

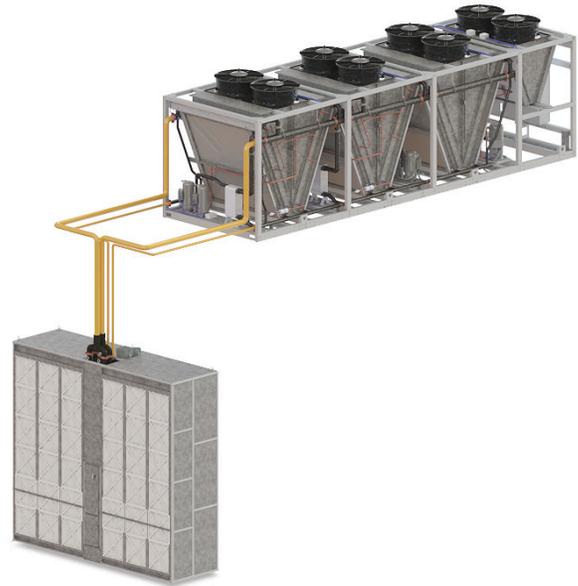
Munters SyCool[®] Split - 400 kW

Indirect Economizer Thermosyphon Split-System

Munters SyCool Split provides an efficient cooling solution for new and retrofit installations where access to a suitable water supply may be limited, expensive or unreliable.

Advantages

- Split system eliminates duct penetrations
- No water consumption
- High-efficiency economization
- Factory-optimized controls



Thermosyphon heat exchangers move heat from the data center to ambient through the evaporation of liquid refrigerant in the SyCool evaporator, and condensing of the same refrigerant in the SyCool condenser. The evaporator is connected to the condenser with refrigerant piping allowing up to 500' of separation (see installation manual for specific fitting losses). As long as the condenser receives air cooler than the evaporator, heat is exchanged passively for “free cooling” of the data center. A simplified version of the system is schematically shown in Figure 1, right.

The SyCool 400 thermal effectiveness is nominally 70%, which greatly exceeds that of competing refrigerant based economizer systems. For example, with air delivered to servers at 75°F and a 20°F delta T across the servers, SyCool achieves 100% free cooling when the ambient dry bulb temperature is 67°F or lower (operating at 75% load). As ambient temperature rises, SyCool transitions from passive to active by staging/modulating compressors located in the condenser section. Data center heat is rejected by the thermosyphon, passively or actively without the need for diverting valves, allowing seamless transition from economizer to active cooling. As the ambient temperature approaches the temperature from the servers, SyCool finally loses free cooling capacity. **The high heat exchange effectiveness coupled with the ability to economize simultaneously with active refrigeration, yields best-in-industry economizer capture efficiency as depicted on page 7.**

