

INOVA Fairfax Hospital

South Patient Tower

Falls Church, VA



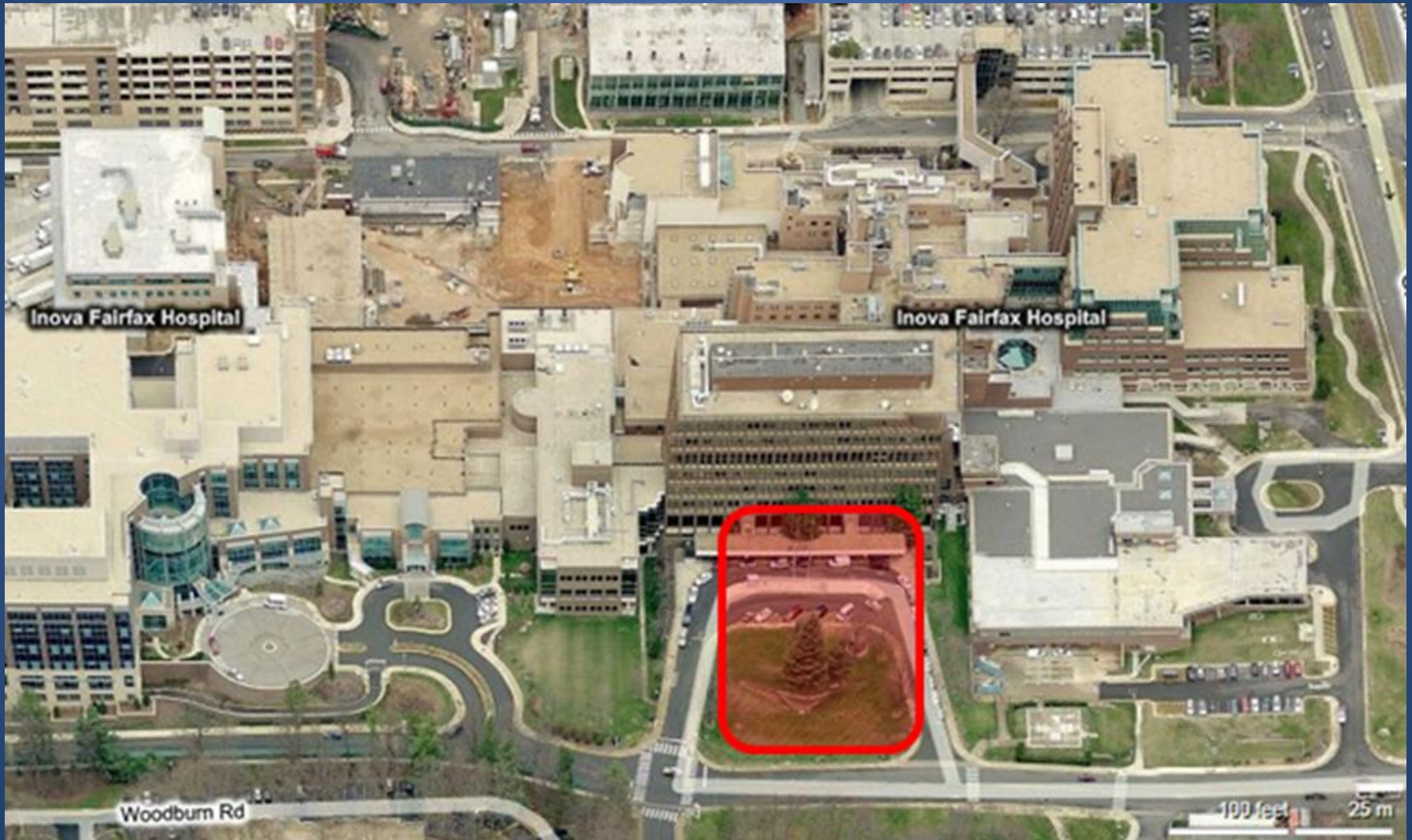
Mike Morder
Mechanical Option
Advisor: Dr. William Bahnfleth



INOVA South Patient Tower

- Introduction
- Depth 1: Central Chilled Water Plant
- Depth 2: Dedicated Heat Recovery Chiller
- Depth 3: Condensate Recovery
- Breadth 1: Two-Way Slab Reinforcing
- Breadth 2: Electrical
- Conclusion
- Questions

