What Shapes CDU Performance?

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In collaboration with Stulz

A Comparative Study of Design Choices for 2.3 MW Systems

THE QUESTION

One capacity target. Four performance goals.

2.3 MW

held fixed in every case

1 Lowest capital cost

What is the least expensive hardware that still delivers the duty?

2 Lowest electrical consumption

What does it cost to run, across a whole year?

3 Effect on pipe sizing

How much primary flow does the selection force?

4 Effect on pump sizing

What head and flow must the facility pump deliver?

The question.
How do we select equipment to optimise these four outcomes, and build a tool that reproduces the process when the external variables change?

Different Types of Heat Exchangers



Gasketed

- More efficient, lower OPEX
- You can add plates later
- Openable, serviceable, re-gasketable

Brazed

- Compact and light
- Easy to install
- Self-cleaning, little maintenance

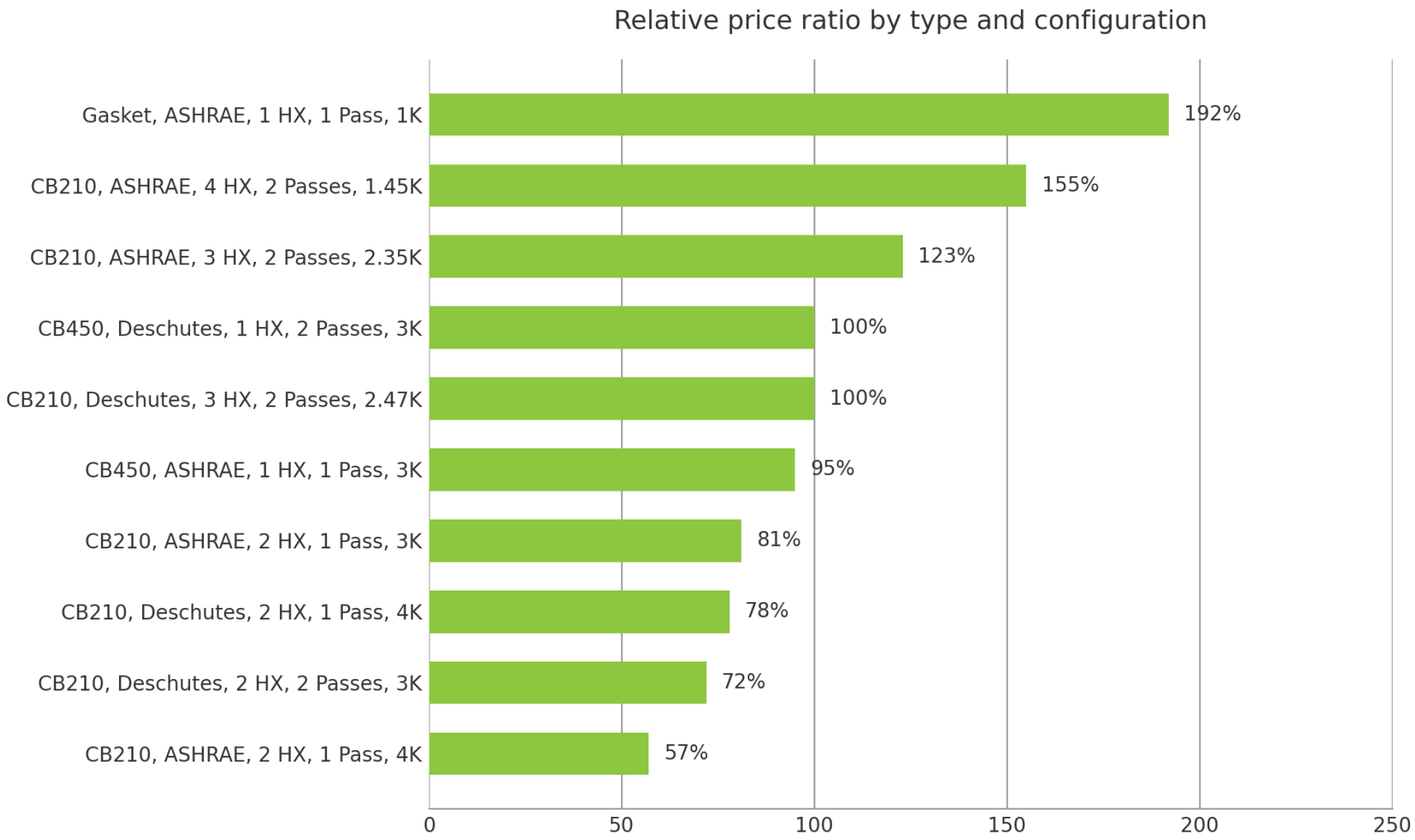
Sizing Basis

- ASHRAE/Deschutes
- 1-4 HX
- 1-2 Passes
- 1°C-4°C Approach
- CB210, CB450

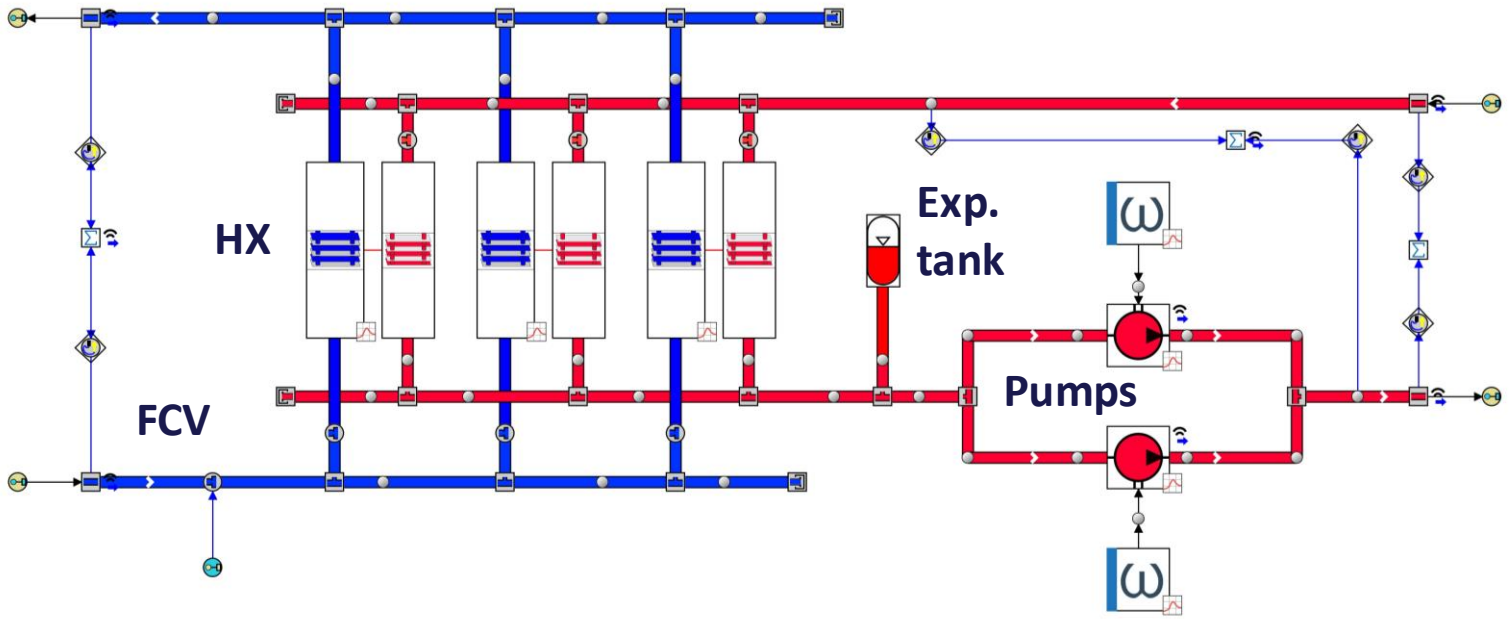


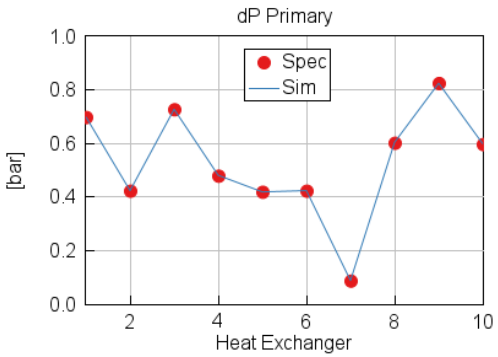
QUESTION ONE

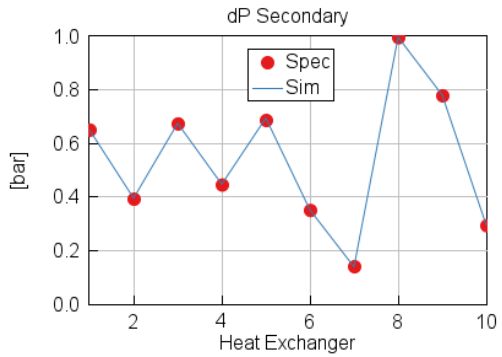
CAPEX Comparison

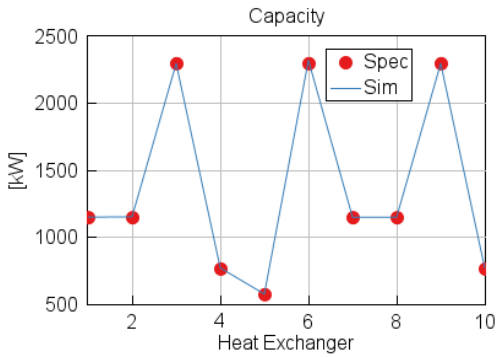


A CDU model calibrated to Deschutes 5









Built and calibrated against the Deschutes 5 specification so that every alternative is compared to a known reference rather than to an assumption.

