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Dubai World Trade Centre

The Use of Excess Steam to Supply Absorption Chillers in Cogeneration Plant

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New & Renewable Energy Technology Div, PS

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ORGANISED BY

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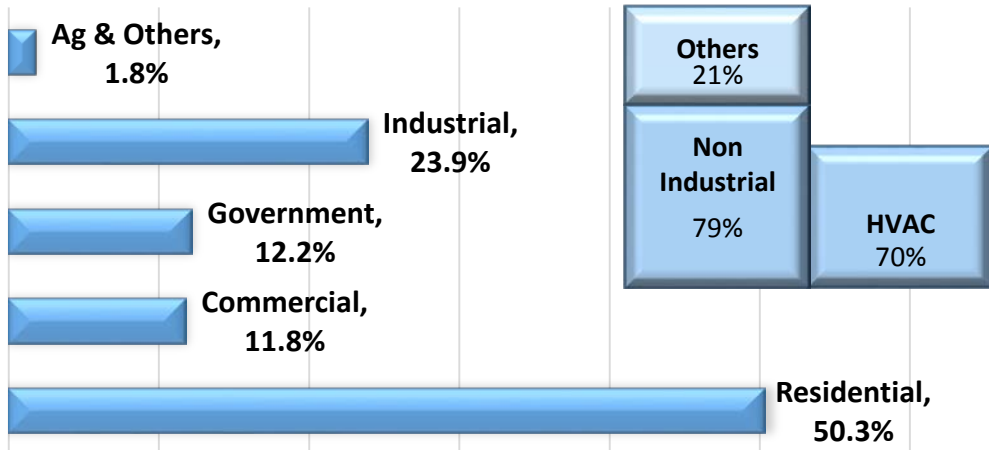
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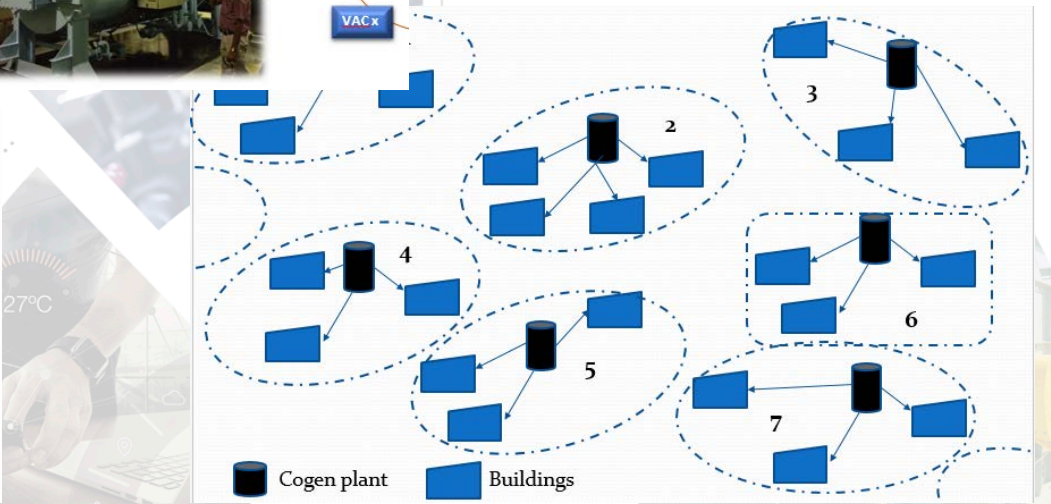
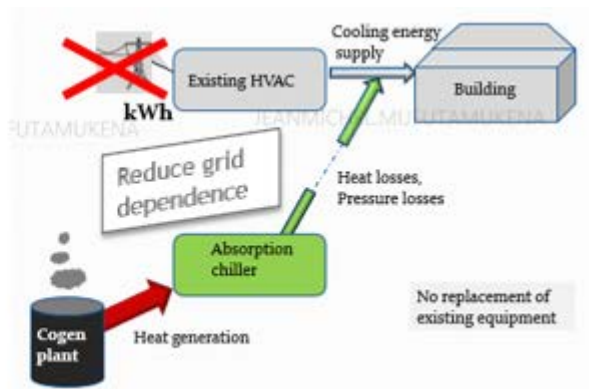
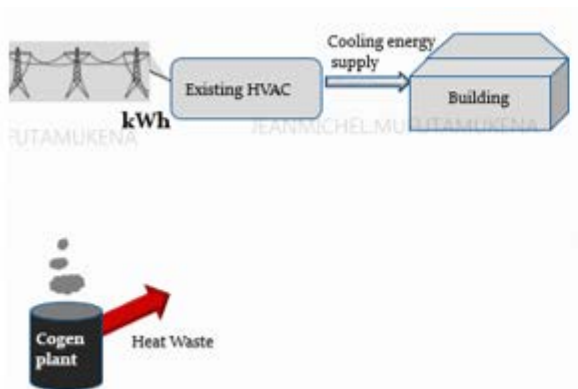
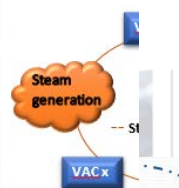
HVAC Energy consumption