Building Introduction



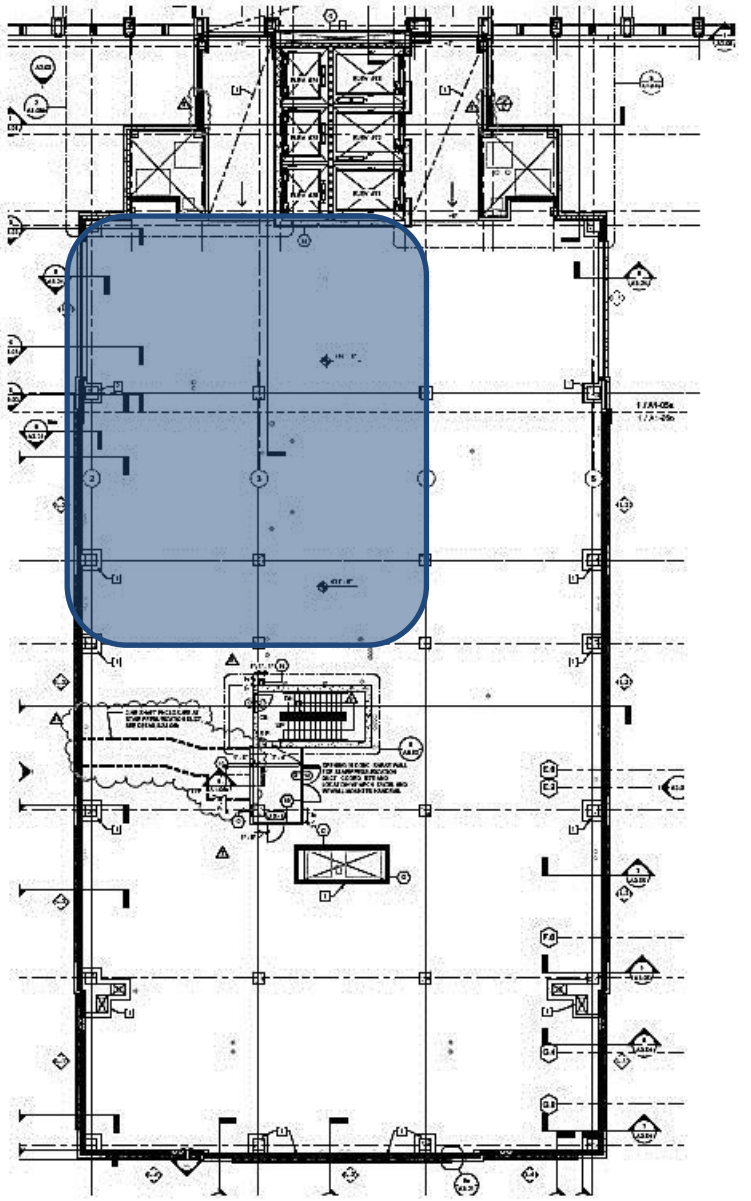
Existing Mechanical System

- **Connected to Existing Campus Central Plant**
- **Steam System-**
 - **Domestic Hot Water Heating**
 - **Heat Exchangers Provide HHW**
- **Chilled Water System-**
 - **Supplies Cooling to AHUs**
 - **No Booster Pumps in Building**

Design Objective

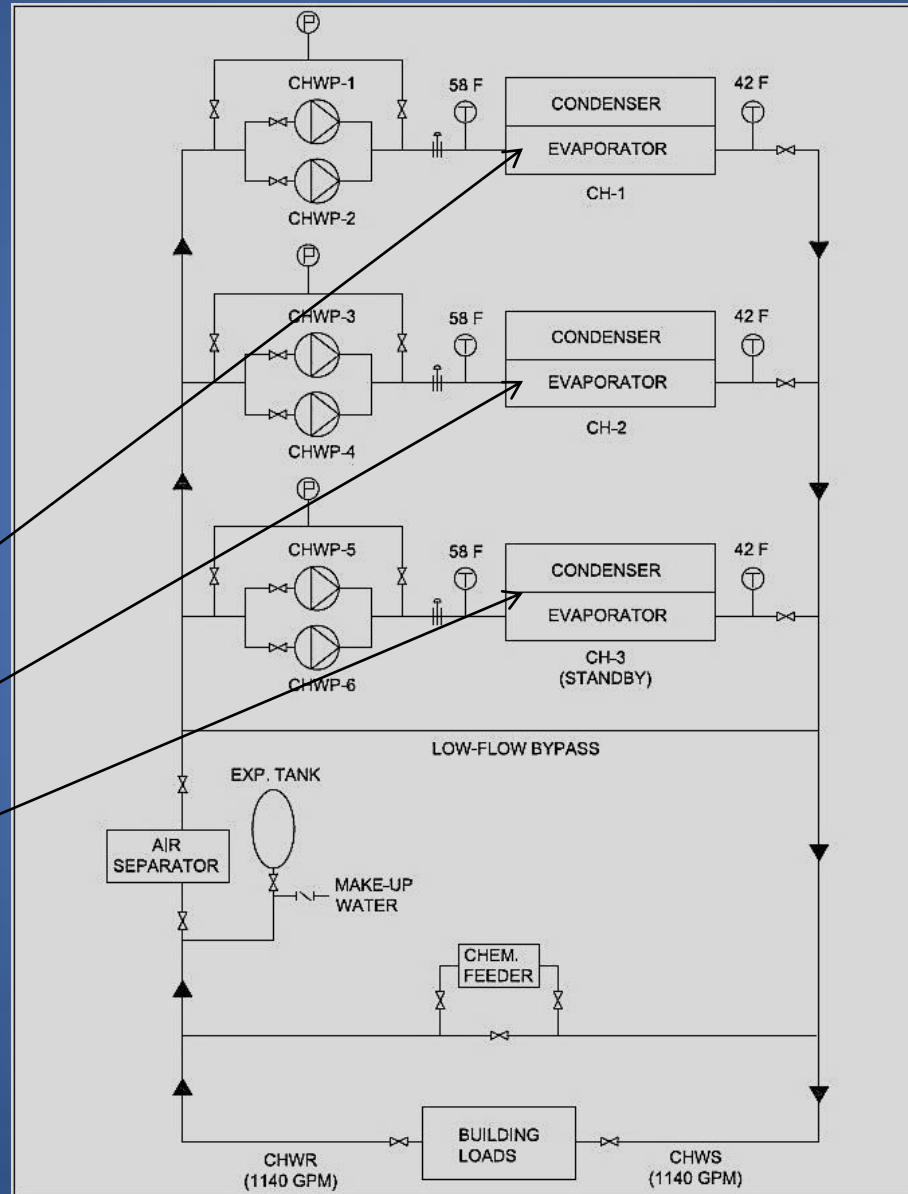
- **Chilled Water Plant Optimization Study**
 - **Chiller Design/ Layout**
 - **Centrifugal vs. Absorption**
 - **Primary Secondary vs. Variable Primary Flow**
 - **Dedicated Heat Recovery Chiller**
 - **Air-Handler Condensate Recovery System**
- **Best Selections = Most Economical**

Design Alternatives



- Location: 5th Floor Mechanical Space
- Alternative 1: Purchased CHW and Steam
- Alternative 2: Centrifugal (Primary/Secondary)
- Alternative 3: Centrifugal (VPF)
- Alternative 4: Absorption (Primary/Secondary)
- Alternative 5: Absorption (VPF)

