Heat Pumps, kWh and Ca$h

Tips, tricks and applications

EECA/IIR WORKSHOP

SEPTEMBER 2021

Case Study: Adding a Heat Pump to an existing Ammonia Refrigeration System ***without compromise!***

Basis of Design – Small to Medium Meat Processor

Refrigeration Plant: 3MW high stage ammonia duty with evaporative condenser:

- ETP: **-10°C** ((170 kPag)Typical IP pressure of compound refrigeration plant)
- CTP @ design conditions: **34°C**
- Loading: Mean demand 60% of design capacity (≈2MW refrigeration)

Heat Pump: Ammonia cascade arrangement;

- ETP 32°C
- CTP 75°C
- Heat Harvesting ***≈ 1MW*** at Heat Pump Suction (***≈ 1.3MW hot water heating***)

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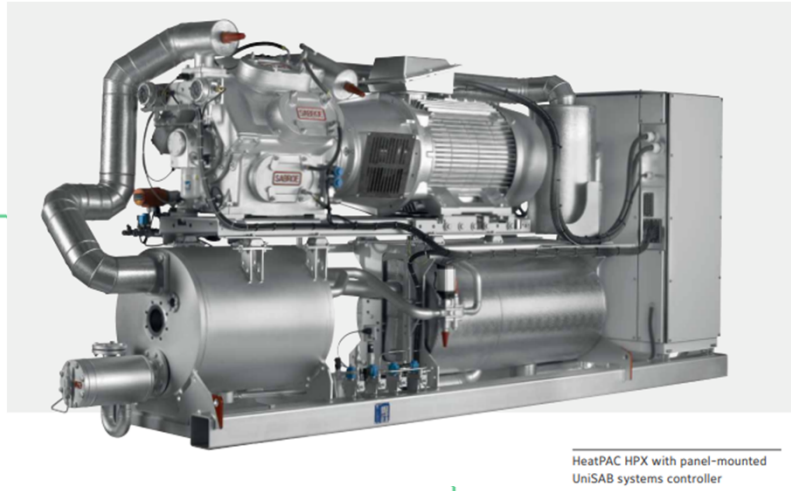
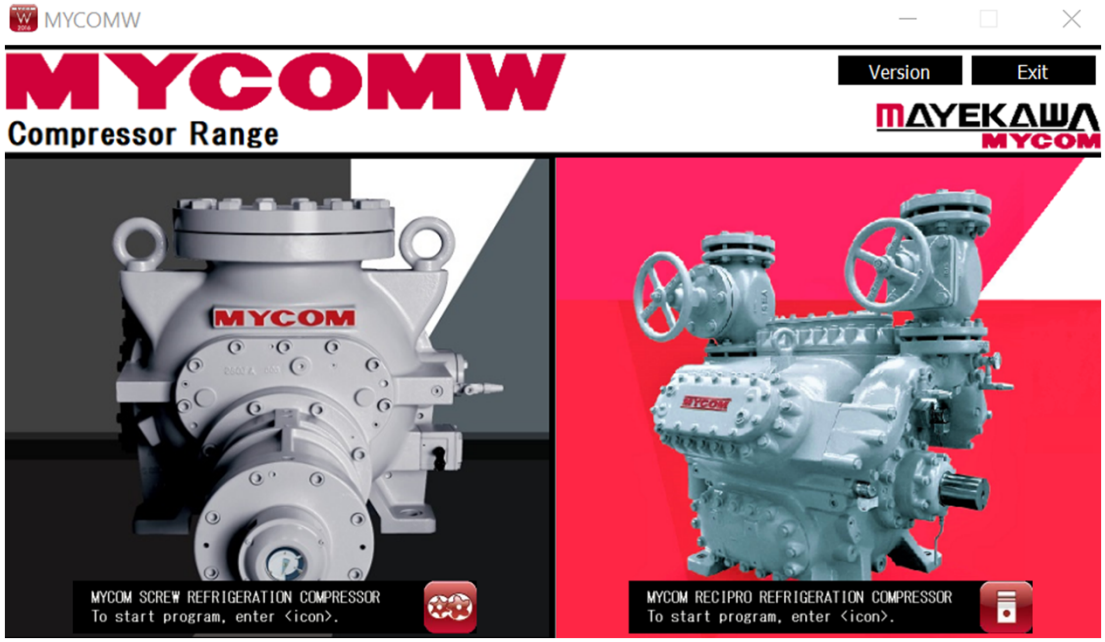
Cascade Heat Pump Retrofit