KSA ENERGY CONSUMPTION BREAKDOWN



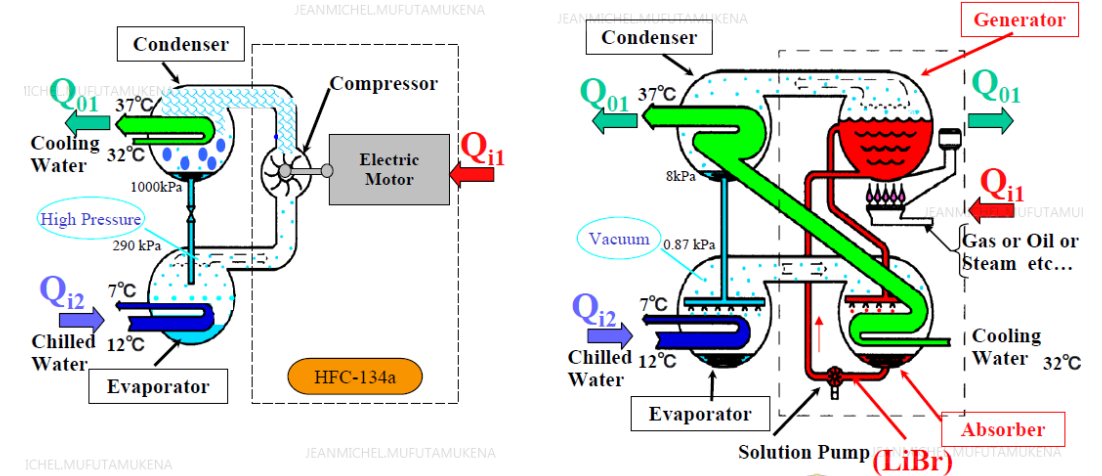
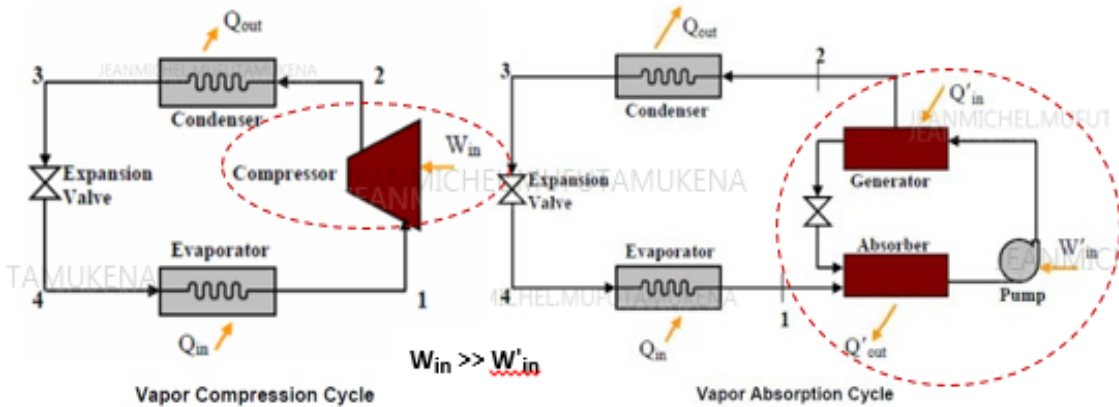
Find solutions to reduce HVAC power consumption

Energy Efficiency goal KSA 2030, rationalize resources, global warming commitment...



The Use of Excess Steam to Supply Absorption Chillers in a Cogeneration Plant

Benefits of absorption chillers



Compression energy (conventional) \gg Pumping energy (Absorption)

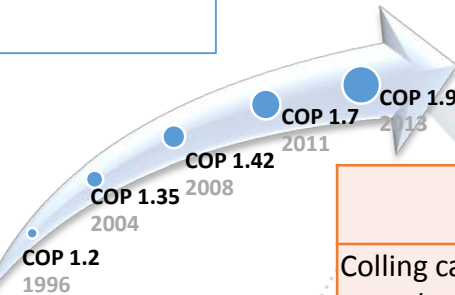
Mechanical vapor compressor is replaced by \rightarrow Thermal compressor : absorber, generator, pump, and a throttling device.

$$COP = \frac{Q_{i2}}{Q_{i1}} = \frac{\text{Cooling Capacity}}{\text{Heat Input}}$$

