ADIABATIC COOLING SYSTEMS

German Engineering, Designed in the USA

Alex Schafer

Business Development Manager

HVAC presentation

4/28/2021

ADIABATIC COOLING SYSTEMS

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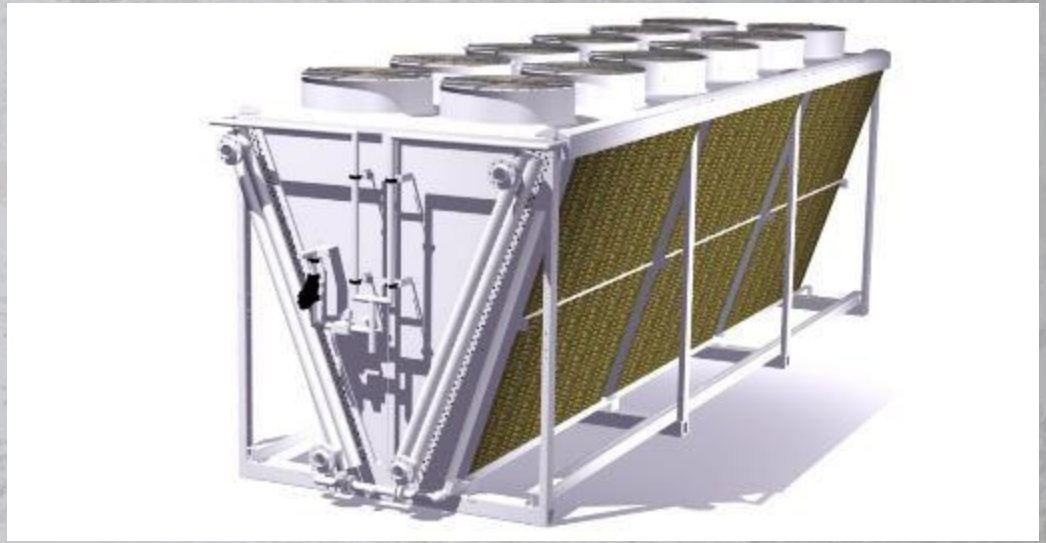
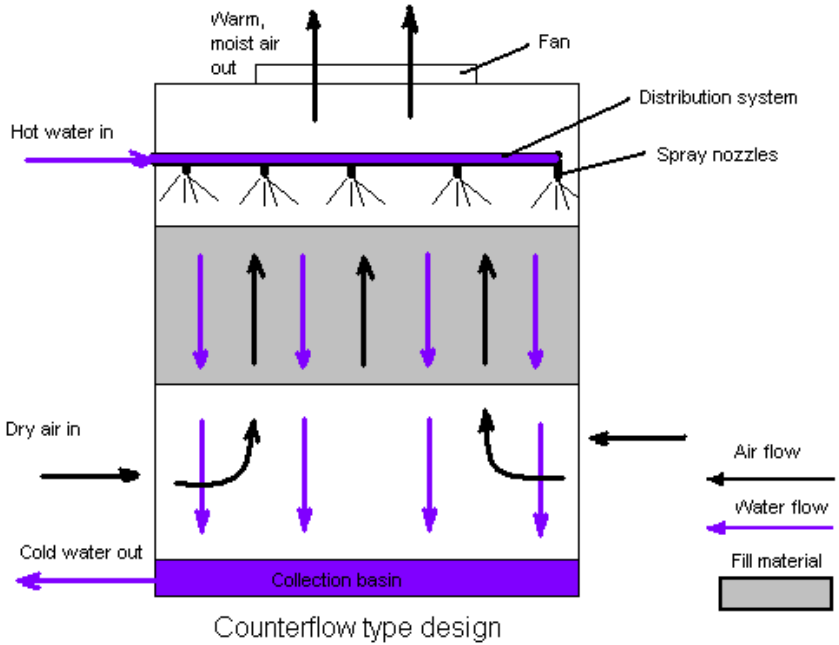


WHY ADIABATIC COOLING?

Heat Rejection Methods

Traditional Cooling Tower

- Rejects heat though evaporation of water
- Energy efficient when well maintained
- Allows lower water temperature based on wet bulb temperature
- Open system requires water treatment



Counterflow type design

WHY ADIABATIC COOLING?