Parameter	Reference value
Capacity	2.0 to 2.3 MW
Approach (ATD)	3 K
TCS flow	500 GPM
FWS flow	500 GPM
TCS fluid	PG25 or treated water
FWS fluid	Water
Heat exchangers	3 brazed, two-pass, parallel
Pumps	N+1, sealless

*results are per HX

Common Evaluation Criteria for Comparison

ANSI/ASHRAE Addendum b to Standard 127-2020

approved by ASHRAE and ANSI on 27 February 2026, bringing liquid-to-liquid CDUs under a method of test for the first time

Parameter	Standard value
Fluids	Water on FWS, PG25 on TCS
FWS supply	26 °C
TCS supply / return	30 °C / 39.6 °C at full capacity
TCS flow	Held at rated across all load points
Part load	75 / 50 / 25 % by TCS entering temperature
Fouling	As-tested fouling factor is zero
Location	Test cell only, not field

Why we switched to it

- Holding the ASHRAE conditions fixed instead makes every exchanger comparison apples to apples.
- The secondary side is then fully constrained, so the whole effect of the selection appears on the primary side. That is what the next slides measure.

Conditions paraphrased from the addendum. ASHRAE distributes addenda and errata separately, so verify currency before the final submission.

The CDU does not act alone, so we modelled the plant

A standalone CDU tells you very little

With the secondary side fixed by the ASHRAE conditions, the selection cannot change the IT-side result. It can only change what it demands of the plant.

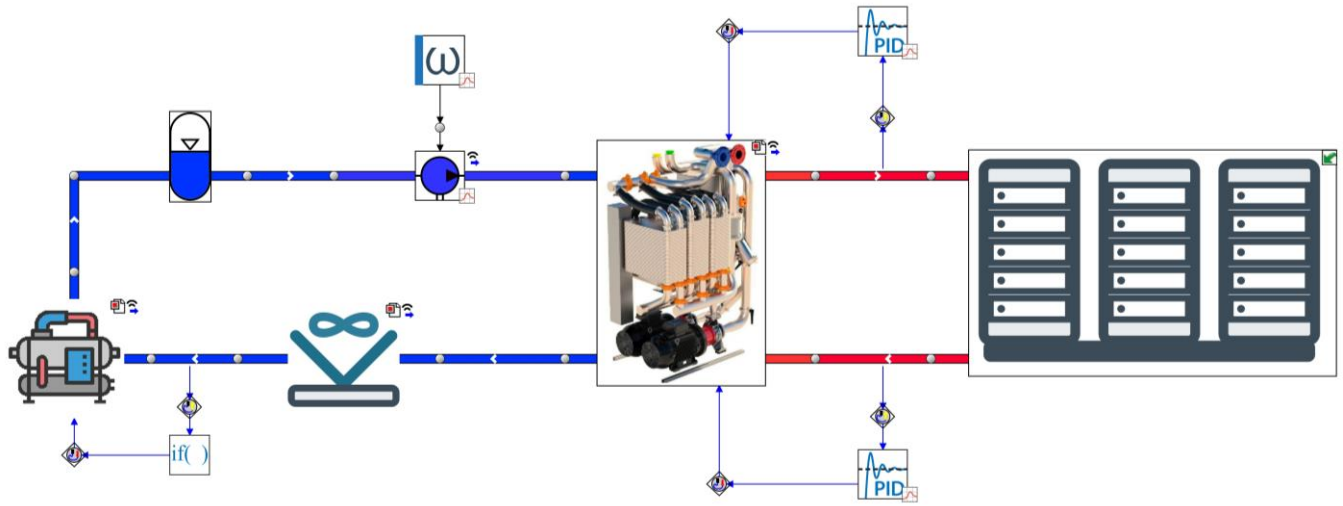
So, the exchanger was integrated into a full system model and everything outside the CDU was held constant.