Absorbent pump,
vacuum pump,
Refrigerant pump

Benefits vs Vapor Compression Chillers

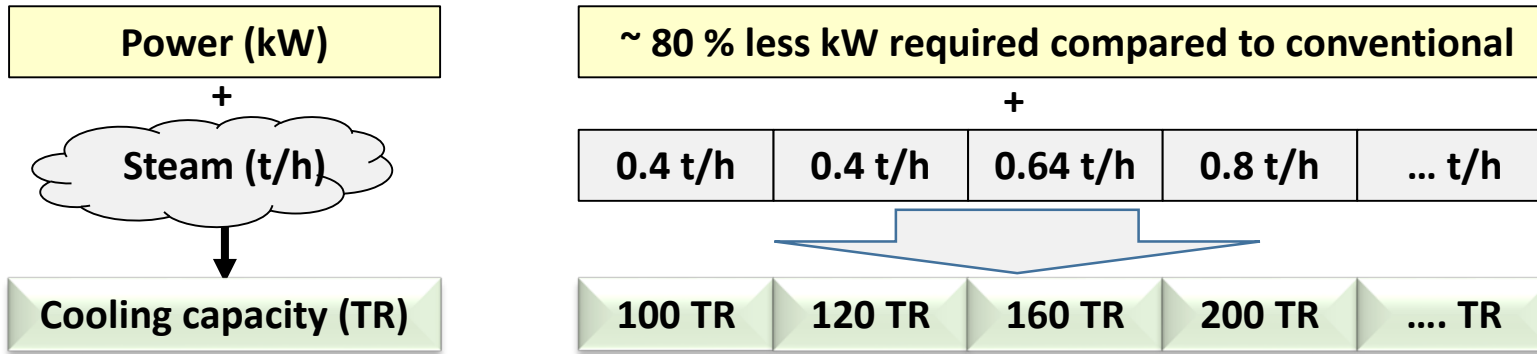
- ✓ Low grade energy (Steam, hot water ...)
- ✓ Few moving parts
- ✓ Natural refrigerant (water)
- ✓ No effect on COP for lower evaporator pressures
- ✓ Not much affected by partial loads



Colling capacity (TR)	Vapor Compression Chillers (VCC)			Vapor Absorption Chillers (VAC)		
	Brand	Model	Power Input (kW)	Brand	Model	Power Input (kW)
80	Zamil	ASY80B	88	Thermax	2B 2LC	21
100		ASY100B	115		2B 2NC	22
250		ASY250B	262		2B 4MC	34
590		ASY590B	662		2B 5NC	64

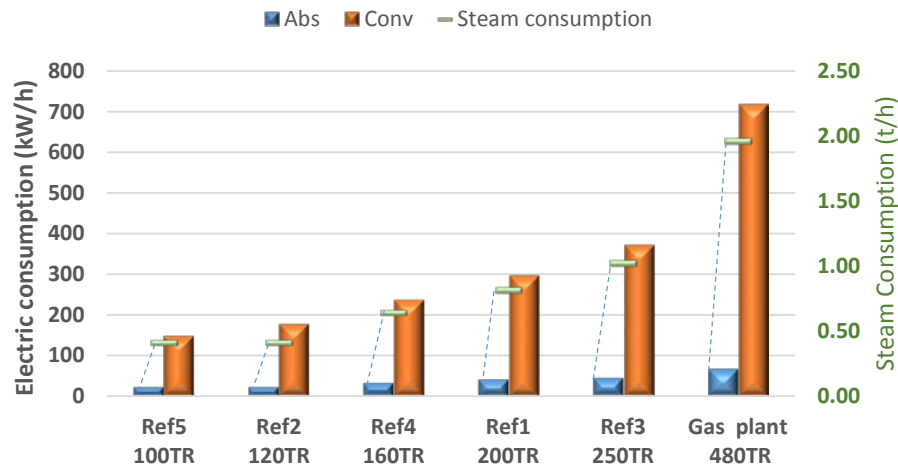
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HVAC electric power demand reduction/load shedding