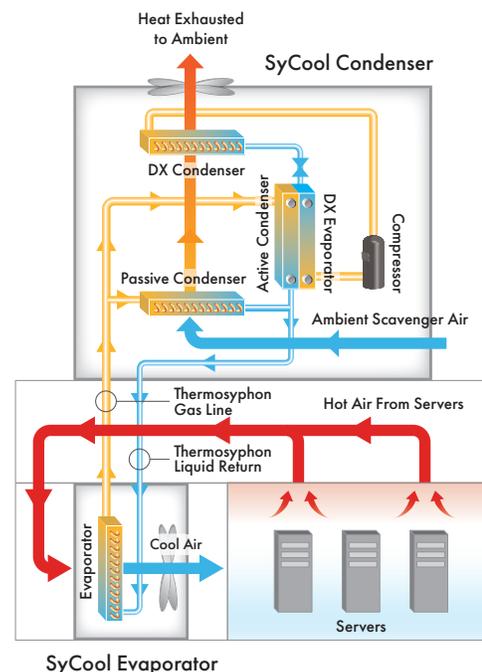


Figure 1

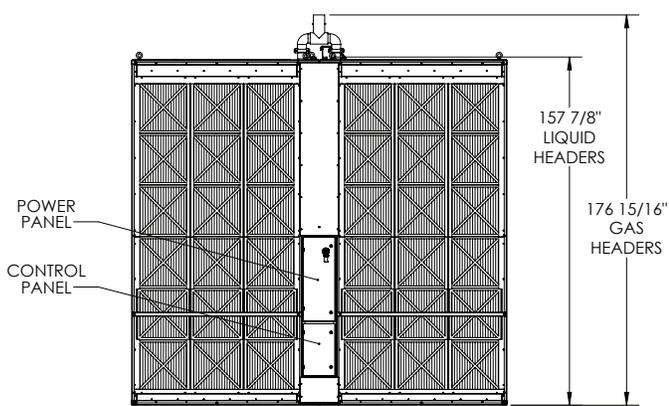
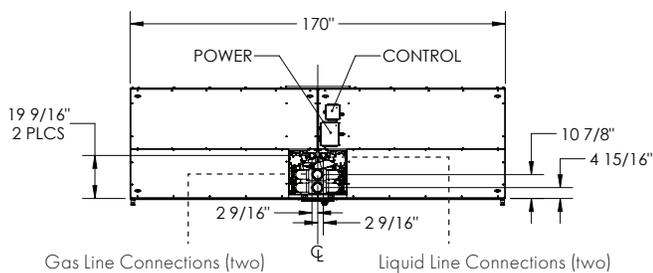
Note: 400 kW system consists of two passive circuits in series. Only one passive circuit shown in above schematic for simplicity.

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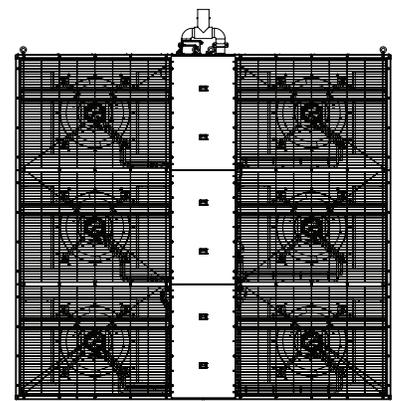
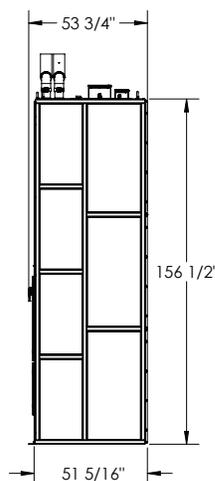
Indirect Economizer Thermosyphon Split-System

SyCool standard evaporator

- Approximate unit weight: 6,200 lbs.
- Minimum 60" clearance required on air inlet and air outlet sides
- No clearance required between units
- Ships in two sections