3MW Refrigeration
1MW shaft power
Only 170 kW harvestable superheat & oil cooling

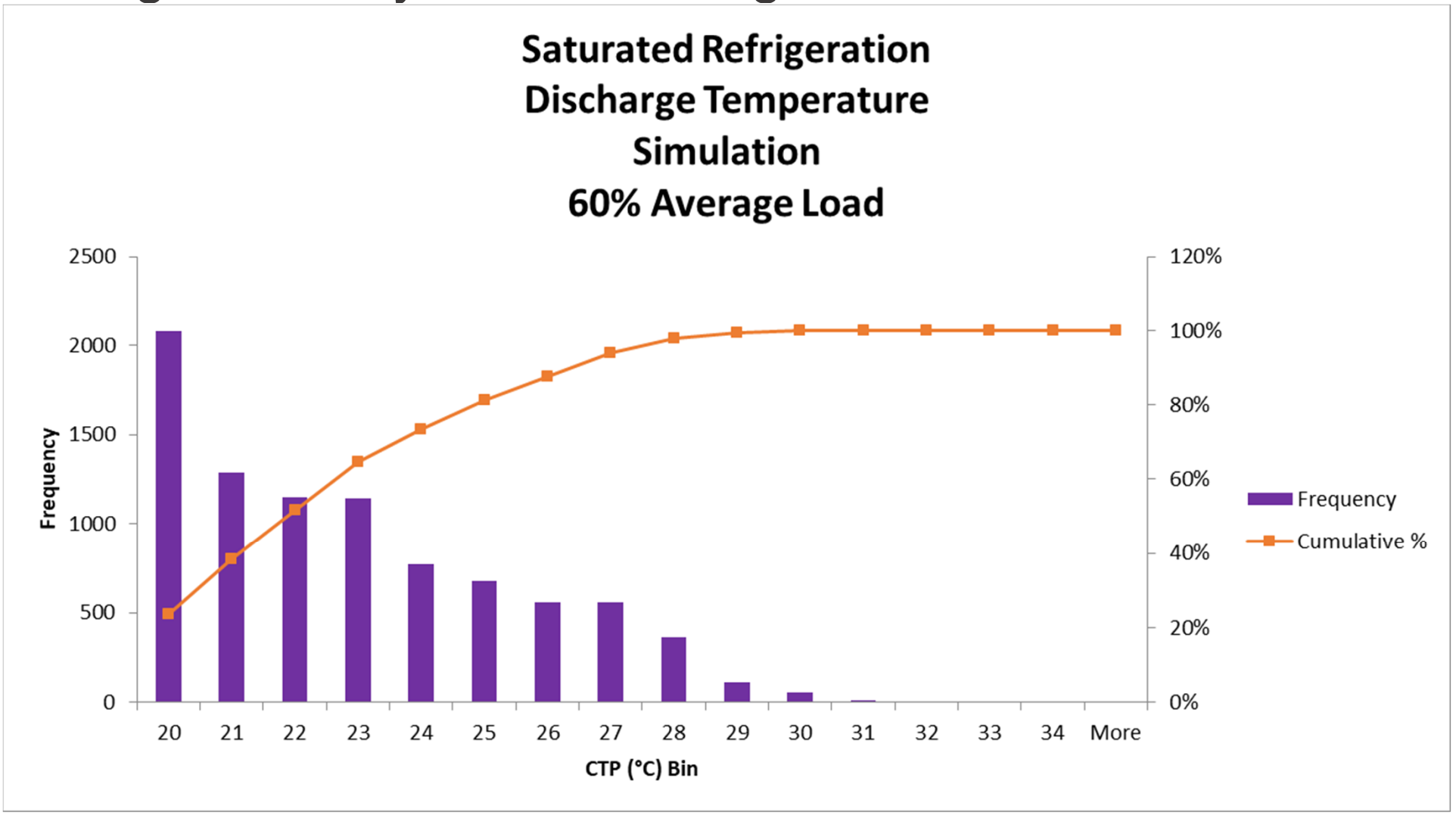
You're going to need to harvest condenser heat!