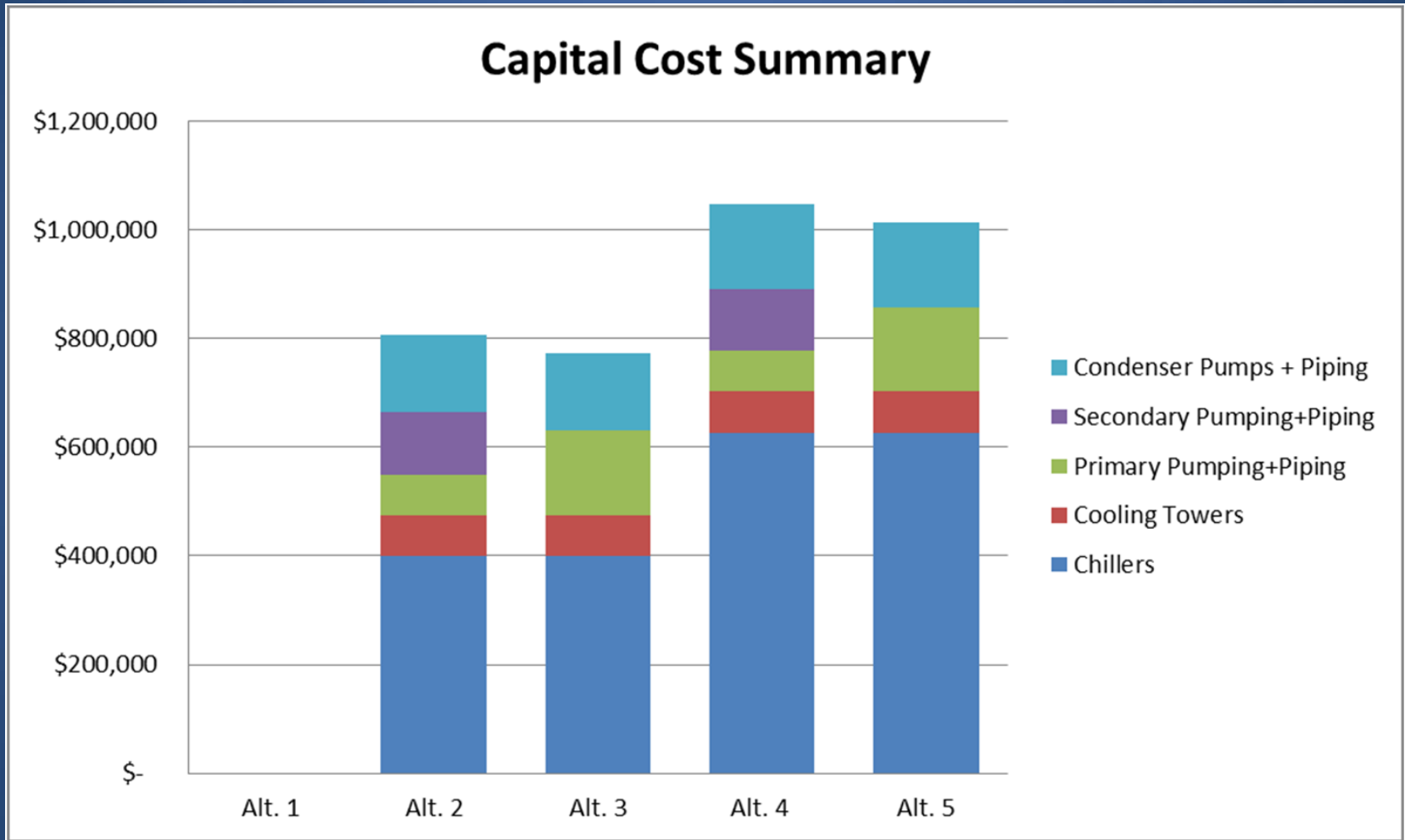
Variable Primary Flow



**Centrifugal
Chiller COP:
1.72**

**Absorption
Chiller COP:
1.12**

First Costs



RANK

1

3

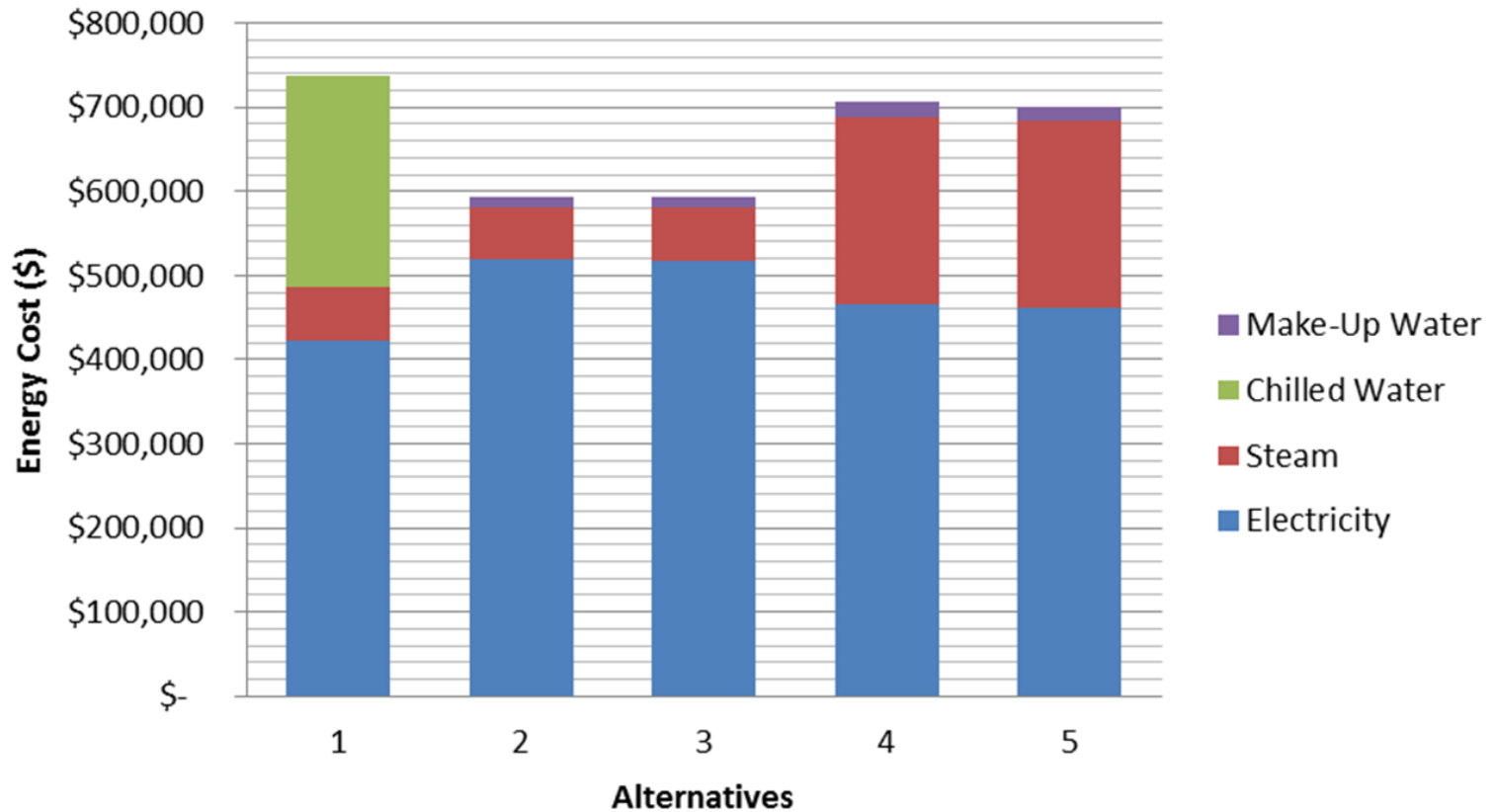
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5

