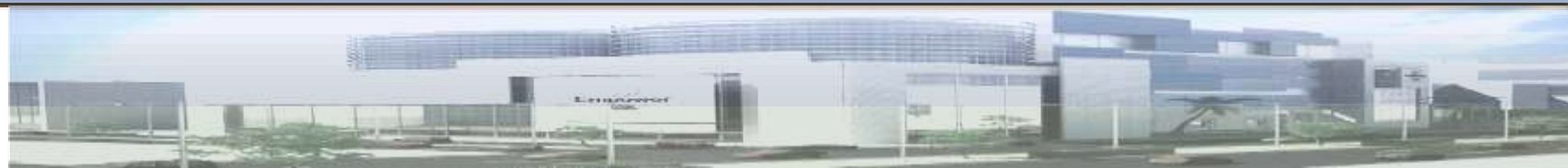

Plant Layout Study

- Plant does not have room for changing to headered pumping or parallel chiller arrangement.
- No space is available to add new primary and secondary chilled water pumps.
- CT's improvement was implemented earlier by increasing the fills height to maximum, any change in condenser water pump will not add value since maximum heat rejection is being already achieved.
- Ample Space available to install VFD's

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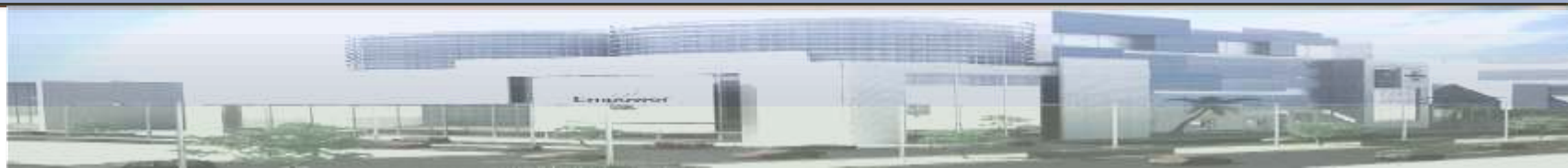

Study Chiller – Design capabilities and Limitations

Pressure Drop

Minimum & Maximum flow rate on evaporate side

Re-selection of chillers as per new parameter

Chiller design limits at higher flow discussed with manufacturer.

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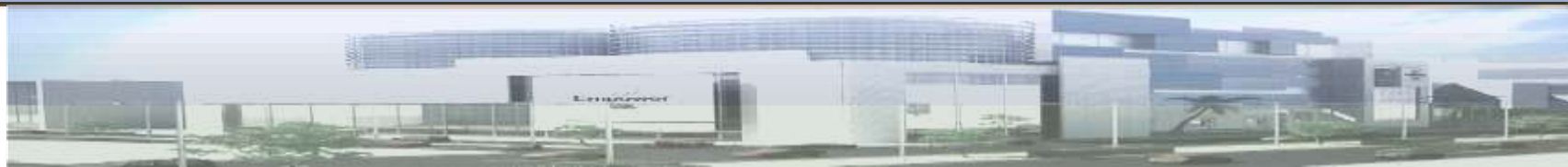

CHILLER SELECTION BASED ON Delta T 10 Deg. F @ 6000 GPM

	Description	Existing Chiller Capacity @ Delta T 12.8 ^{0}C	Chiller Selection at Higher Flow @ Delta T 10 ^{0}C
Capacity @ 100% Load	Up stream (TR)	1,298	1,298
	Down stream (TR)	1,228	1,242
	Overall (TR)	**2,526**	**2,540**
Evaporator Temp.	In (deg. F)	53.8	51.12
	Out (deg. F)	41	41
	Delta T (deg. F)	**12.4**	**10.12**
Evaporator Flow	Up stream (GPM)	**4,709**	**6,000**
	Down stream (GPM)	**4,709**	**6,000**
Condenser Flow	Up stream (GPM)	7,384	7,384
	Down stream (GPM)	7,382	7,384
Kw/Ton at Full Load	**Overall**	**0.77**	**0.76**
Condenser Temp.	In (deg. F)	95	94.73
	Out (deg. F)	104.9	104.63
	Delta T (deg. F)	**9.9**	**9.9**
Pressure Drop Evaporator	Up stream	16.1	20.4
	Down stream	18.3	20.6
	Total	**34.4**	**41**
Pressure Drop Condenser	Up stream	31.8	31.8
	Down stream	32	32
	Total	**63.8**	**63.8**
Motor	Up stream Load (amp)	175	172
	Down stream Load (amp)	168	166
	Total (amp)	**343**	**338**