Heat Pump Performance

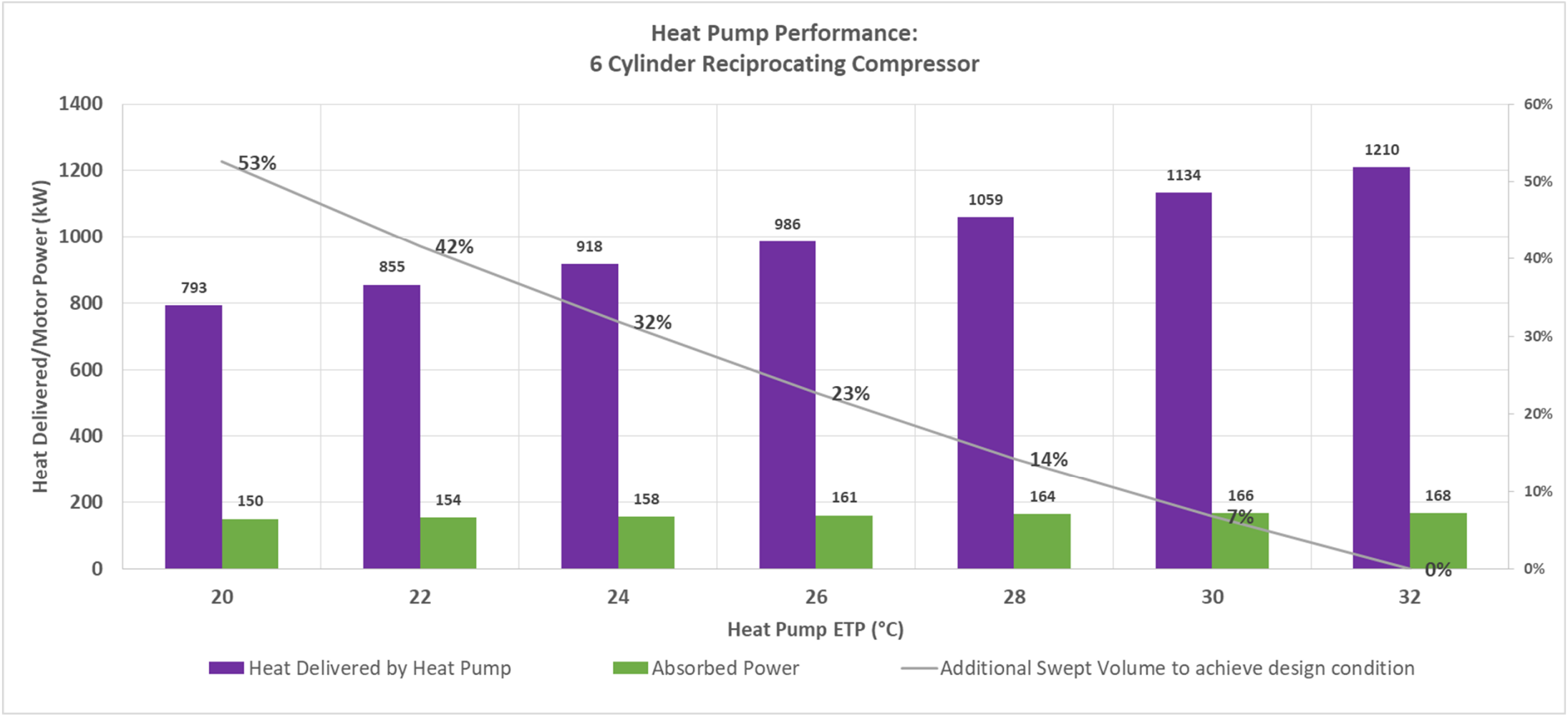


Title :	Heat Pump Selection	
MODEL :	N6HS	
REFRIGERANT :	AMMONIA	
BOOSTER :		N
CAPACITY :	[kW]	954.7
CAPACITY :	[TR]	271.5
ABSORBED POWER :	[kW]	168.1
SPEED :	[min-1]	1000
LOAD :	[%]	100
CONDENSING TEMP. :	[degC]	75.0
EVAPORATIVE TEMP. :	[degC]	32.0
SUCTION SUPERHEAT :	[degC]	0.00
LIQUID SUBCOOLING :	[degC]	20.0
SUCTION TEMP. :	[degC]	32.0
SUCTION PRES. :	[MPaA]	1.24
DISCHARGE PRES. :	[MPaA]	3.71
SUCTION PRES.LOSS :	[MPa]	0.000
DISCHARGE PRES.LOSS :	[MPa]	0.000
SWEPT VOLUME :	[m3/h]	401
DISCHARGE TEMP. :	[degC]	120
REFRIG. FLOW RATE (SUC.) :	[m3/h]	349
REFRIG. FLOW RATE (DIS.) :	[m3/h]	147
REFRIG. FLOW RATE (SUC.) :	[Kg/h]	3374
REFRIG. FLOW RATE (DIS.) :	[Kg/h]	3374