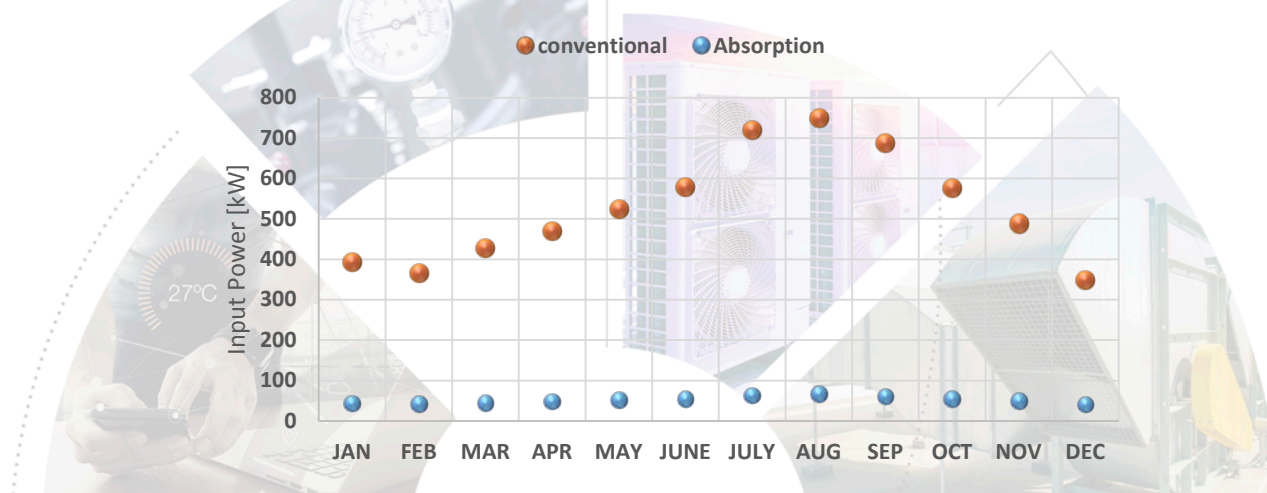


Steam specific Consumption		
Single stage	8kg/h/TR	1 bar
Double stage	4 kg/h/TR	8bar

Absorption Chillers vs Compression Chillers



AC Load Conventon Chillers vs. Absorption Chillers (480TR)



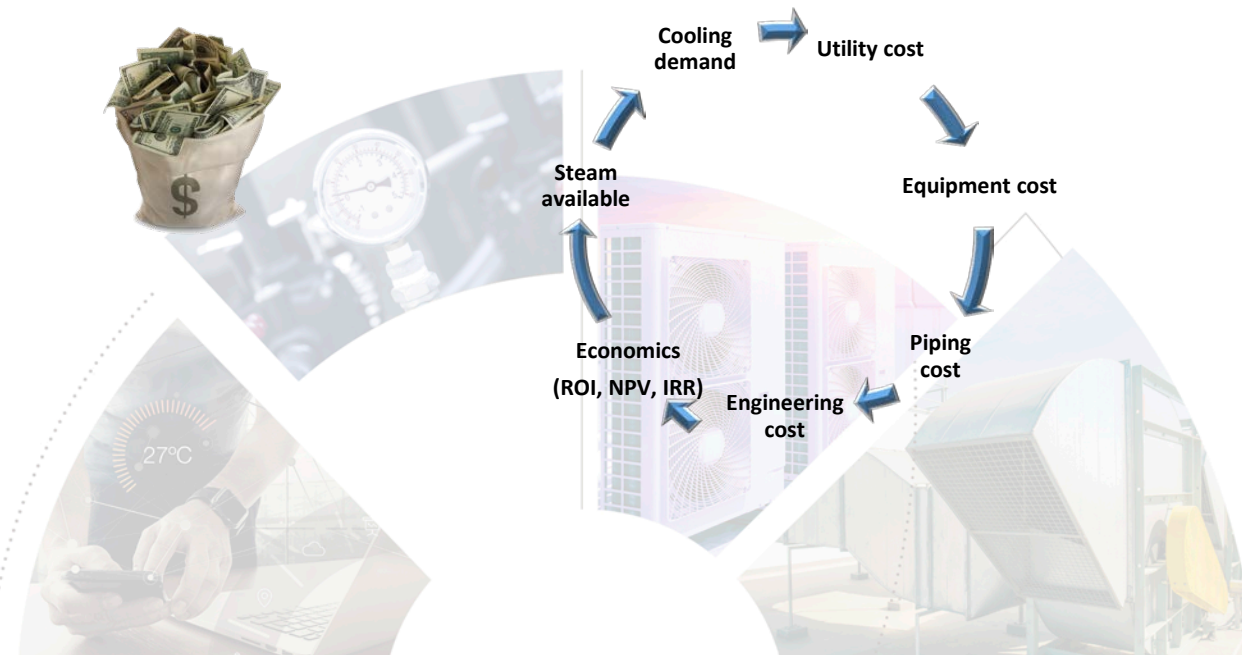
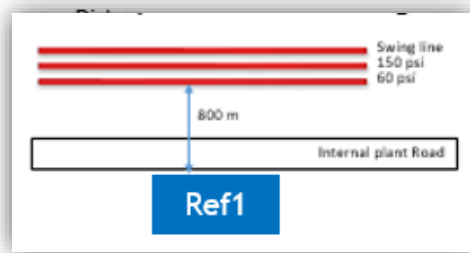
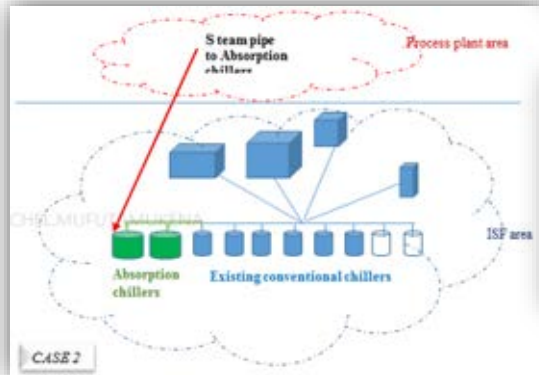