Heat Rejection Methods

Traditional Dry Cooler

- Minimal maintenance
- Leaving fluid temperature based on dry bulb temperature

WHY ADIABATIC COOLING?

Heat Rejection Methods

	Air Cooled	Water Cooled
Heat Transfer Medium	Air	Water
Fluid Temperatures	Dependent on dry bulb temperature	Dependent on wet bulb temperature
Fan Energy Requirements	High	Low
Footprint	Larger	Smaller
Maintenance	Minimal	Extensive
Water Treatment Required	No	Yes
Water Consumption	None	High

WHY ADIABATIC COOLING?

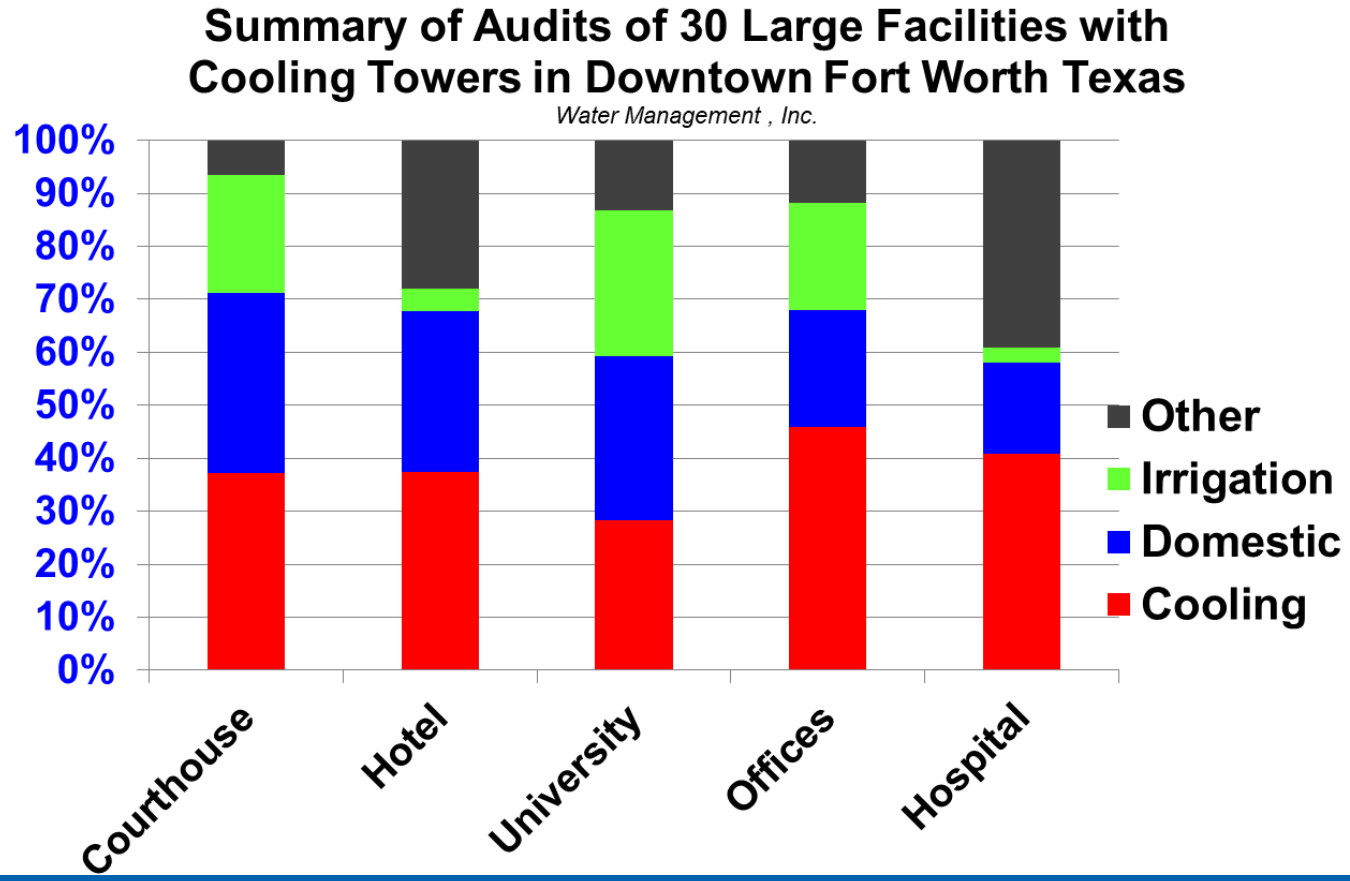
Heat Rejection Methods