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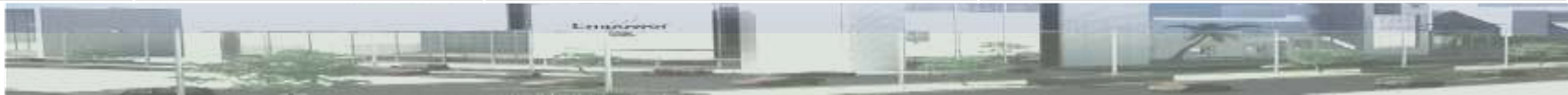

Study Reselection of Primary Chilled Water Pumps

- The primary pumps are re-selected to operate up to 2.4 GPM/TR instead of 1.875 GPM/TR.
- Design delta T correction to 10 °F instead of 12.8°F
- Introduction of VFD pumps which ensure effective chiller utilization and mitigates capacity reductions because of Low Delta T syndrome.
- This viable solution not only improved the plant efficiency, but also caters for any potential capacity / load requirements as well.

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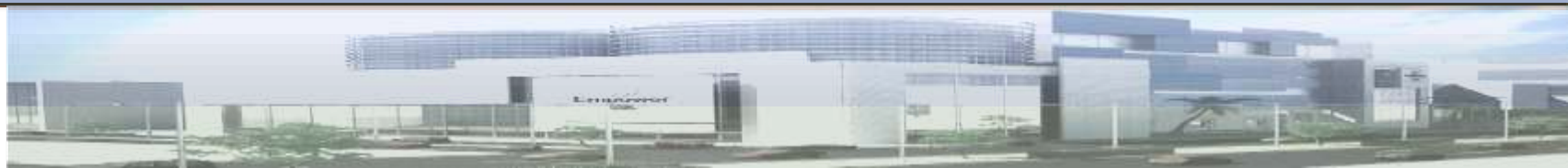

Plant Efficiency Improvements

- Study Energy consequences at part load conditions
- Developed chiller and auxiliary efficiency matrix table comparing before and after scenarios.
- An insignificant energy penalty due to new pump selection duty point is diminished by overall benefits from chiller plant.

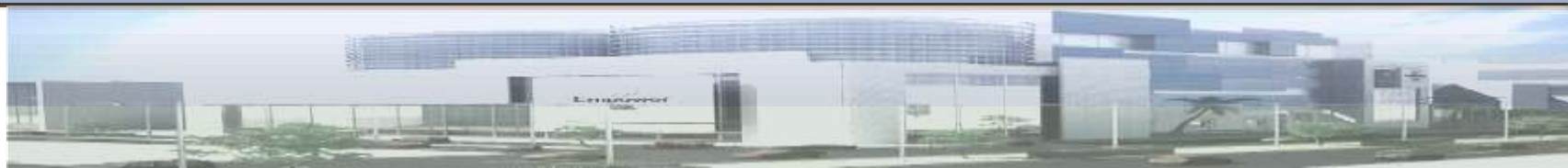

Table 1 – Chiller Plant Part Load Performance Data

SN	Load in %	Chiller Compressor KW/TR	Auxiliary KW/TR	Plant KW/TR	Chiller Compressor KW/TR	Auxiliary KW/TR	Plant KW/TR
1	10%	N/A	N/A	N/A	N/A	N/A	N/A
2	20%	0.83	0.94	1.77	0.83	0.94	1.77
3	30%	0.74	0.56	1.3	0.74	0.56	1.3
4	40%	0.71	0.4	1.12	0.71	0.4	1.12
5	50%	0.72	0.33	1.05	0.72	0.33	1.05
6	60%	0.76	0.29	1.05	0.76	0.29	1.05
7	70%	0.75	0.24	0.99	0.75	0.24	0.99
8	**Plant was unable to operate at more than 70% of its capacity**				0.74	0.21	0.95
9					0.75	0.19	0.93
10					**0.76**	**0.17**	**0.94**