What an integrated approach achieves

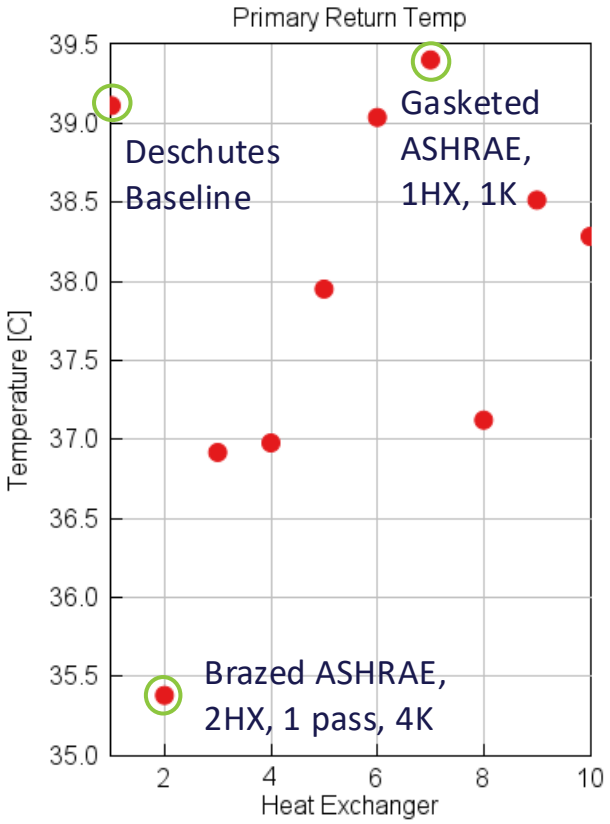
One apples-to-apples question, asked eleven times: for the same duty at the same rating conditions, what does each exchanger demand of the primary loop, and what does that cost to run across a year?

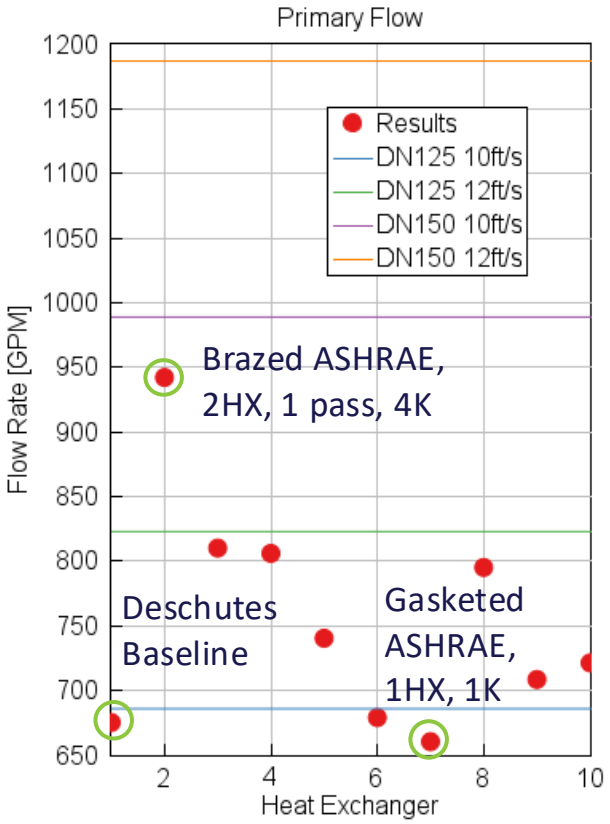
What the system model contains

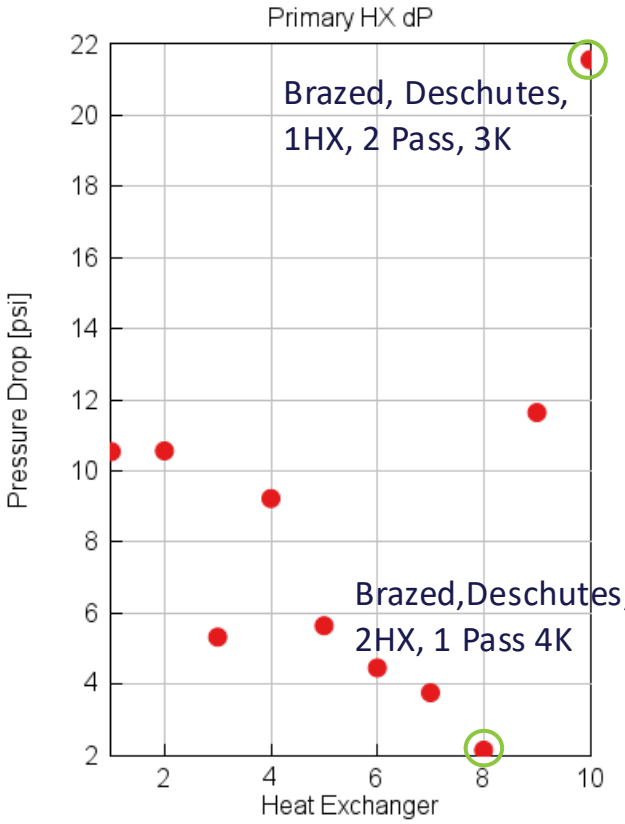
- Primary side: dry cooler, air-cooled chiller, buffer tank and facility pump
- Secondary side: fixed IT load of 2.3 MW
- Secondary pressure drop fixed at 50 psi
- Estimated dry cooler approach, CoP
- Estimated chiller CoP as function of load, air temp, liquid temp
- Estimated FWS pump map