	Air Cooled	Water Cooled	Adiabatic
Heat Transfer Medium	Air	Water	Air and Water
Fluid Temperatures	Dependent on dry bulb temperature	Dependent on wet bulb temperature	Co-dependent on dry bulb and wet bulb
Fan Energy Requirements	High	Low	Middle
Footprint	Larger	Smaller	Middle
Maintenance	Minimal	Extensive	Minimal
Water Treatment Required	No	Yes	No
Water Consumption	None	High	Low

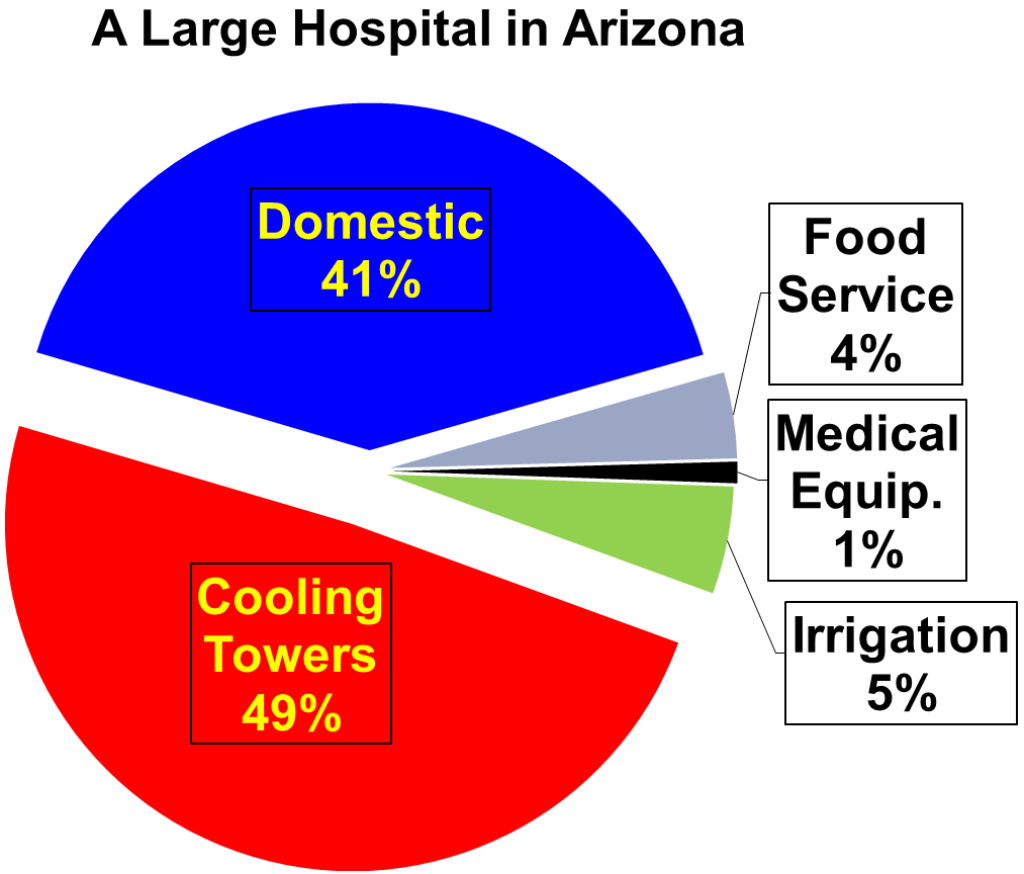
INDUSTRY TRENDS

- Water Scarcity
- Cost of Water
- LEED
- Legionella concerns
- Water quality
- Minimize maintenance
- Energy efficiency