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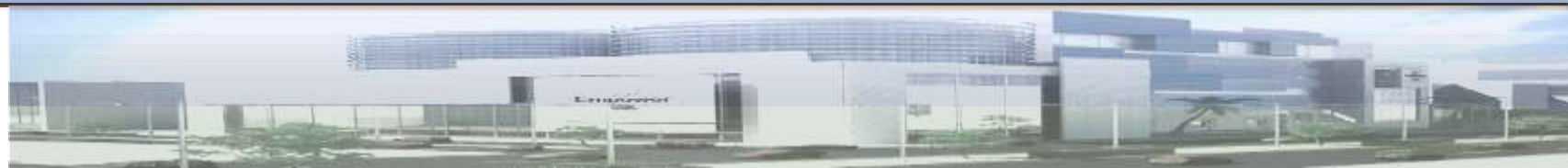

Environmental Advantages

- Energy consumption of chiller plant improved substantial and subsequently cutting down carbon-dioxide emission to atmosphere indirectly.

- We estimate at least 4 MW of demand power is reduced in central power grid. Indirectly power generation and associated emission is reduced.

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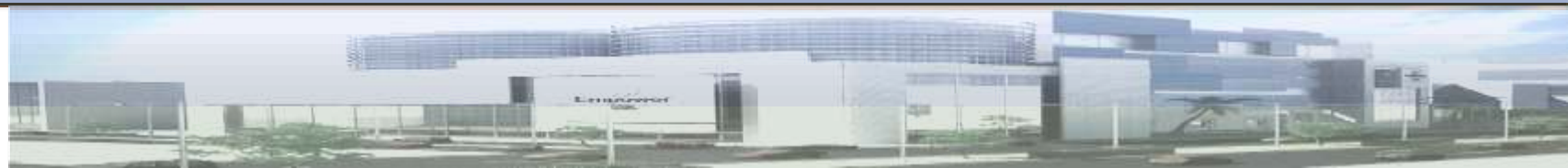
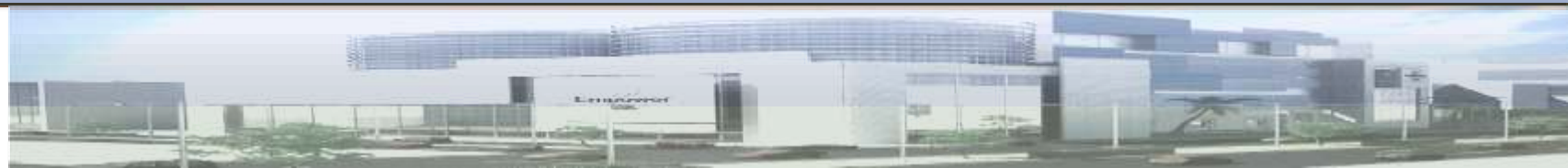


Financial Benefits

- Chiller plant capital Investment
- Utilization of existing network
- Electrical demand



VFD Pumps

GN-03 DCP EFFICIENCY AFTER VFD PUMPS			
Year	**Plant TRH**	**Electrical KWH**	**KW/TR**
2013	33,257,289	35,632,570	1.07
2014	34,231,410	36,880,000	1.08
2015 (VFD)	32,992,300	33,090,300	1
2016 (VFD)	33,466,527	34,424,522	1.03
2017 (VFD)	35,149,329	34,844,470	0.99

GN-03 DCP EFFICIENCY AFTER VFD PUMPS			
Energy Saving	0.08 KW/TR	2,811,946	KWH
Cost Saving		348,620/Year	USD