Air Inlet Side



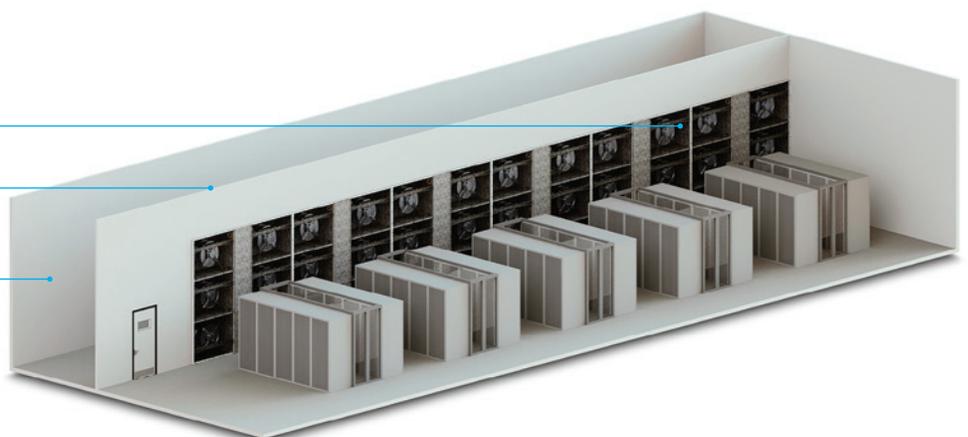
Air Leaving Side

Supply air to the data hall

Partition between the return and supply of the evaporator

Hot aisle containment return plenum

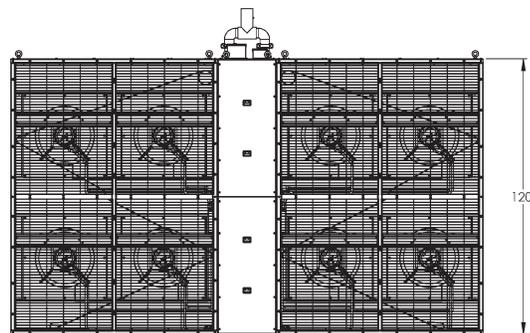
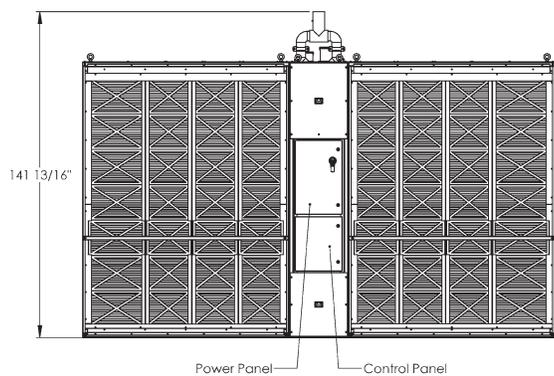
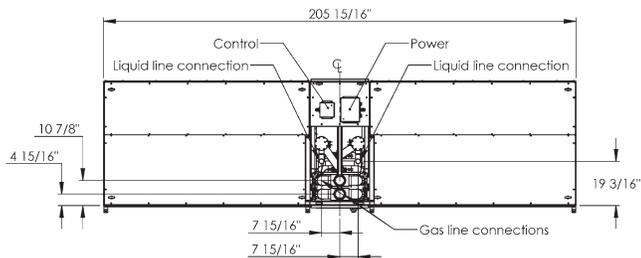
*Hot aisle containment system not shown



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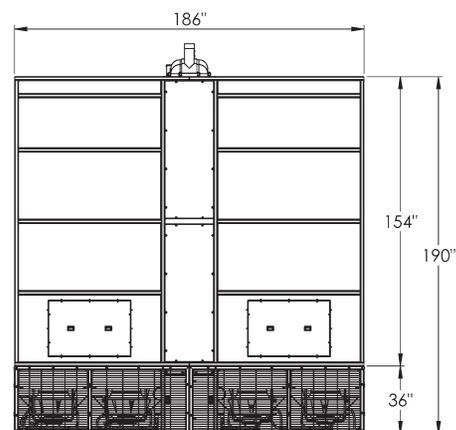
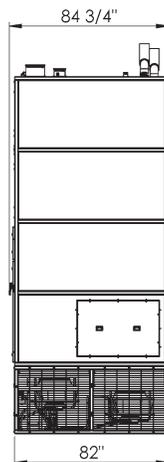
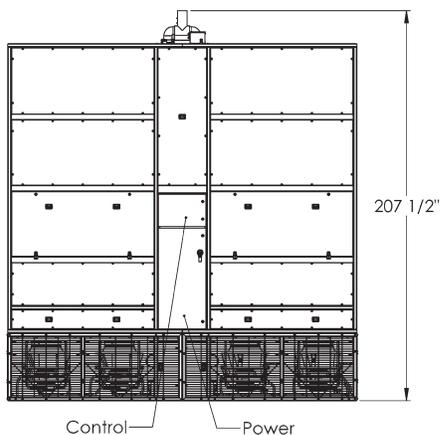
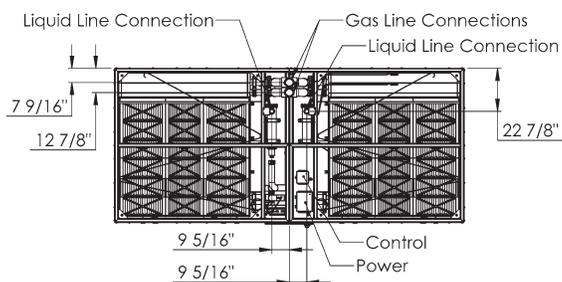
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SyCool low height 10 foot evaporator



Approximate unit weight — 6,500 lbs

SyCool downflow evaporator



Approximate unit weight — 7,800 lbs (weight of 36" stand excluded)