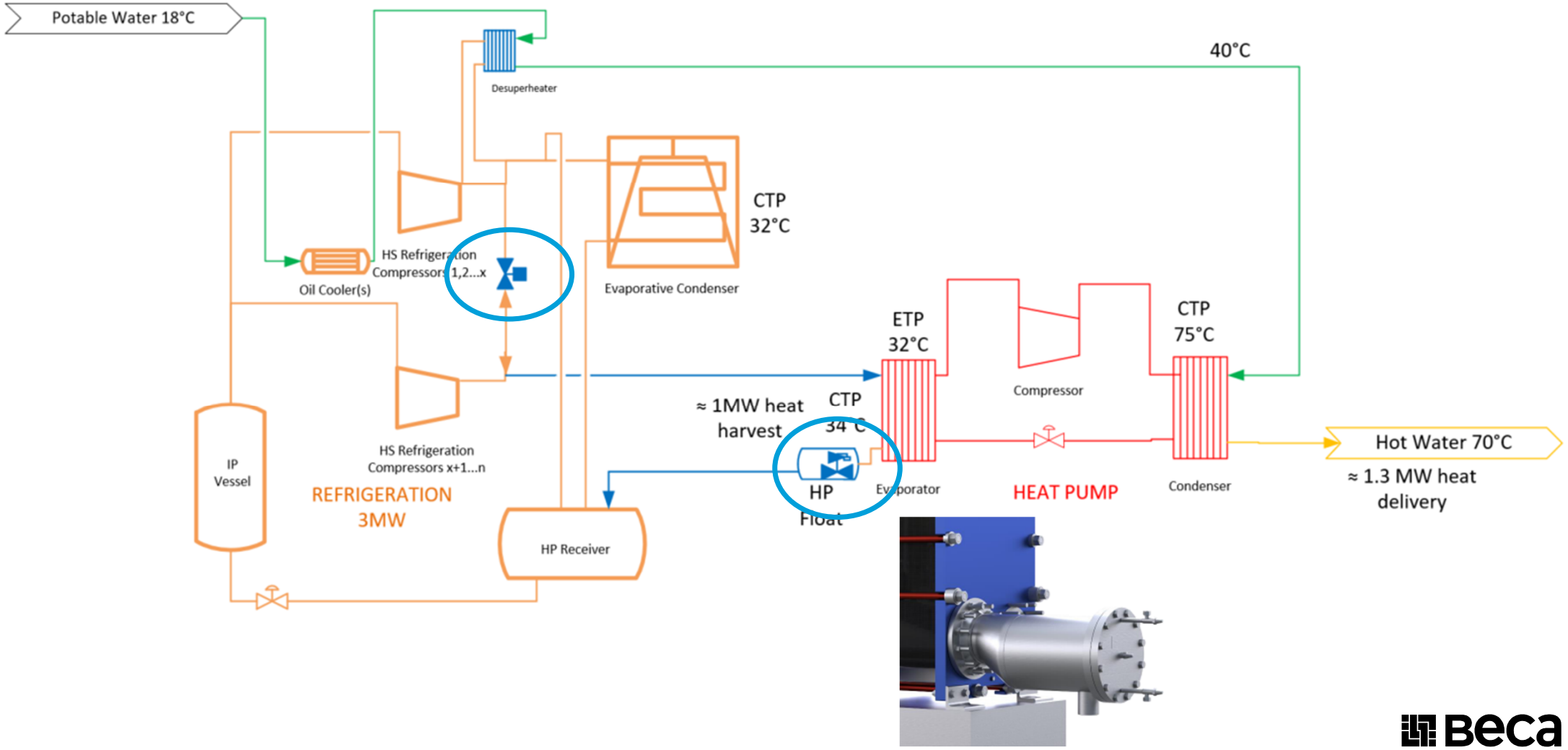
Refrigeration System Discharge Pressure



Heat Pump Performance



Proposed Solution