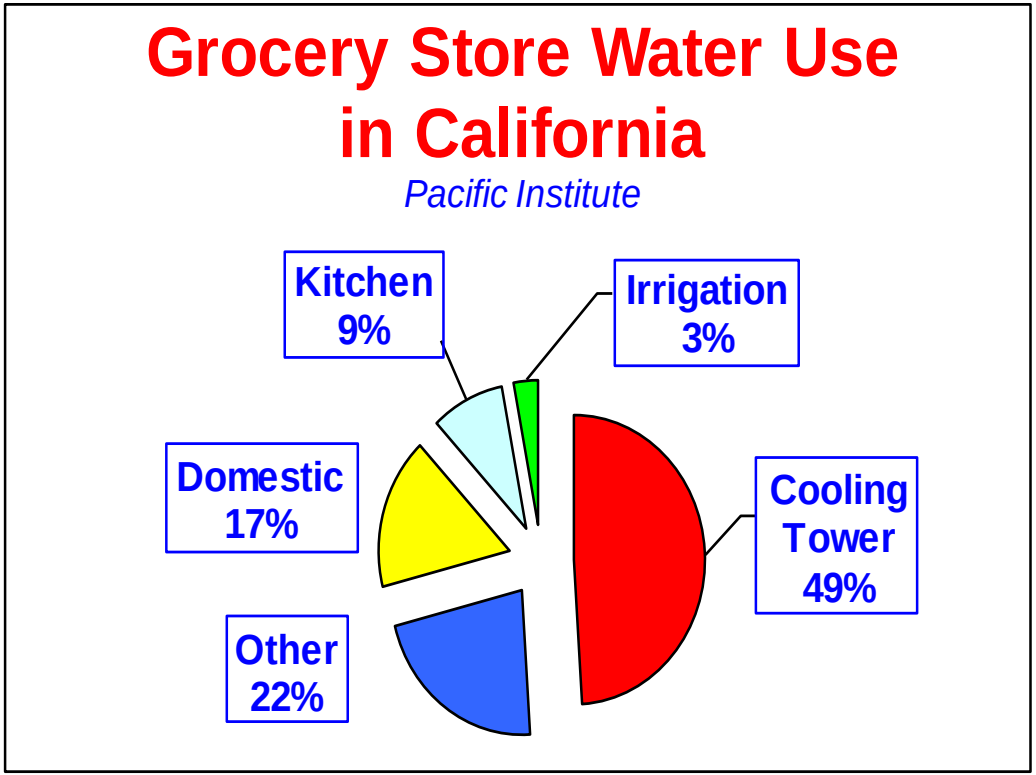
ADIABATIC COOLING SYSTEM



ADIABATIC COOLING SYSTEM

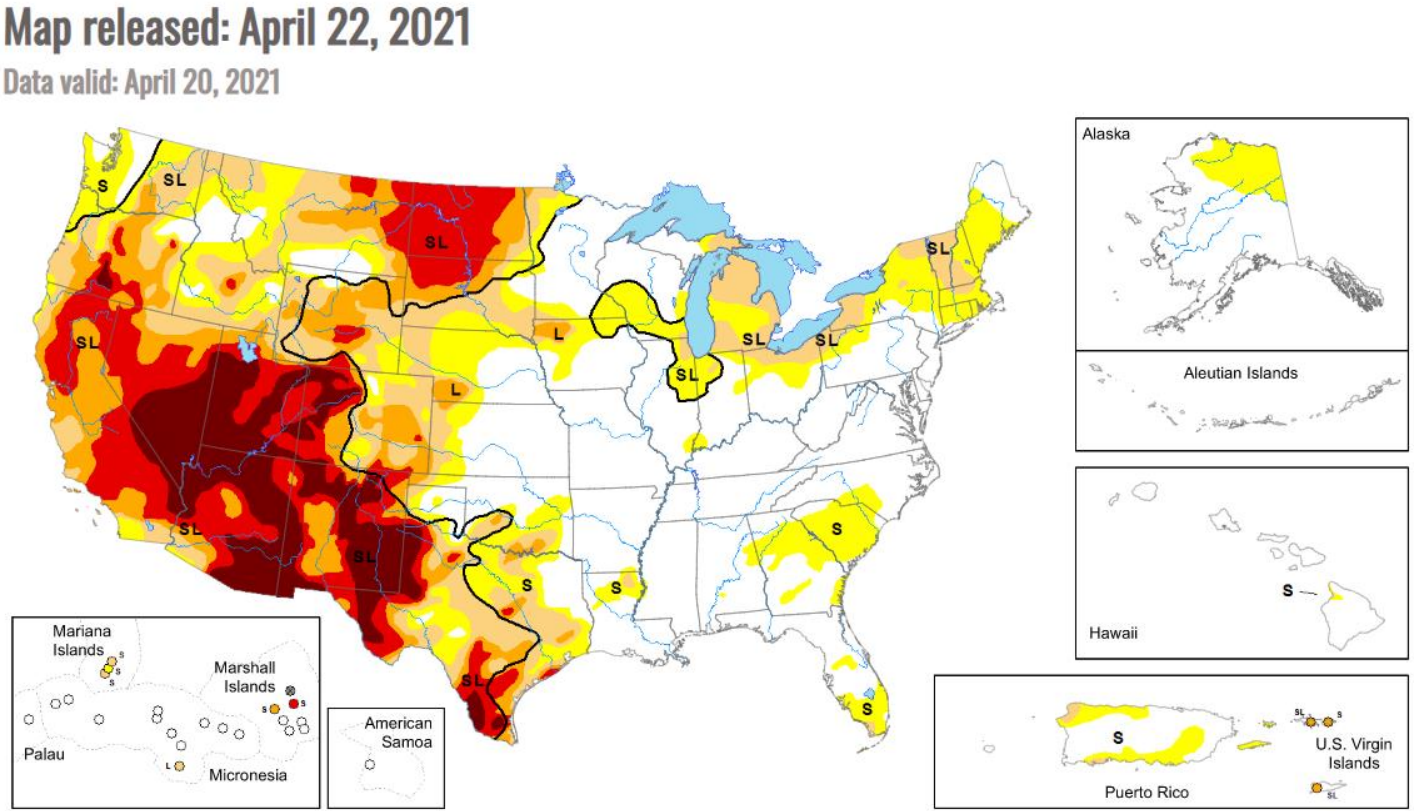