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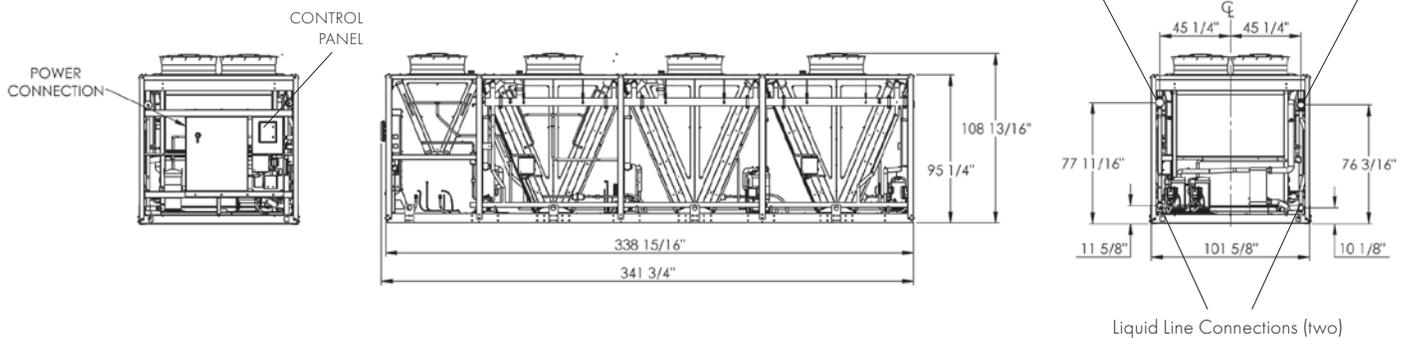
Indirect Economizer Thermosyphon Split-System

SyCool condenser

- Approximate unit operating weight: 12,500 lbs.
- Minimum 96" between units side to side*
- Minimum 60" between unit end to end*

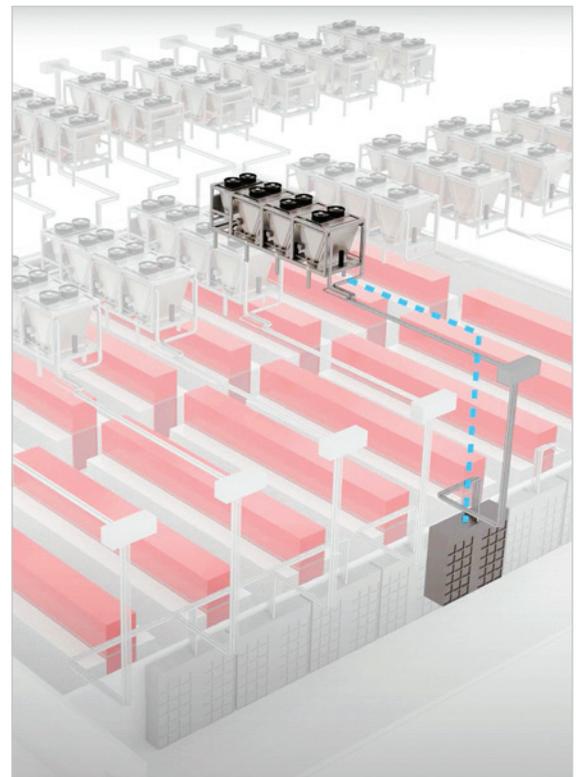
*Contact Munters for options that may reduce clearances

An option for condenser air inlet evaporative pre-cooling to reduce peak power is available.



Installation notes:

1. Two gas lines and two liquid lines are required per 400 kW system. Gas lines shall be either 3" or 4", and liquid lines shall be 1-5/8" or 2", depending on vertical and horizontal separation and number of elbows.
2. Refrigerant grade clean type "L" ACR copper pipe (cleaned and capped) between SyCool 400 kW Condenser and Evaporator.
3. Copper lines may be connected using Victaulic[®] type fittings, or they may be brazed with nitrogen purge.
4. Connecting copper lines not to exceed 500 equivalent feet per run (see installation manual for specific fitting losses).
5. All connecting lines require contractor install of minimum 1/2" insulation or equivalent heat gain/loss prevention using insulated chases.
6. All connecting lines shall be leak tested at 250 PSIG, and vacuum tested to below 500 microns prior to charging process.
7. Contractor to evacuate and charge each thermosyphon circuit.
8. Each 400 kW system contains two thermosyphon circuits. Each circuit typically requires 250-420 lbs R-134A refrigerant. (Refrigerant by contractor. Munters to verify exact charge based on vertical and horizontal piping distance. Long piping runs exceeding 200 ft require more refrigerant.)
9. Do not add oil to the refrigerant charge. Thermosyphon circuits do not require lubrication.
10. Thermosyphon piping does not require any traps.
11. Active DX circuits at the condenser use R-410a and are factory piped and tested.