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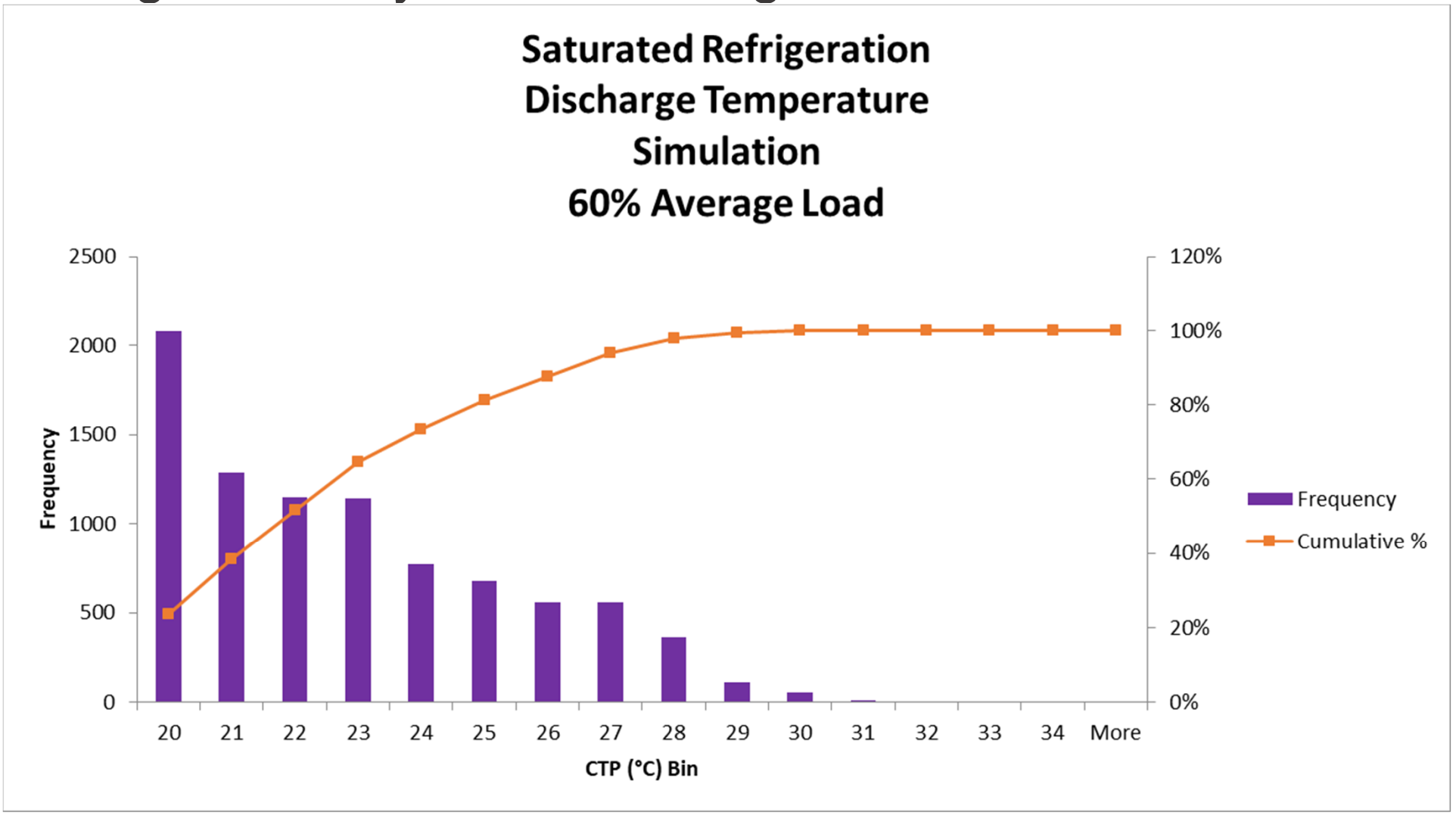
Refrigeration System Discharge Pressure