4

Energy Costs

Energy Cost Comparison



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5

2

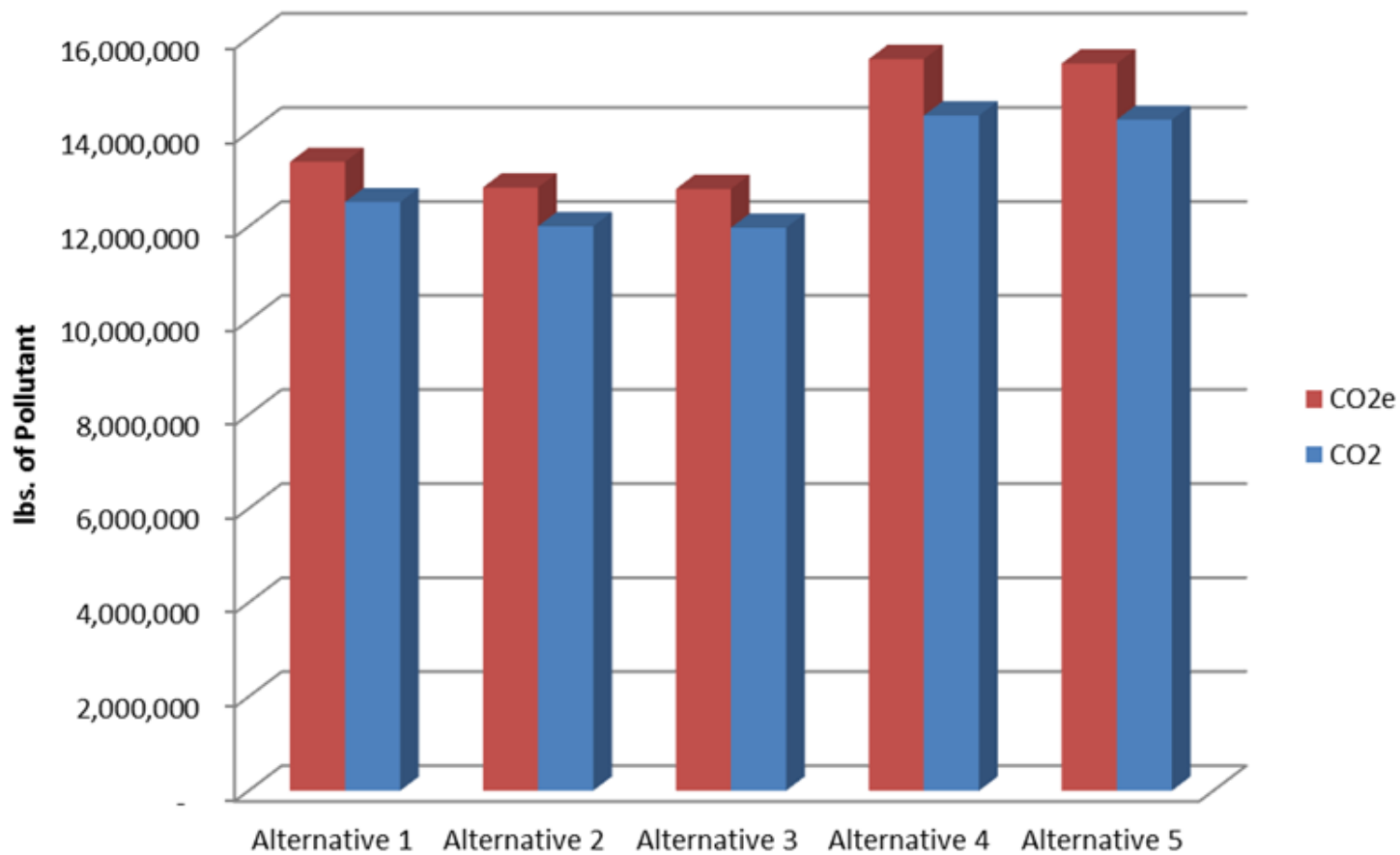
1

4

3

Emissions

CO_{2e} and CO₂ Emissions



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3