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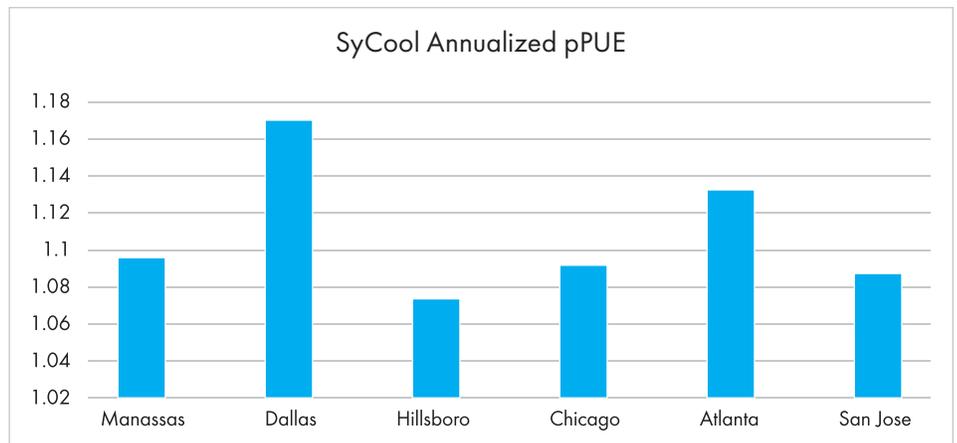
SyCool performance

			Supply Temp., 20 Deg.F Delta T			Supply Temp., 25 Deg.F Delta T		
			70	75	80	70	75	80
Ambient Temperature (Deg. F)	105	Cooling Capacity (kW)	370	400	400	375	400	430
		Peak Power (kW) - Note 1 and 2	156	158	155	150	151	159
		Peak PUE	1.422	1.395	1.388	1.400	1.378	1.370
		Full Ambient Economizer (Deg. F) - Note 3	62	67	71	63	67	71
	100	Cooling Capacity (kW)	382	400	400	385	420	440
		Peak Power (kW) - Note 1 and 2	152	153	149	147	152	155
		Peak PUE	1.398	1.383	1.373	1.382	1.362	1.352
		Full Ambient Economizer (Deg. F) - Note 3	62	67	71	63	67	71
	95	Cooling Capacity (kW)	390	400	400	390	430	450
		Peak Power (kW) - Note 1 and 2	148	146	139	142	148	152
		Peak PUE	1.379	1.365	1.348	1.364	1.344	1.338
		Full Ambient Economizer (Deg. F) - Note 3	61	67	71	62	66	70

- Notes:
1. Data is based on 100% cooling (Peak) capacity at sea level. Consult Munters for different elevations.
 2. Peak data based on 0.25" WG external static pressure and partially loaded MERV 8 filters.
 3. Full Ambient Economizer (Deg. F) based on 75% Cooling Capacity.

SyCool provides annualized pPUE values less than 1.1 for many USA cities.

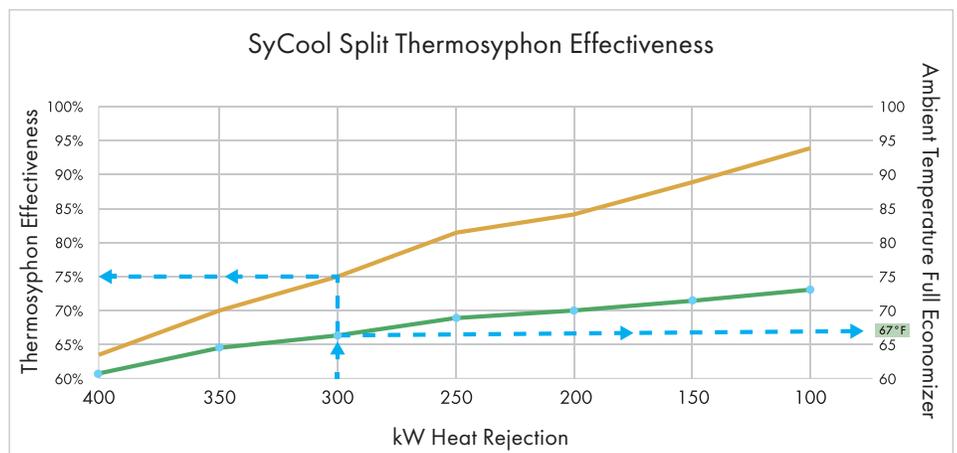
Note: 75°F supply, 20°F delta T, operating with 75% of maximum load per system