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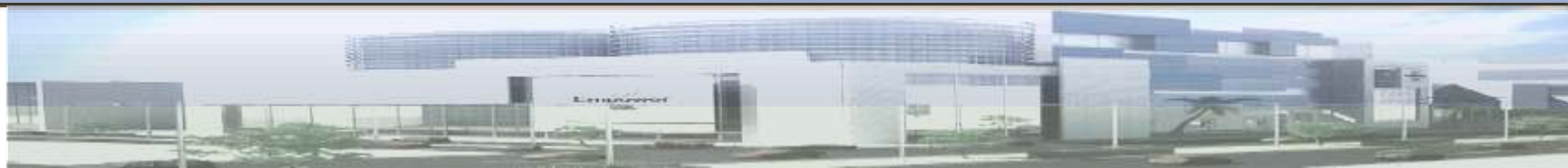

Plant Construction CAPEX

SN	Description	Unit Price	Total Cost in USD
1	Chiller Plant (Chiller, Auxiliary Units) - 4,000 TR	1,000 USD/TR	4,000,000
2	Piping Network - 4,000 TR (Cost for 2.0 km)	2,500 USD/Meter	5,000,000
3	Electricity Charges for 4,000 TR (Indirect and Direct Cost)	1,000 USD/KW	4,000,000
		Over all Cost	**13,000,000**

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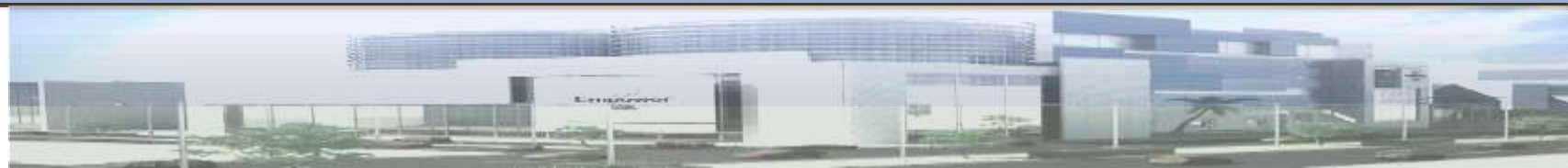

Project Cost

SN	Description	Total Cost in USD
1	General Requirements (site mobilization, preparation, office construction, etc.)	25,000
2	Civil Works	30,000
3	Mechanical Works	600,000
4	Electrical/Control Works (Garden 3)	350,000
	Overall Cost	**1,005,000**

- **Cost Saving of 12 Million USD**

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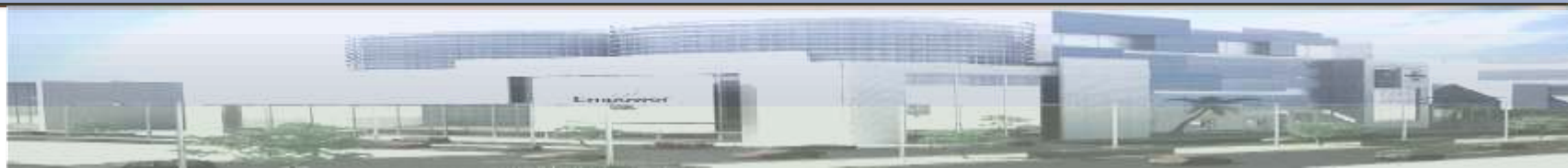

Project Progress

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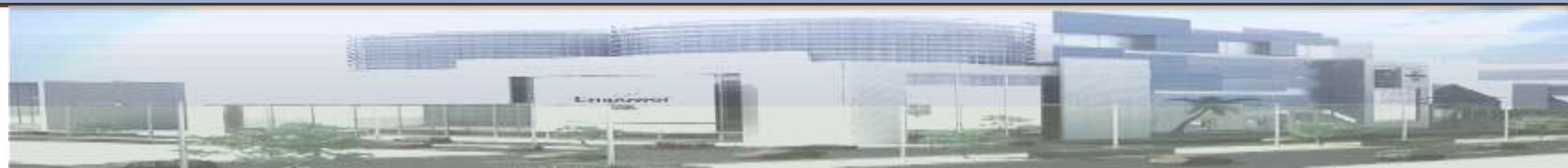