ADIABATIC COOLING SYSTEM



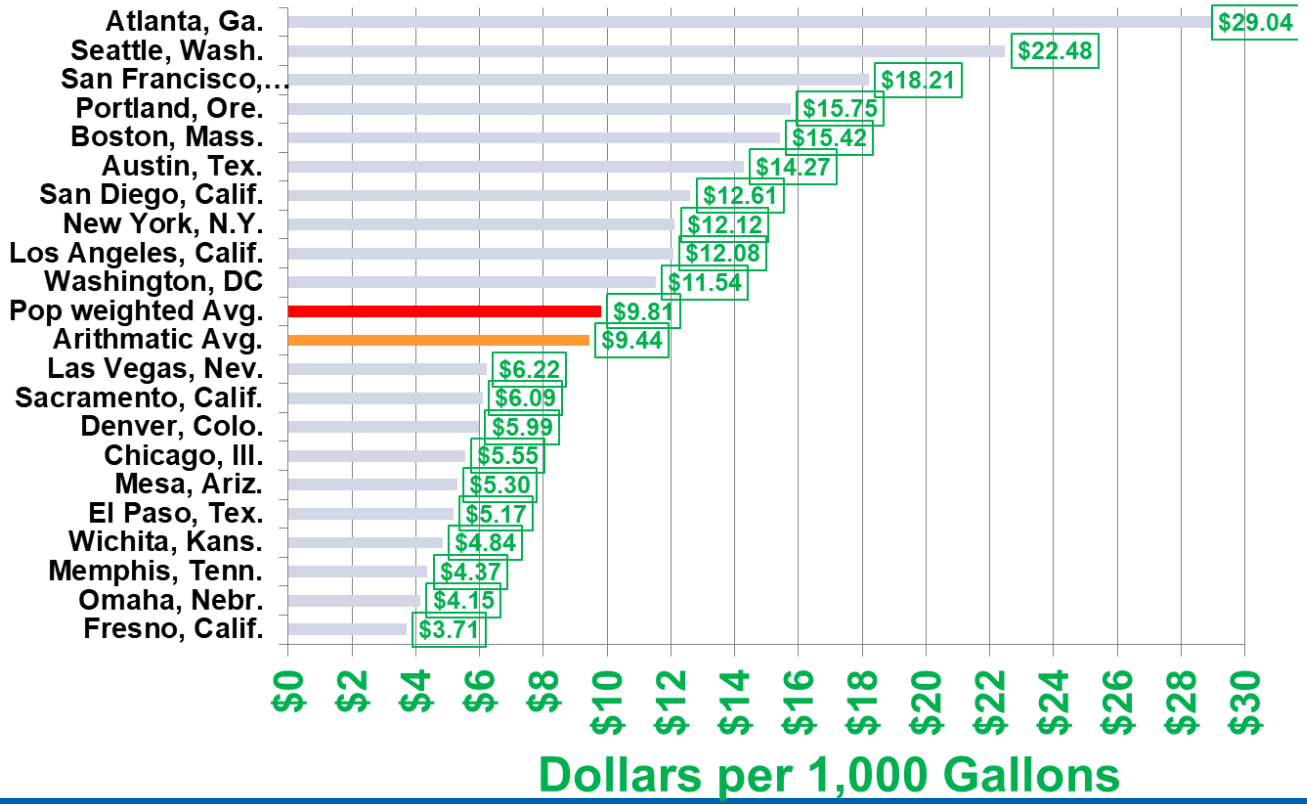
WHY ADIABATIC COOLING?