Return = 95°F
Supply = 75°F

Effectiveness

Ambient temperature where 100% passive economizing achieved



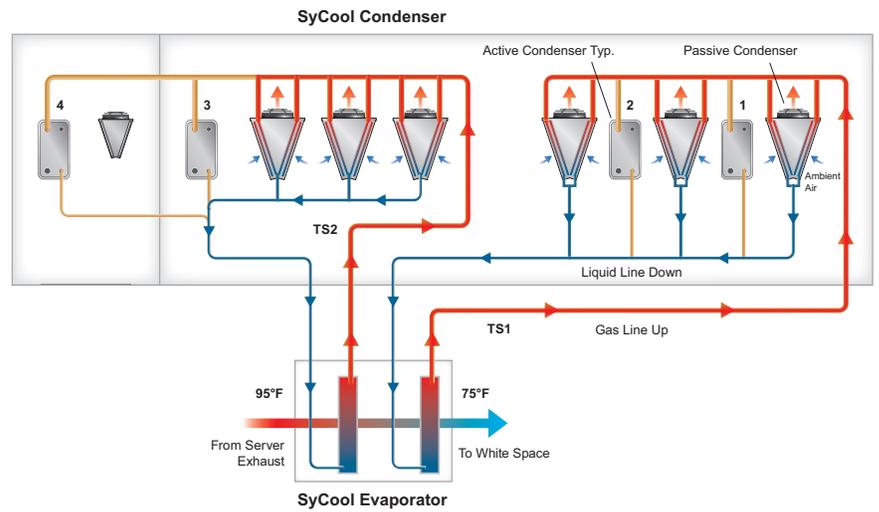
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SyCool[®] piping

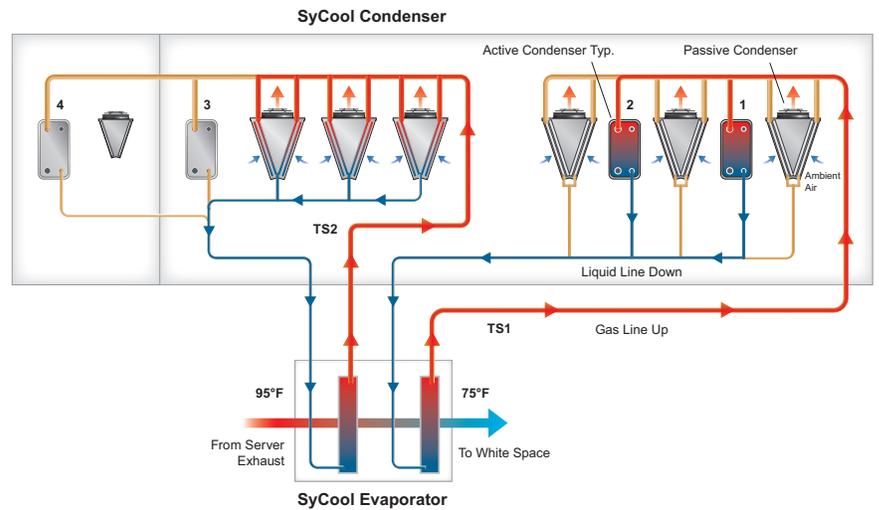
Full Economizer Mode

Refrigerant gas is condensed by drawing ambient air, 67°F or cooler over the passive condensers (based on operating conditions shown). The condenser fans ramp up to a maximum speed at the point ambient temperature can no longer support the full economizer mode. At this speed, the condenser and supply fans consume *48 kW of energy.