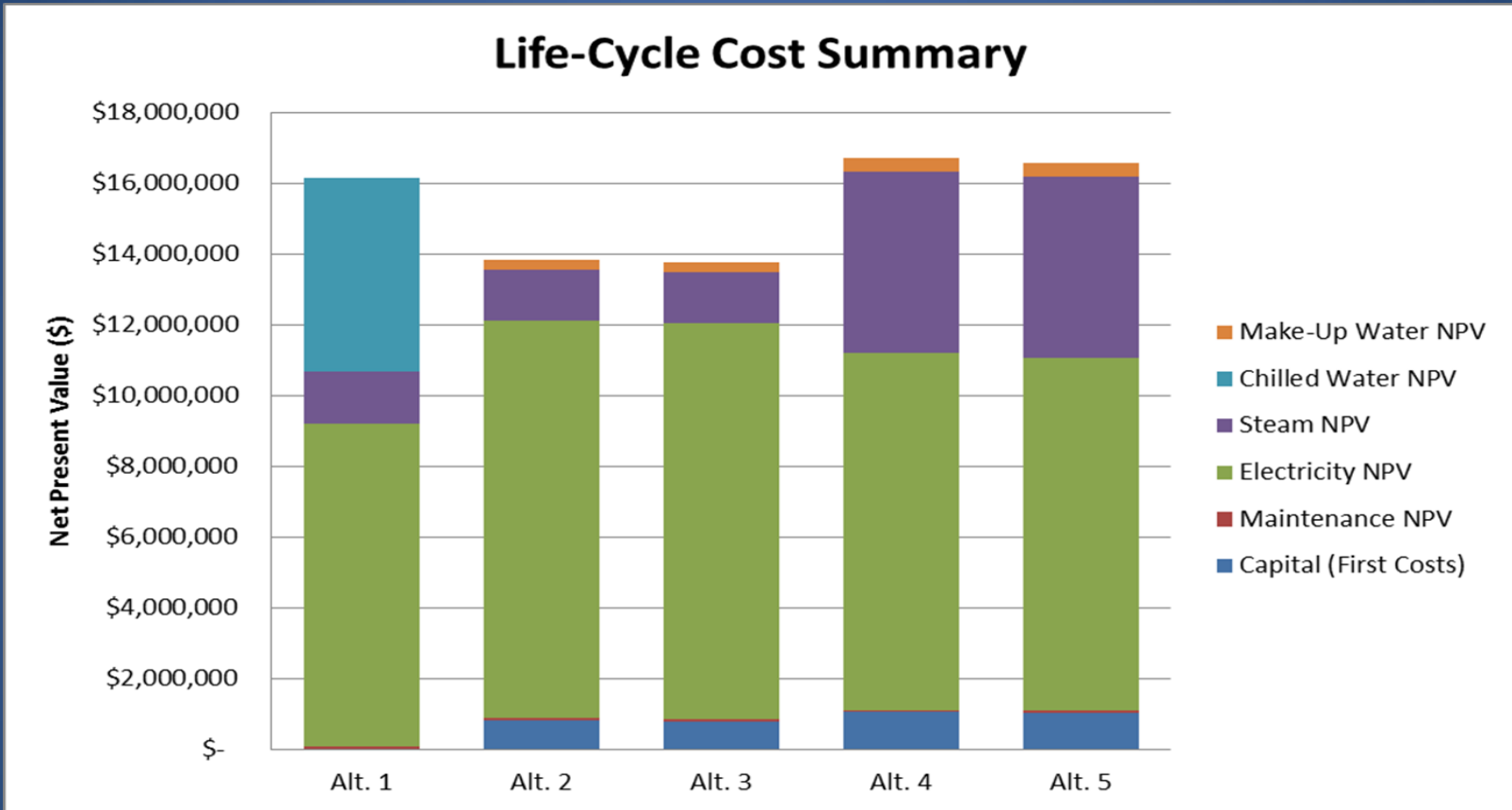
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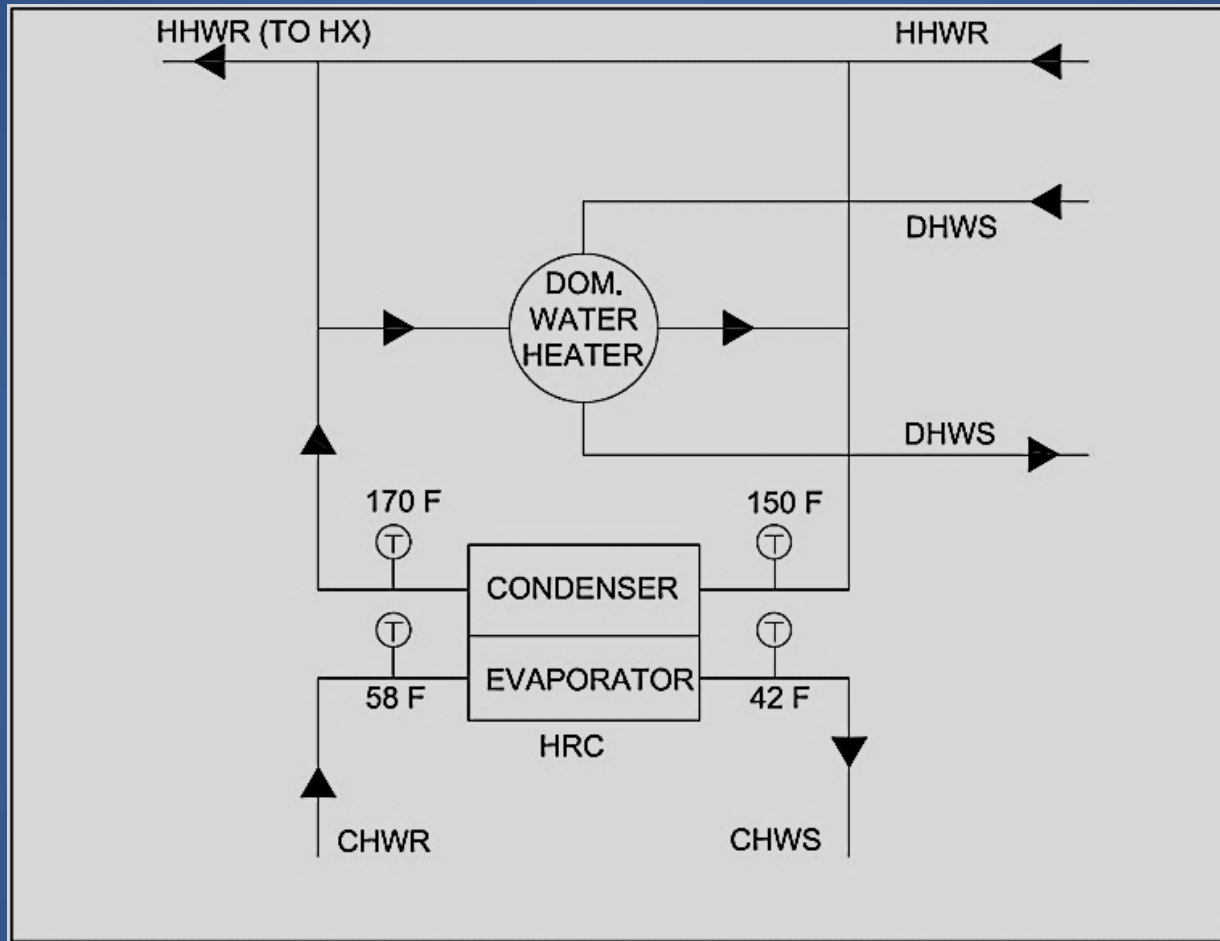
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Life-Cycle Cost Analysis