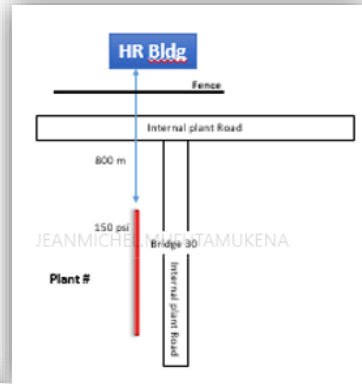
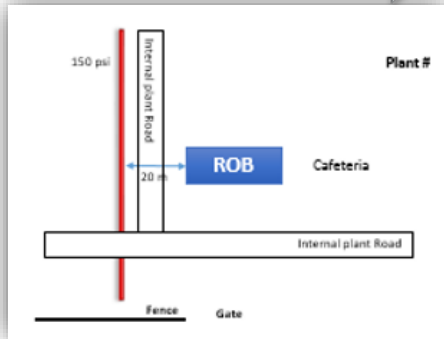
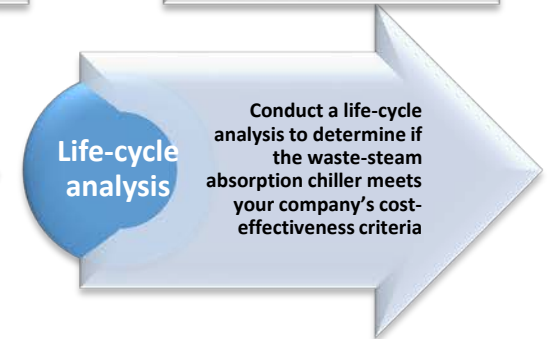
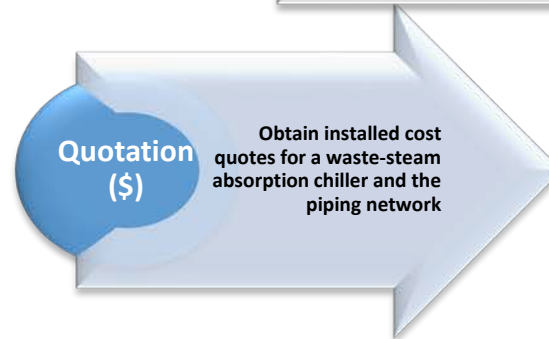
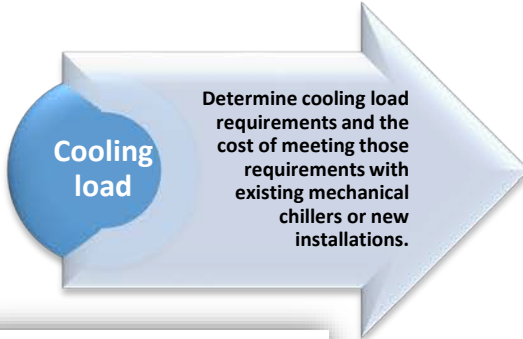
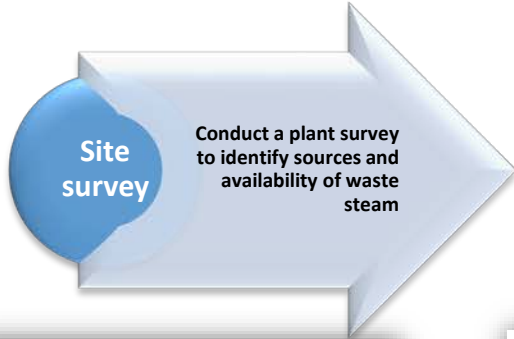
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Case studies for Refinery and Gas plant (KSA)