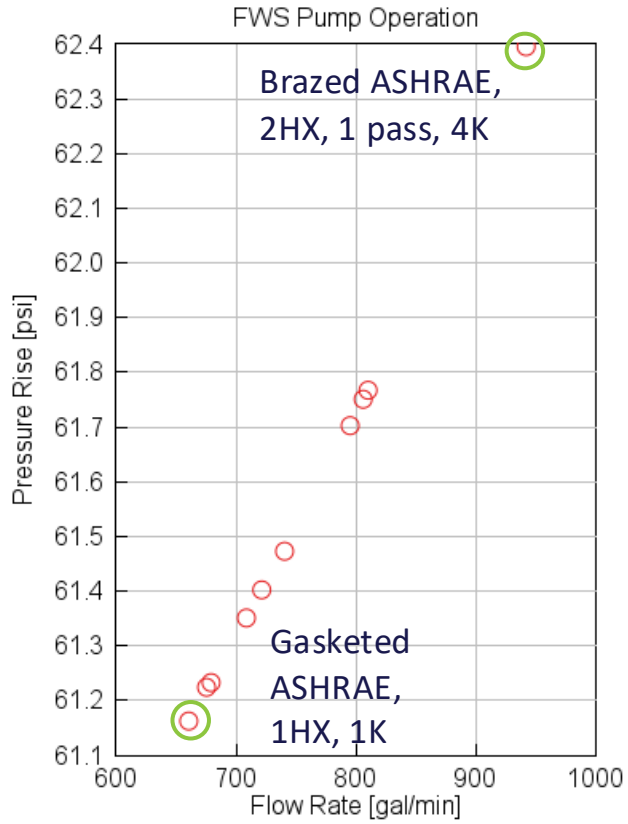


Baseline Comparison: Results @25C Ambient

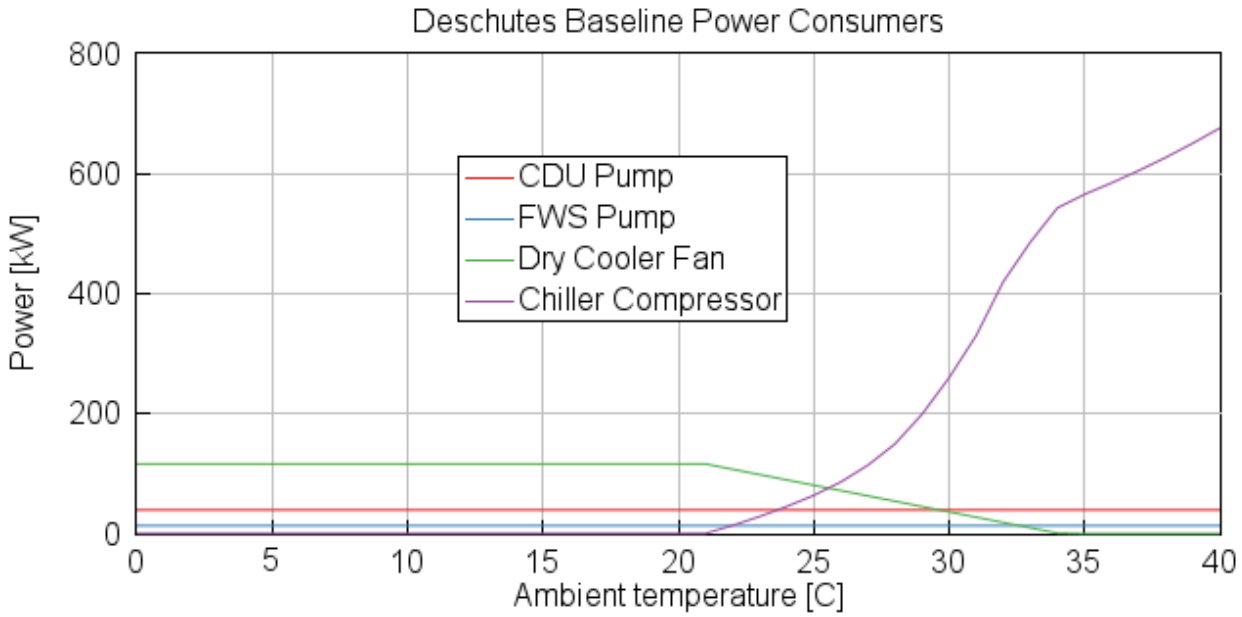


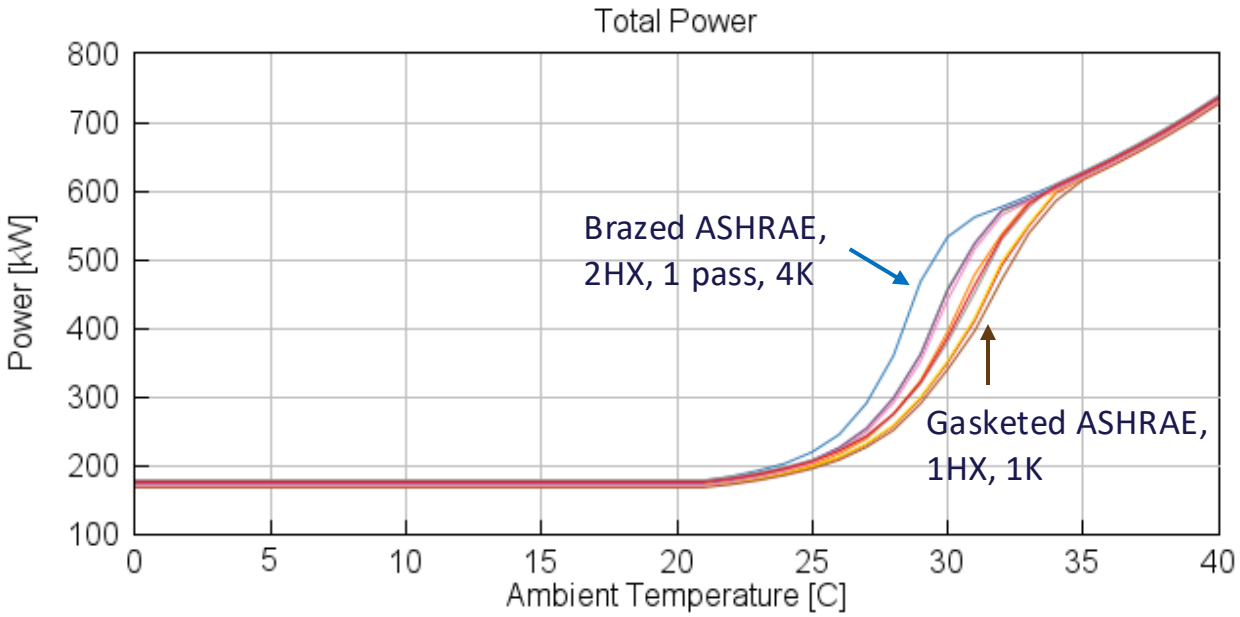






Evaluation of each power consumer as a function of ambient temperature



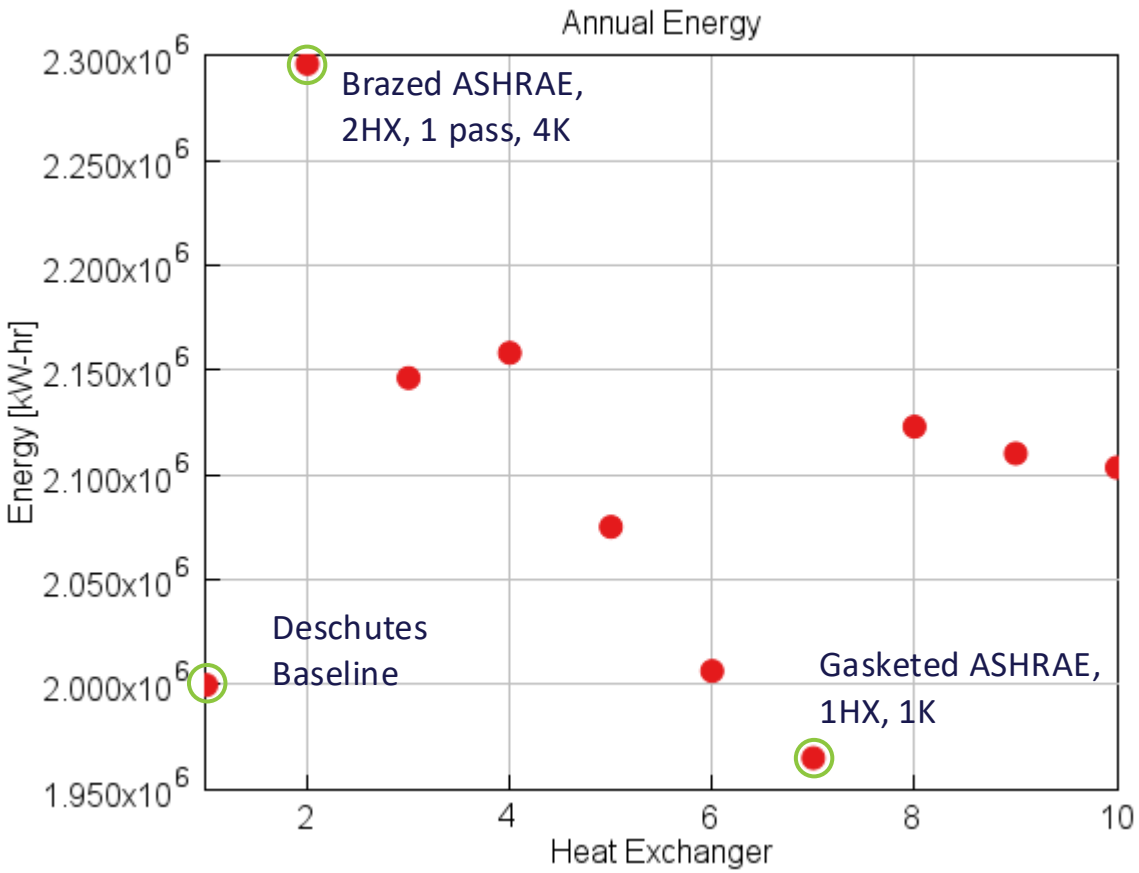


At low ambient every selection looks much the same, because the dry cooler is doing all the work and pump power is a small share of the total. Above the changeover the chiller takes over, and the selections that return the primary water hotter keep the compressor off for longer.