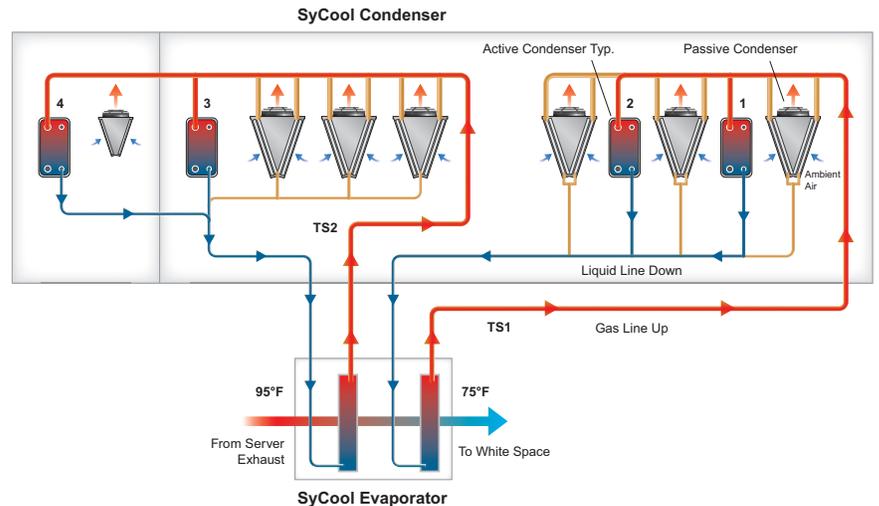
Transition Mode

Between 67 and 90°F ambient, refrigerant gas is condensed by drawing ambient air over the passive condensers and by active condensers contained within the thermosyphon refrigerant circuits. The active condensers reject heat to an integrated compressor based DX system. Power consumed by condenser fans, supply fans, and compressors at the upper end of this transition is approximately *128 kW.



Full DX Mode

Above 90°F ambient, refrigerant gas is condensed by active condensers. Maximum energy for all fans and compressors is approximately *170 kW.



	Passive Condenser
	Active Condenser Typ.
* Peak power in mode shown	

Active Condenser	Compressor Stage
1	1 (Digital), 2
2	3
3	4, 5
4	6

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Economizer Capture Efficiency

Economizer Capture Efficiency demonstrates economizer cooling achieved relative to maximum available, providing a means to compare the annual economizing potential of various cooling systems. As shown in Figure 2, SyCool technology captures close to 90% of the available free cooling for the cities shown. Maximizing free cooling helps to minimize the mechanical PUE of the cooling system. This characteristic combined with low fan energy, results in SyCool consuming about 50% of the annual cooling energy of the primary competing waterless technology.

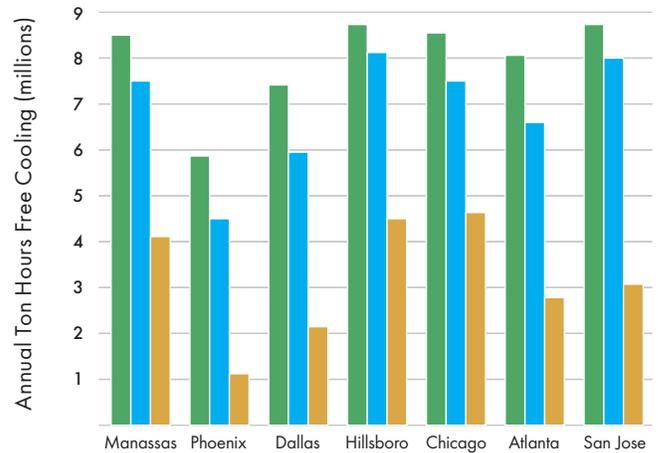
Other SyCool features

Multi-story compatible: SyCool Split is designed for up to 500' of equivalent straight pipe length between the evaporator and condenser, solving the design challenge of achieving high efficiency cooling with multiple story data centers.

Scalable blocks of capacity: SyCool 400 kW condensers coupled with 400 kW evaporators offer “plug and play” building blocks.

High density applications: SyCool evaporator systems configured side-by-side along both sides of the white space perimeter can achieve over 56 kW of cooling capacity per lineal foot of wall. This cooling capacity can accommodate densities of over 400 watts per square foot, depending on operating parameters. SyCool evaporator units flood the room with low exit velocity air, ensuring that all servers receive the cooling required.

Figure 2



3.6 MW Critical Load; N+1 Operation
95°F Return Air Temperature
75°F Supply Air Temperature

Perfect
SyCool®
Alternate Competing System

Low pressure refrigerant piping: SyCool refrigerant lines operate at low pressure and do not require oil management traps such as traditional split refrigeration systems. Each 400 kW system will require two gas lines and two liquid lines. Type “L” copper pipe combined with Victaulic® connections may be used, reducing installed cost compared to copper with brazed piping joints.



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