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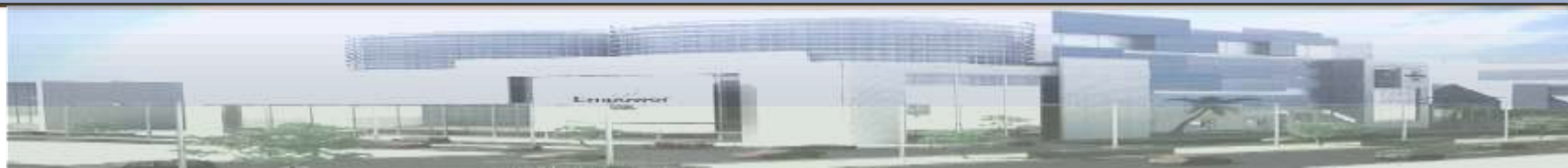

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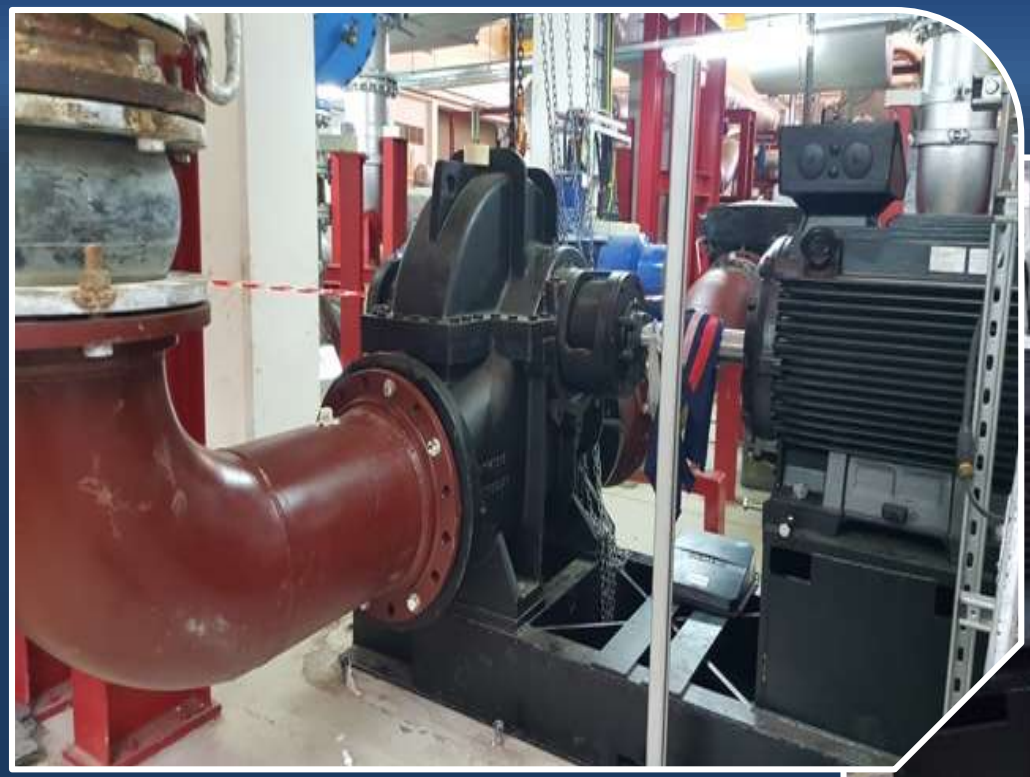

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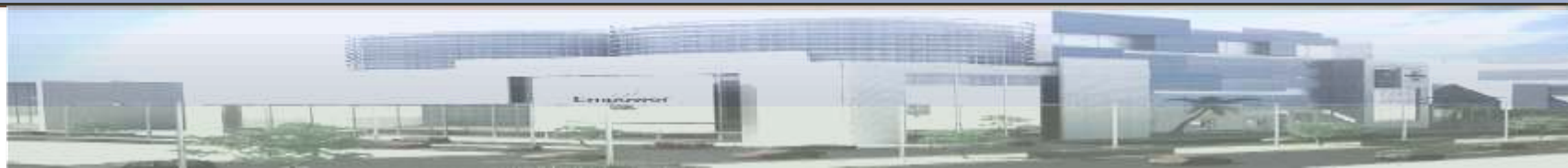

Thank you!

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