Annual Energy Consumption for Different HX Selections

Dallas, TX

Temp Bin (°C)	Hours
-12 to -10	2
-10 to -8	16
-8 to -6	18
-6 to -4	47
-4 to -2	74
-2 to 0	117
0 to 2	161
2 to 4	205
4 to 6	221
6 to 8	351
8 to 10	247
10 to 12	396
12 to 14	426
14 to 16	395
16 to 18	594
18 to 20	509
20 to 22	782
22 to 24	947
24 to 26	788
26 to 28	859
28 to 30	469
30 to 32	542
32 to 34	424
34 to 36	131
36 to 38	37
38 to 40	2
TOTAL	8760



Results will vary by location:

- Ambient temperature
- Price of electricity (impact on OPEX)

Other site-specific considerations also effect results:

- Actual load vs. nominal capacity
- Evaporative cooling
- Performance of external equipment

Three variables the rating point does not cover

Tighter approach

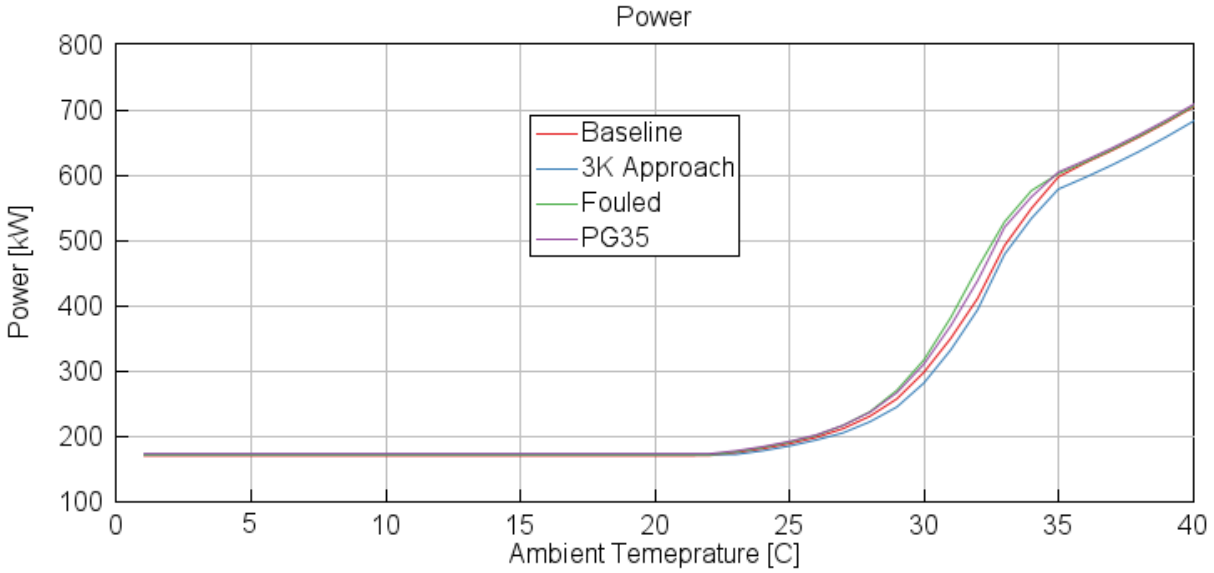
3 K instead of 4 K

Primary-side fouling

0.9e-4 m²K/W

Different primary fluid

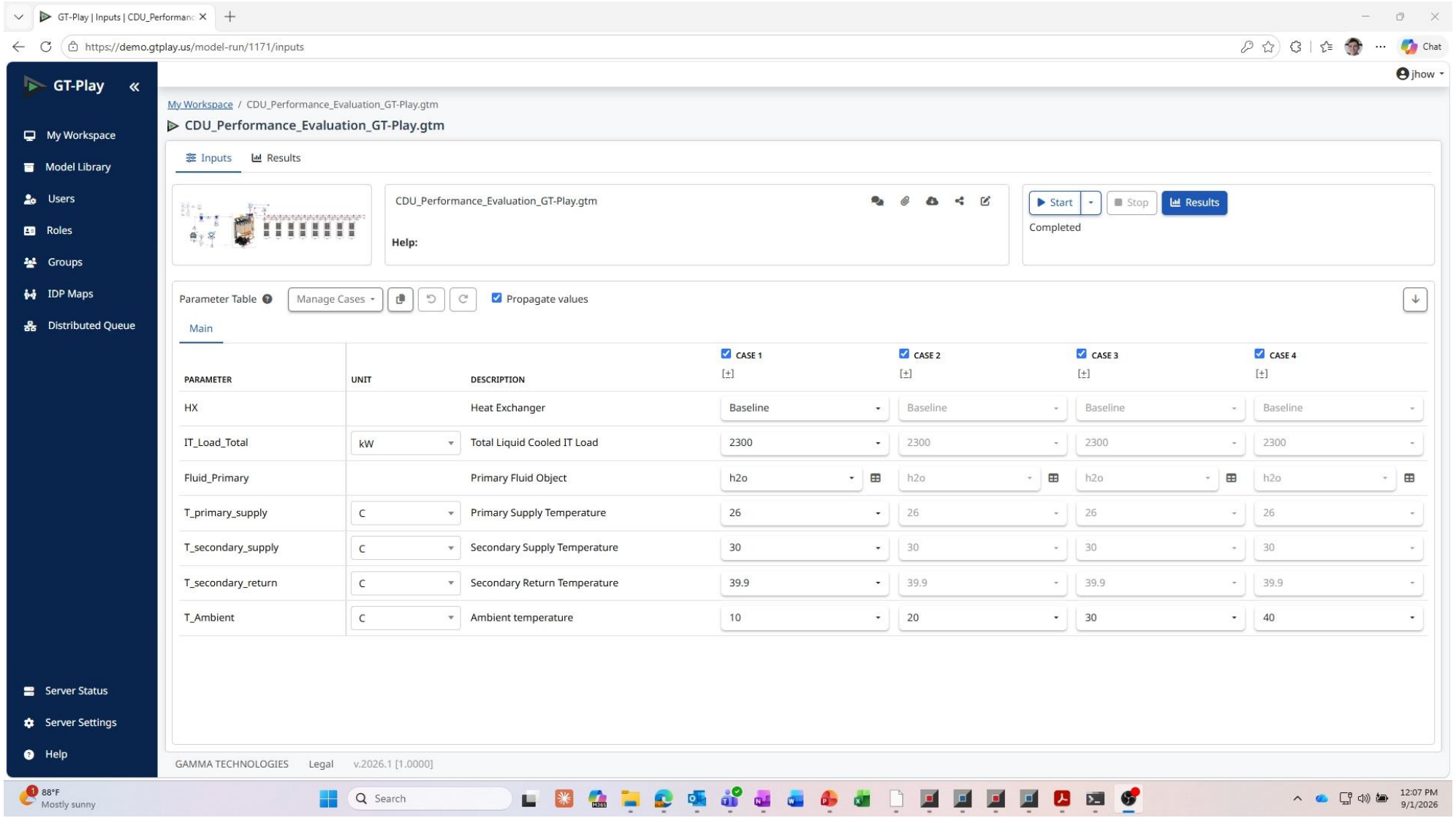
PG35 instead of water



	Relative Increase in Energy Consumption		
HX	3K Approach	Fouling	PG35
Deschutes Baseline	-1.7%	3.0%	2.6%
Brazed ASHRAE 2 HX, 1 pass, 4K	-0.5%	7.0%	N/A*
Gasketed, ASHRAE, 1HX, 1K	-2.1%	0.4%	0.4%

*cannot supply target temperatures

An easy way to run this analysis



What we would take away from this

1. **2.3 MW can mean very different machines**

   Every one of these ten does the same duty. Change the operating conditions and you get a different box: return temperature ran from 34 to 39 °C and primary flow from 660 to 940 GPM.

2. **That changes your pump, your pipe size, your CAPEX and your cost to run.**

   Capital cost spans a factor of three. Annual energy spans about 17 %. Flow crosses two pipe classes and drags the facility pump with it. The cheapest one to buy is not the cheapest one to run.

3. **So design and optimize the cooling loop as a system.**

   Once the conditions are fixed, the heat exchanger cannot change what the IT equipment sees. All it changes is what it asks of the plant around it. Judge it there, over a year, and not on a single number on a datasheet.

Call to Action

- **Off-design belongs in our specifications.**
  - Specifications typically list a CDU at one design point. This study demonstrates interesting behavior in other conditions.
- **Let us agree how to evaluate performance.**
  - A shared way of doing ambient sweeps, fouling allowance, alternative fluids and part load would let operators compare CDUs on what they actually cost to run.
- **Publish the operating point, not just the megawatts.**
  - Many other factors beyond the capacity are required to properly characterize the CDU performance.
- **Let's discuss!**
  - Please continue the conversation at the summit or in the CDU workstream.

Thank You

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Heat exchanger selections and technical review contributed by Stulz and Alfa Laval.