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Maestro

Refrigeration **Energy** Reduction

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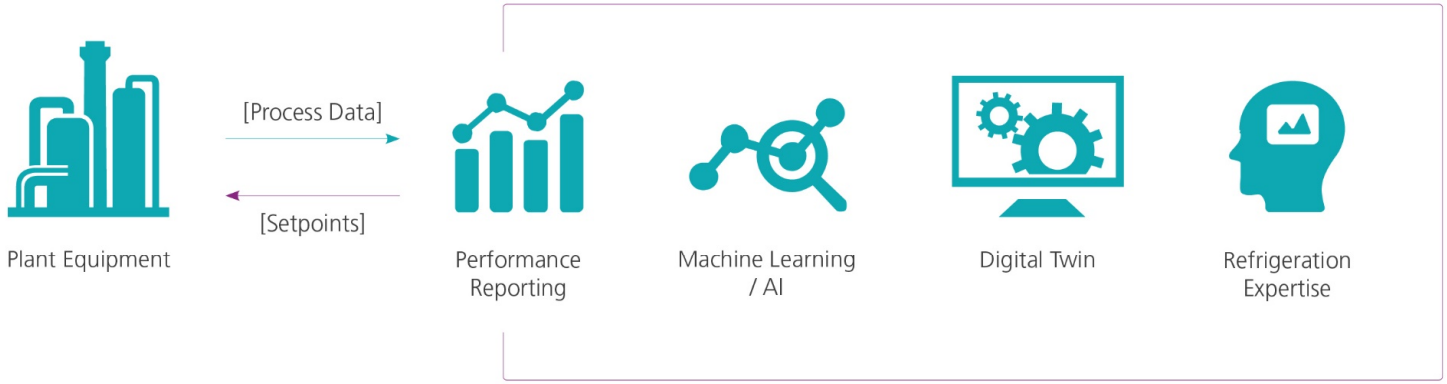
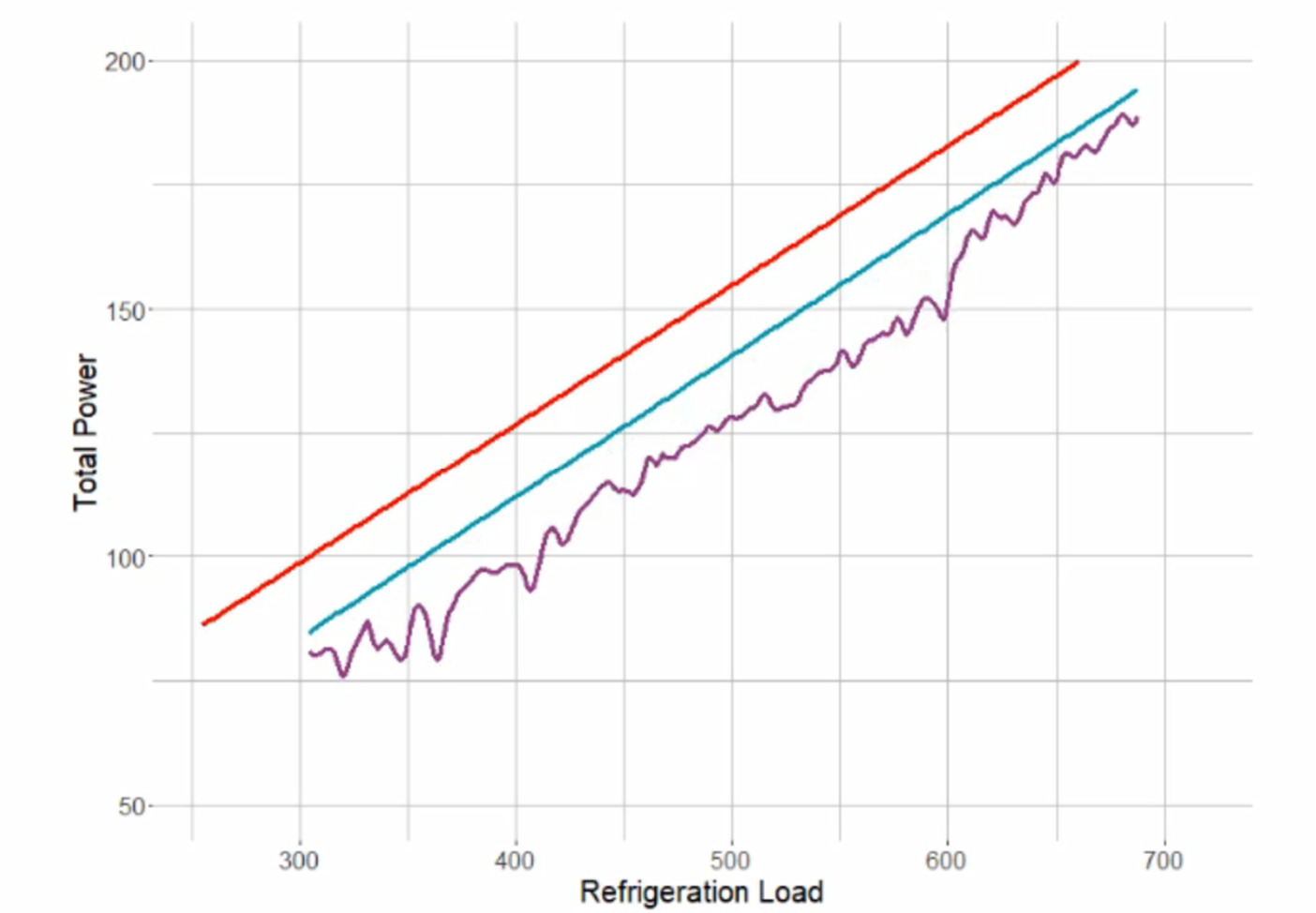
"Maestro - Your Refrigeration System Operating In Concert"