Demand Side cooling requirement

Steam Generation availability

US DOE



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Case studies for Refinery and Gas plant (KSA)

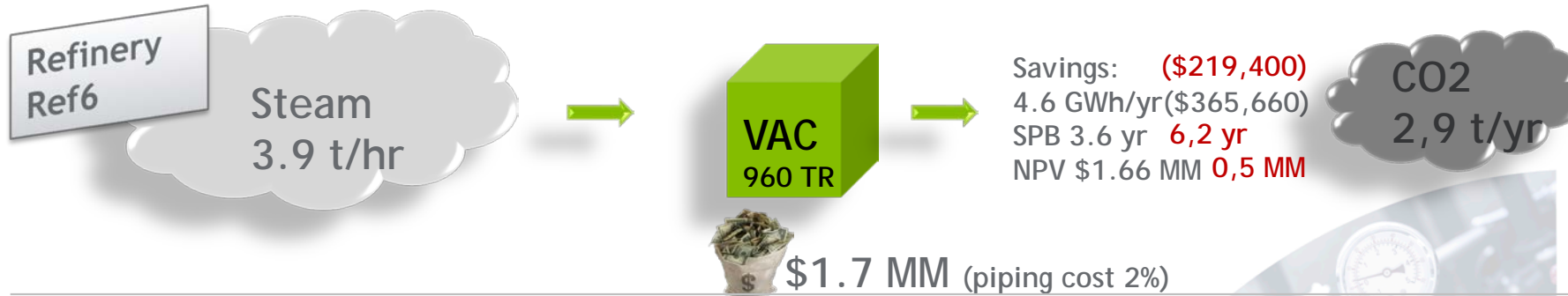
Eight (8) sites investigated

Discount rate 0,053/inflation 3%

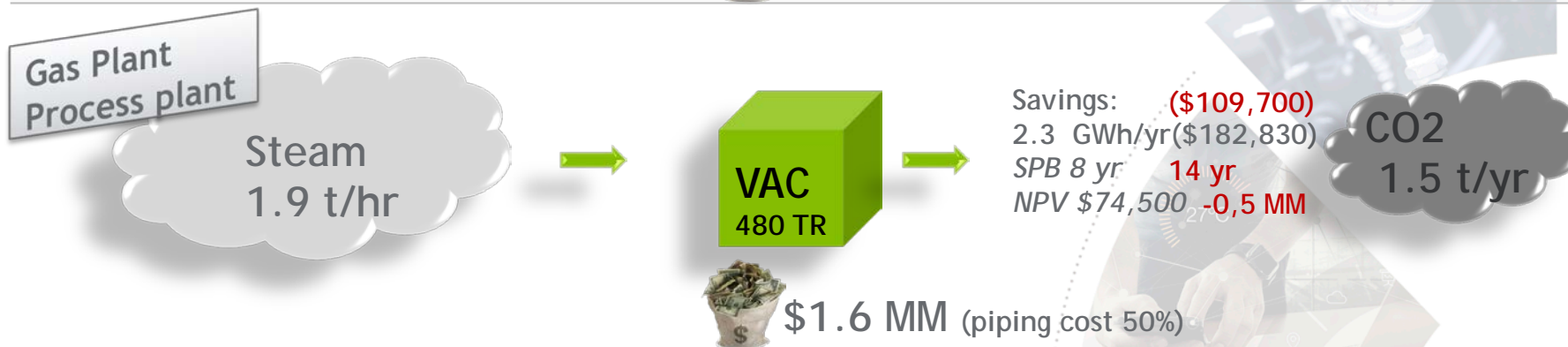
Double effect



THERMAX	Model 2B 7KC	
Chilled water flow	M3/hr	542.9
Cooling water flow	M3/hr	700
Steam pressure	Kg/cm2(g)	8
Steam consumption	Kg/hr	3571.9



THERMAX	Model 2B 6KC	
Chilled water flow	M3/hr	289.5
Cooling water flow	M3/hr	400
Steam pressure	Kg/cm2(g)	4.1
Steam consumption	Kg/hr	1950