	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Simple Payback	BASELINE	5.6 yrs.	5.3 yrs.	32.1 yrs.	26.9 yrs.
Discounted Payback	BASELINE	7.0 yrs.	6.0 yrs.	30+ yrs.	30+ yrs.

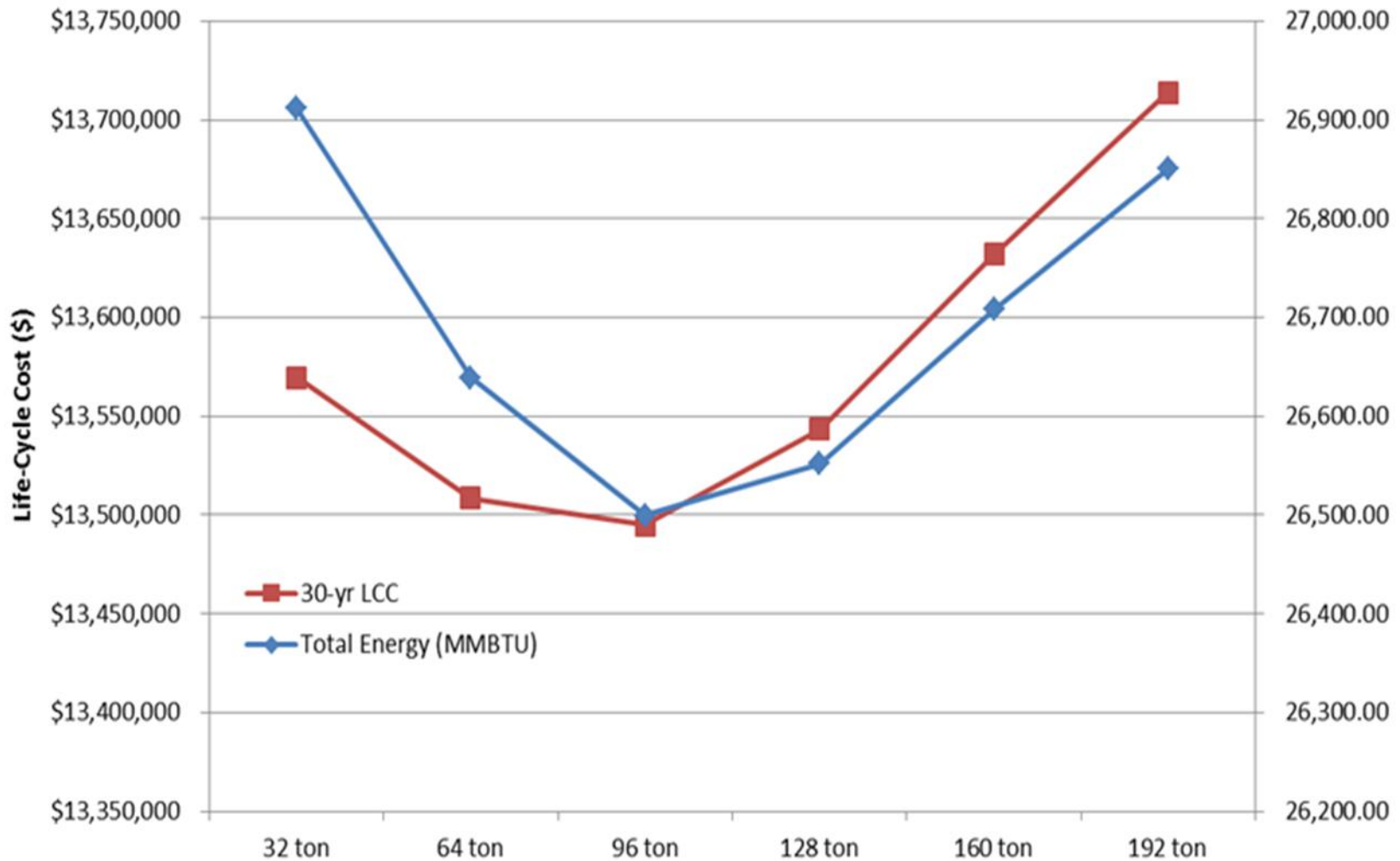
Dedicated Heat Recovery Chiller



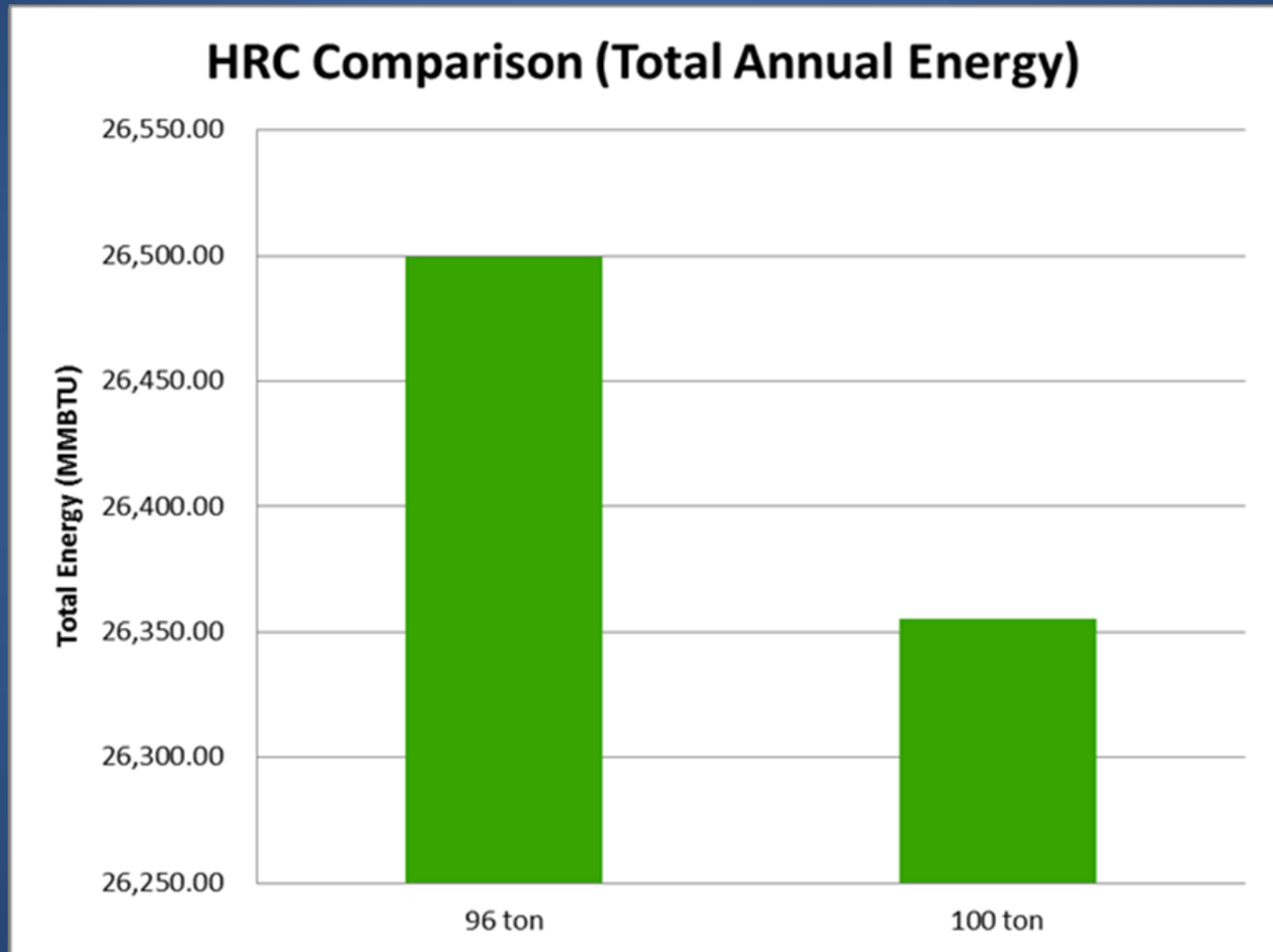
25 ton and 32 ton Modules

Dedicated Heat Recovery Chiller

Comparison of 32 ton HRC



Dedicated Heat Recovery Chiller



Condensate Recovery System

$$\text{Condensate} \left(\frac{\text{lbs.}}{\text{hr}} \right) = \text{CFM} * \rho_{\text{air}} * 60 \frac{\text{min}}{\text{hr}} * \Delta w$$

Where:

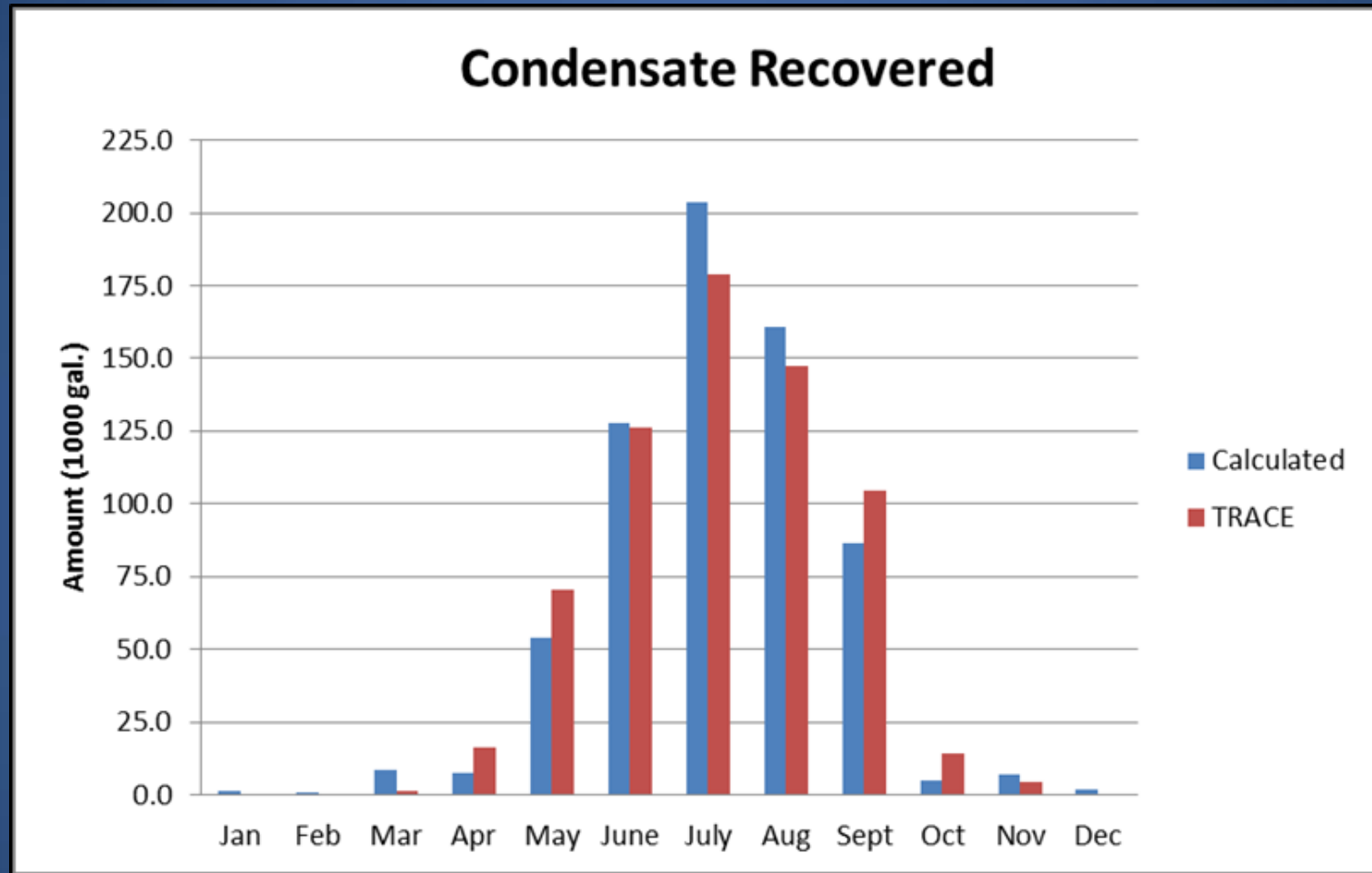
CFM = Airflow over Coil

ρ_{air} = density of air

Δw = difference in humidity ratios across cooling coil

	January	February	March	April	May	June
Condensate (1000 gal.)	1.1	0.8	8.6	7.5	53.9	128.0
	July	August	September	October	November	December
Condensate (1000 gal.)	203.9	161.1	86.4	4.7	6.8	1.8

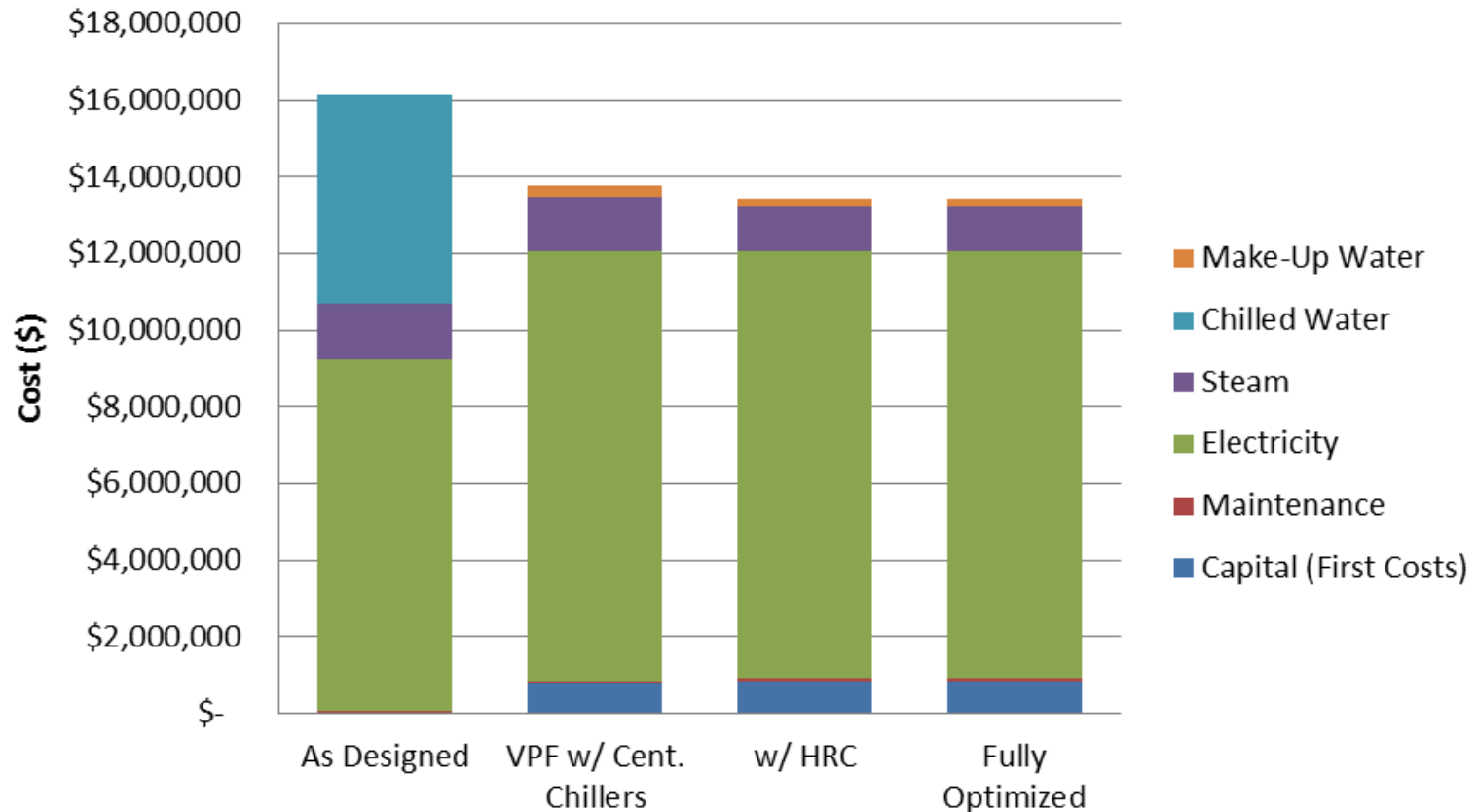
Condensate Recovery System



	Amount (1000 gal.)	Annual Cost
Water (Make-Up)	4,891	\$ 10,565
Reduced Make-Up	4,226	\$ 9,129
Savings	14 %	14 %

Depth Conclusions

Optimization Comparison



SPB:

BASE

5.3

5.2

5.1

Breadth Conclusions

- **Additional Reinforcing Necessary in Slab**
 - **Cost: \$ 1,306**
- **Additional Electrical Equipment Needed**
 - **Cost: \$ 73,500**

Recommendations

- **Centrifugal Chillers with VPF**
 - **Dedicated Heat Recovery Chiller**
 - **Condensate Recovery**
- **Savings: \$ 2.729 million over 30 year life**
- **Simple Payback: 5.1 years**

- **Additional Structural / Electrical Costs Included**
- **Savings: \$ 2.655 million over 30 year life**
- **Simple Payback: 5.6 years**

Questions

THANK YOU

QUESTIONS?