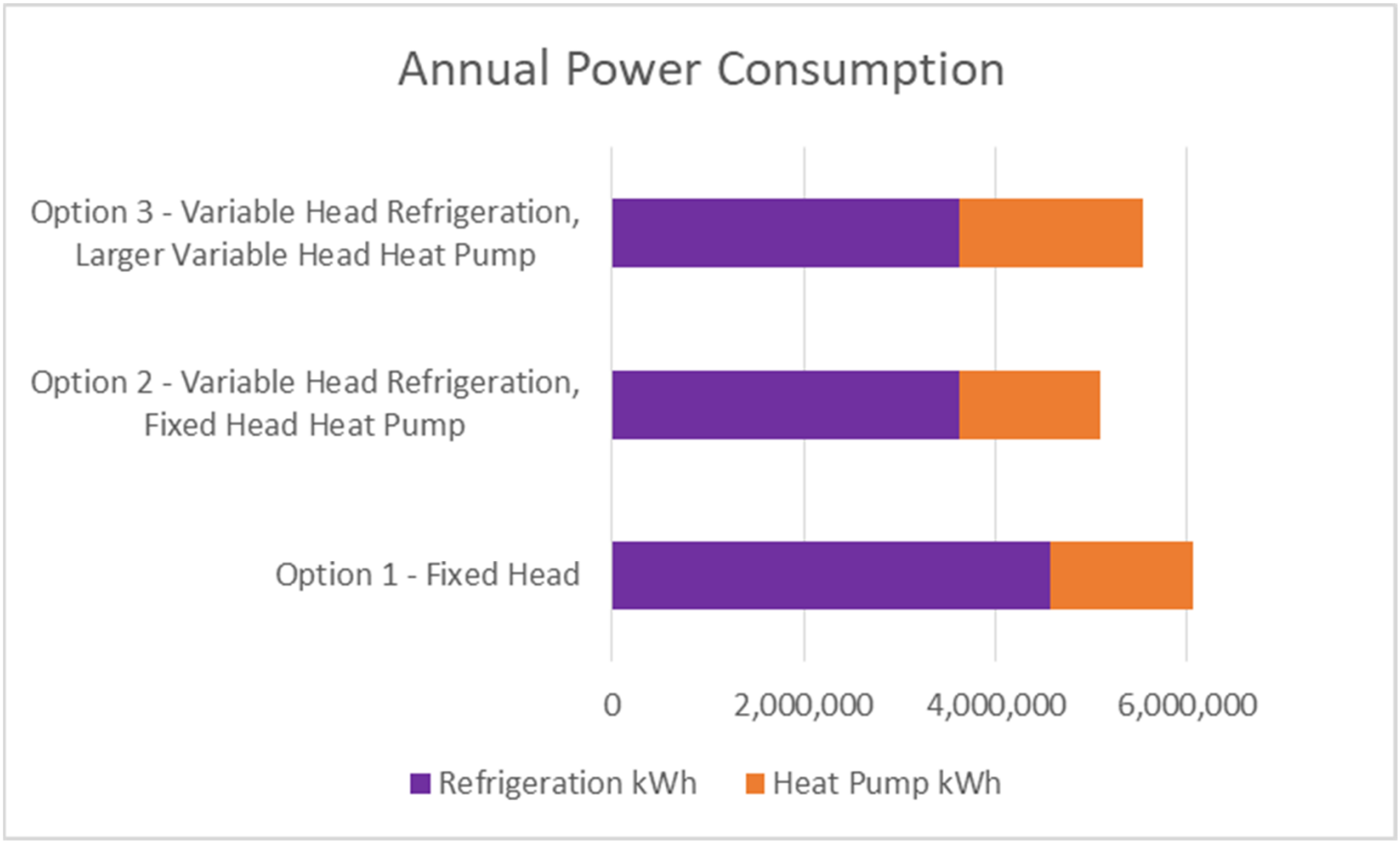
The Solution **Maestro**

make everyday better.