Availability of Water



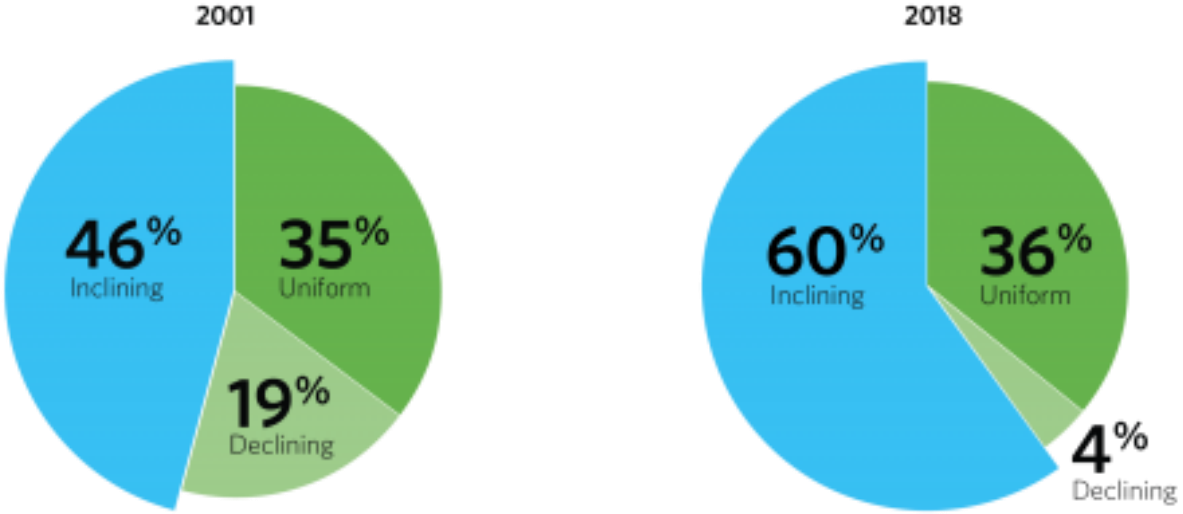
COMMERCIAL COMBINED WATER AND SEWER RATES FOR 50 LARGEST CITIES IN 2013

http://bv.com/docs/management-consulting-brochures/50-largest-cities-brochure-water-wastewater-rate-survey



WHY ADIABATIC COOLING?