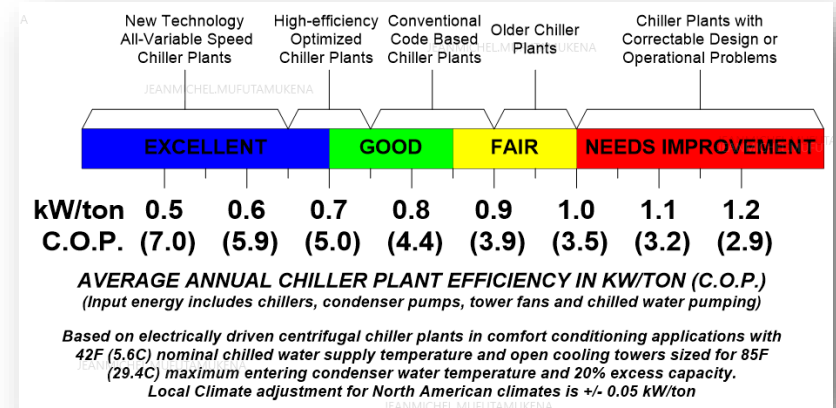
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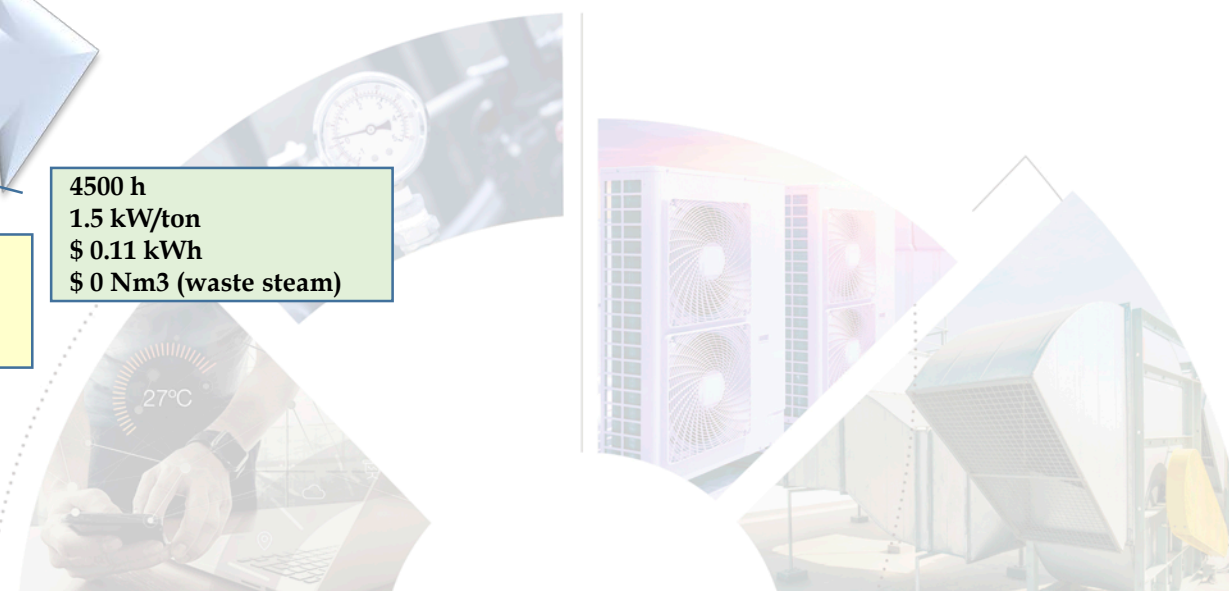
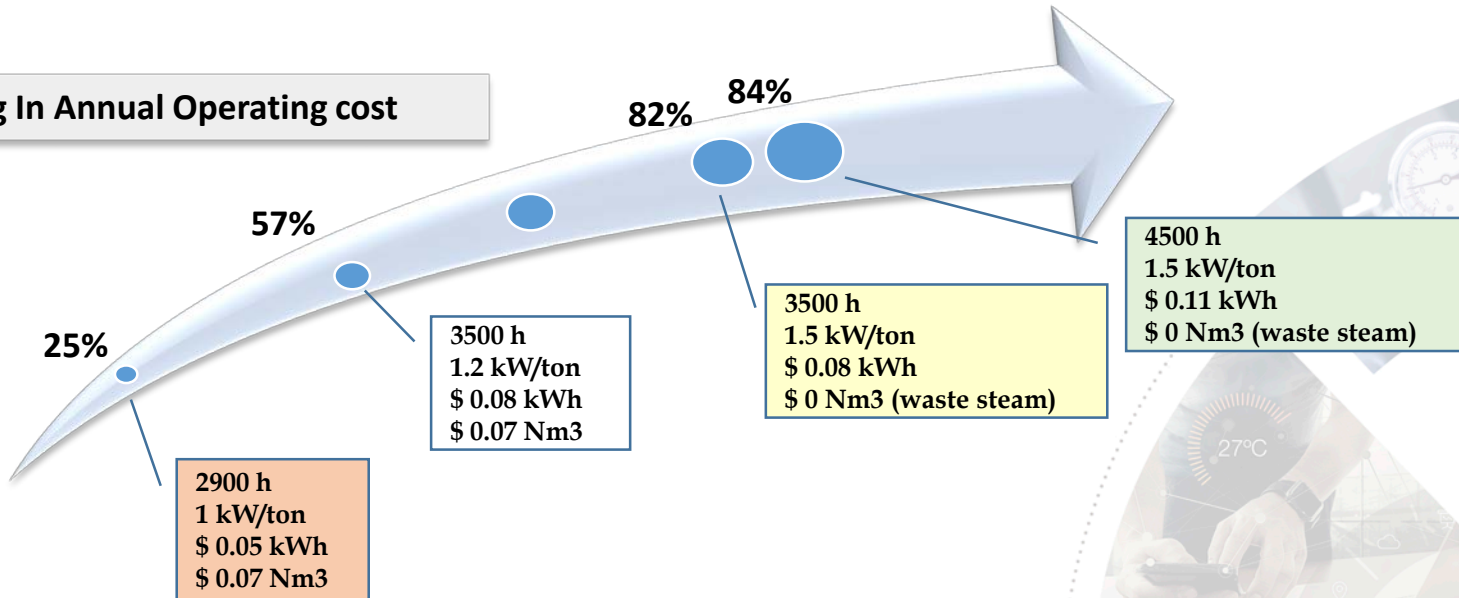
Key parameters to consider for investment

Capex: Equipment cost, piping cost, design, labor

Opex: Utility cost (electricity rate, steam (NG) cost, water cost), old equipment efficiency, operating hours