Red: original system power
Teal: Maestro seed values
Purple: Maestro machine learning



Option Analysis

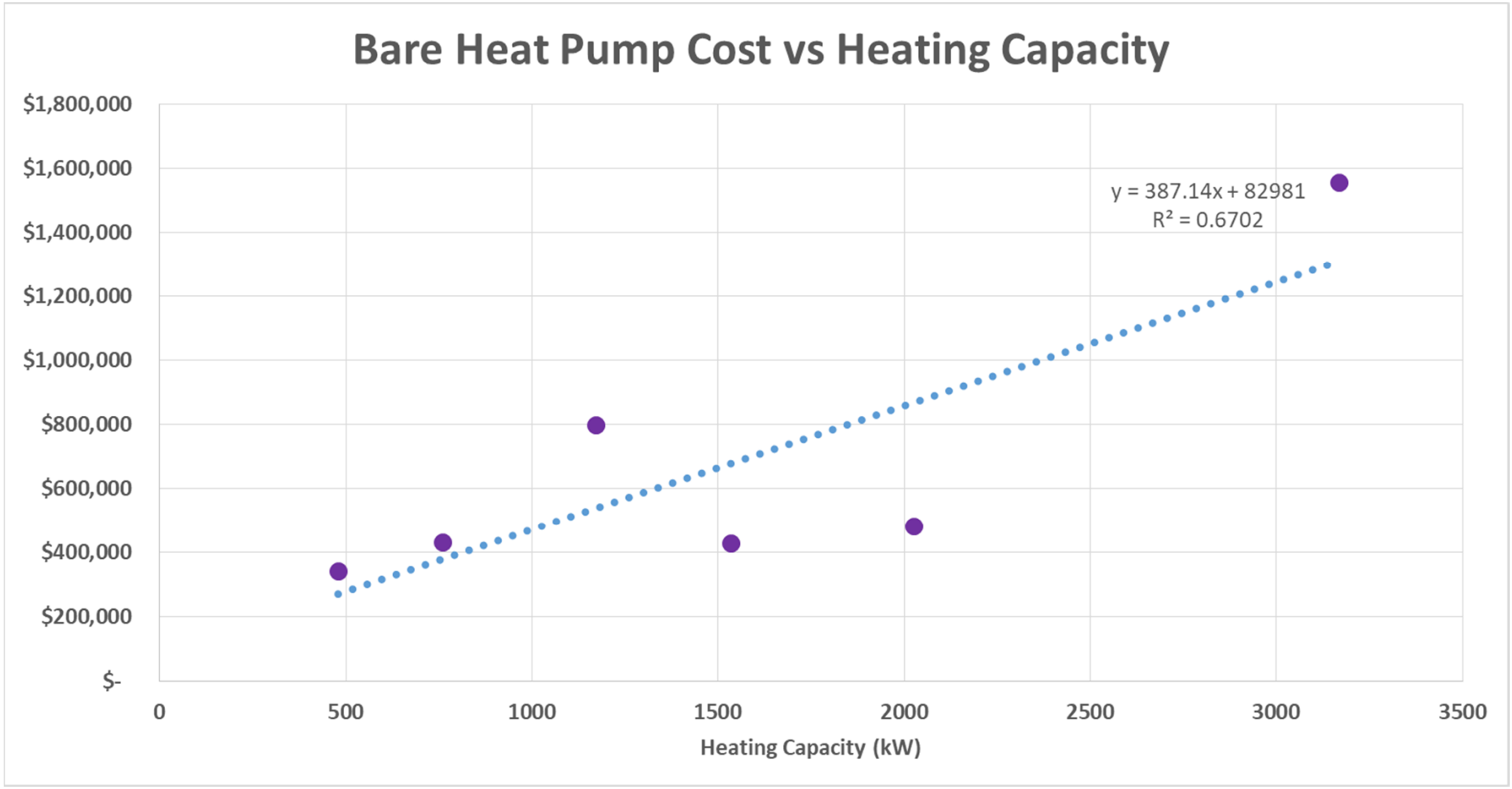


5,553,667 kWh
(+8.5%)

5,097,947 kWh
(baseline)

6 052,698 kWh
(+18.7%)

Heat Pump Unit Costs



Cost Summary

(Electricity: $0.14/kWh)	% kWh consumed	Energy Cost	Energy Savings	Additional CAPEX
Option 1 - Fixed Head	119%	$ 847,378	-$ **133,665**	$ -
Option 2 - Variable Head Refrigeration, Fixed Head Heat Pump	**100%**	**$ 713,713**	$ -	**$ 25,000**
Option 3 - Variable Head Refrigeration, Larger Variable Head Heat Pump	109%	$ 774,713	**-$ 61,001**	**$ 250,000**

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Conclusions

- Don’t run your heat pump at the cost of refrigeration system efficiency
- A split discharge arrangement for the refrigeration plant allows separation of heat pumping and condensing functions
- It doesn’t make economic sense to oversize a heat pump
- Make sure your water circuit is organised correctly

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