Cost of Water

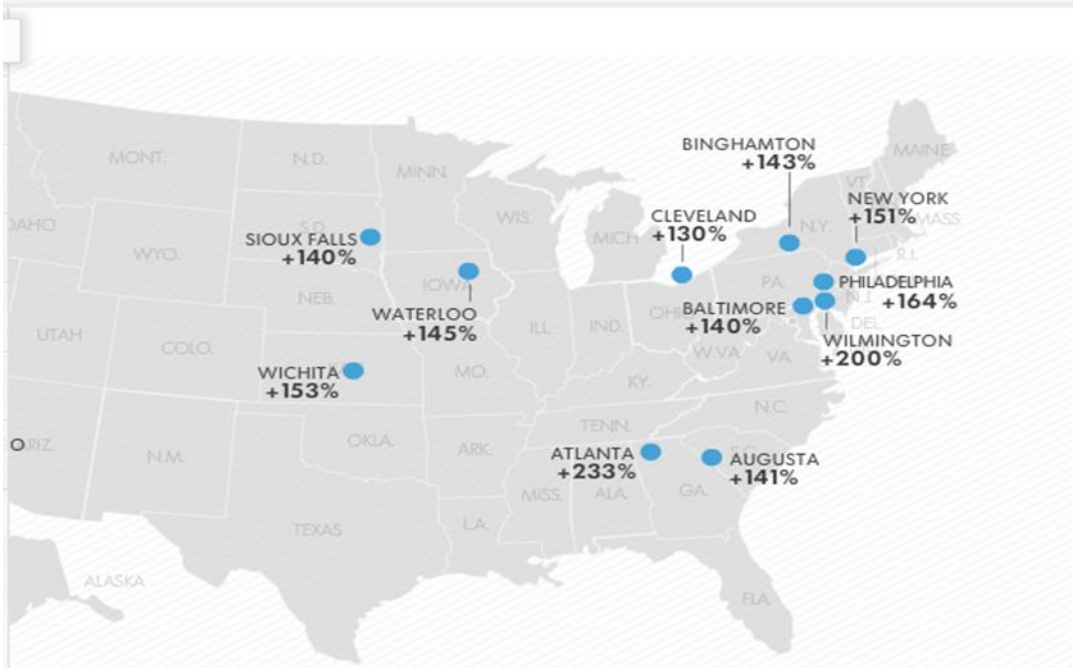


WHY ADIABATIC COOLING?

Cost of Water

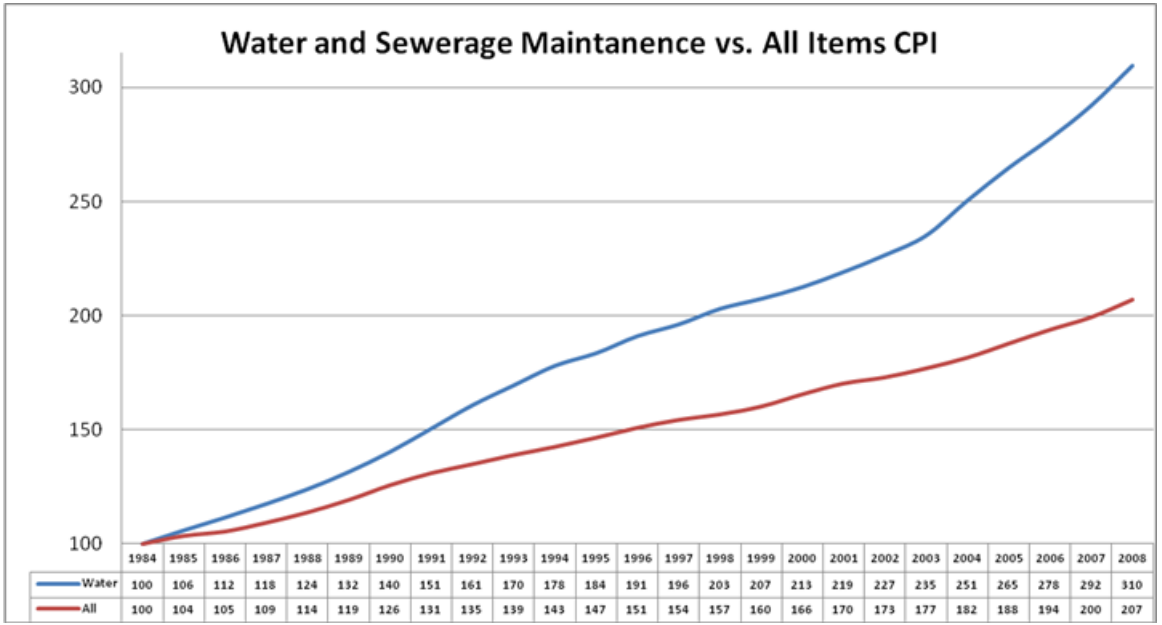
USA Today Survey of 100 municipalities

1 in 4 residential water bills have doubled in the past 12 years



WHY ADIABATIC COOLING?