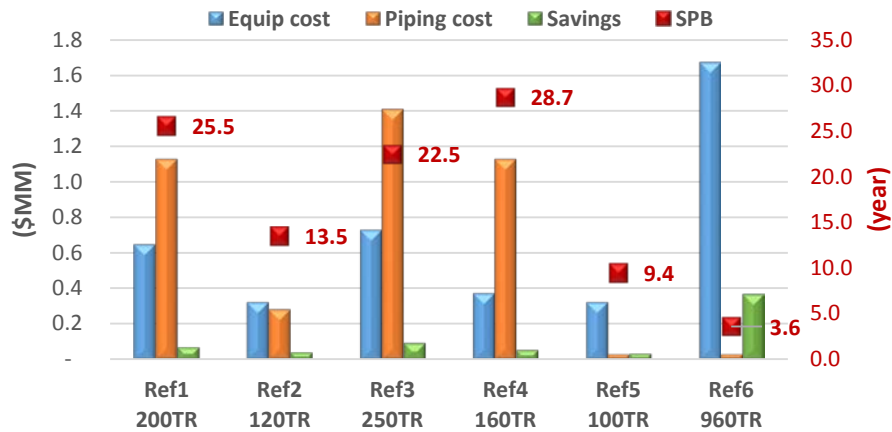
Saving In Annual Operating cost



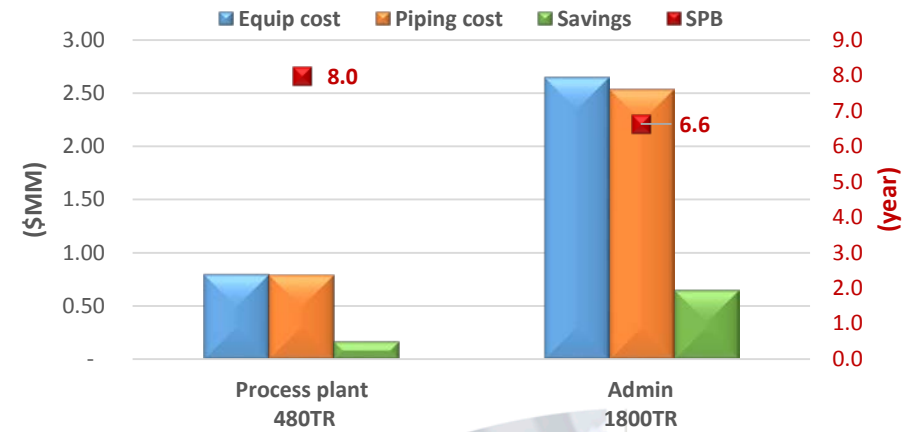
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Key parameters to consider for investment

Refinery Absorption Chiller project



Gas Plant Absorption Chiller project



	2900 h 1 kW/ton \$ 0.05 kWh \$ 0.07 Nm3	3500 h 1.2 kW/ton \$ 0.08 kWh \$ 0.07 Nm3	3500 h 1.5 kW/ton \$ 0.08 kWh \$ 0 Nm3 (waste steam)	4500 h 1.5 kW/ton \$ 0.08 kWh \$ 0 Nm3 (waste steam)	4500 h 1.5 kW/ton \$ 0.11 kWh \$ 0 Nm3 (waste steam)
SITES	SIMPLE PAYBACK				
Ref1		48.2	25.5	19.9	14.5
Ref2		23.3	13.5	10.5	7.7
Ref3		39.5	22.5	17.5	12.9
Ref4		56.8	28.7	22.3	16.2
Ref5		18.1	9.4	7.3	5.4
Ref6		6.3	3.6	2.8	2.1
Process plant		14.1	8.0	6.2	4.6
Admin		11.5	6.6	5.2	3.8

Capex: Equipment cost, piping cost, design, labor
Opex: Utility cost (electricity rate, steam (NG) cost, water cost), old equipment efficiency

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Summary

Consider VAC anytime heat source is readily available.

- ✓ The use of absorption chillers can contribute to reduce the **AC grid dependence**.
 - Absorption machines use hot source and small amount of electric power to generate the cooling capacity. (No compressor needed but pumps → much small energy pulled from the grid)
- ✓ Benefit for the grid as it contributes to **shaving off the peak power demand**.
 - In case of power demand restriction from utility company's (DR) air conditioned can still be supplied to the buildings.
- ✓ A study was conducted in eight sites and the recommendation was to use absorption chillers on duty mode and convention on stand-by mode: payback estimated less than 10 years.
- ✓ **Key parameters:** Electric cost (c\$ 5 & 8/kWh), waste steam, piping distance, equipment efficiency
- ✓ Recommendation: **Include VAC in the HVAC replacement Standard:** consider absorption chiller feasibility study in steam/flue gas generation plant.

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END

References and Acknowledgement:

- [THERMAX/ENJAZ](#), Absorption Machines Manufacturer.
- [SENDAN International](#), Piping systems.
- [ZAMIL](#) Air Conditioners, local HVAC manufacturer
- US Energy Department source, Manufacturer source & manufacturers
- Absorption chillers guidelines, New Buildings Institute
- Energy flow in the Kingdom of Saudi Arabia, SEC source (2009)
- Saudi Aramco KGP& RTR