Cost of Water



	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Water	100	106	112	118	124	132	140	151	161	170	178	184	191	196	203	207	213	219	227	235	251	265	278	292	310
All	100	104	105	109	114	119	126	131	135	139	143	147	151	154	157	160	166	170	173	177	182	188	194	200	207

U.S. Bureau of Labor Statistics

WHY ADIABATIC COOLING?

Aging Infrastructure

- ½ of Philadelphia's water mains were installed before 1930.
- Average age of a water main in Baltimore is 75 years.

- Each year about 240,000 water main breaks result in lost water and disruptions to daily life. (U.S. Environmental Protection Agency)
- Repairing and replacing old water pipes could cost more than $US 1 trillion over the next two decades. (American Water Work Association)

WHY ADIABATIC COOLING?

Reliability

- Simple effectiveness of dry cooler
  - Eliminate need for water treatment
- Peak system efficiency of wetted system
- Water savings typically 60% to 90%(+) vs evaporative towers/coolers/condensers
- Performance in the event of no water

ADIABATIC COOLING SYSTEM

WATER MANAGEMENT – LEGIONELLA CONCERNS

Conditions favorable for amplification

- Warm water (77-108 °F)
- Stagnant water
- Sediment

Common form of transmission

- Inhaled respirable droplets (1-5 micrometers in diameter)

Cooling towers and evaporative condensers specifically listed in ASHRAE Standard 188-2015

World Health Organization

ASHRAE Guideline 12-2000

ASHRAE STANDARD

ASHRAE STANDARD

ANSI/ASHRAE Standard 188-2015

ADIABATIC COOLING SYSTEM

WATER MANAGEMENT – LEGIONELLA CONCERNS

Dry cooler water distribution systems and wetting pads

- Cooler water
- No water recirculating pump necessary
- No stagnant water
- No aerosols (spray nozzles)*

ADIABATIC COOLING SYSTEM

Wet When You Need It, Dry When You Don’t

ADIABATIC COOLING SYSTEM

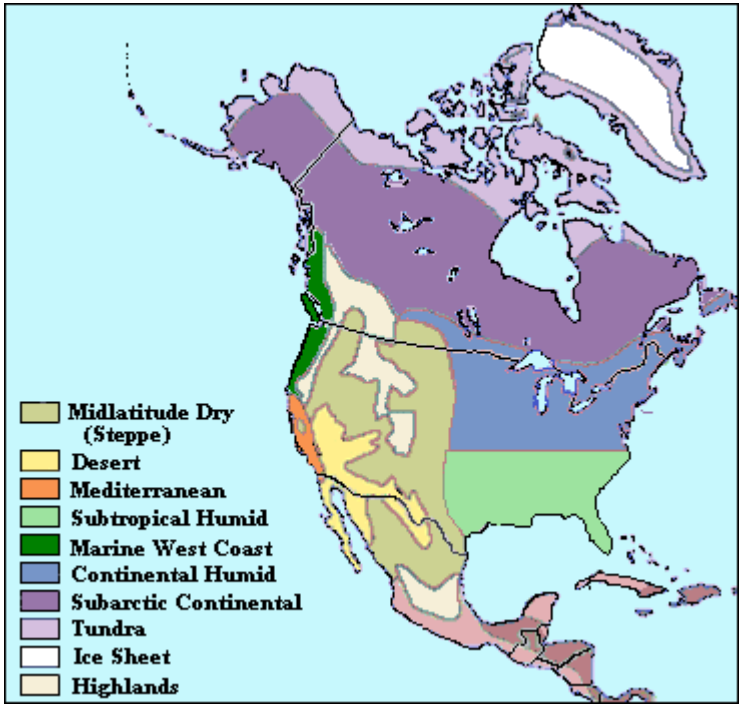
Wet When You Need It, Dry When You Don’t

- Simple effectiveness of dry cooler
- Maintain system efficiency majority of the year
- Minimize winterization concerns

ADIABATIC COOLING SYSTEM

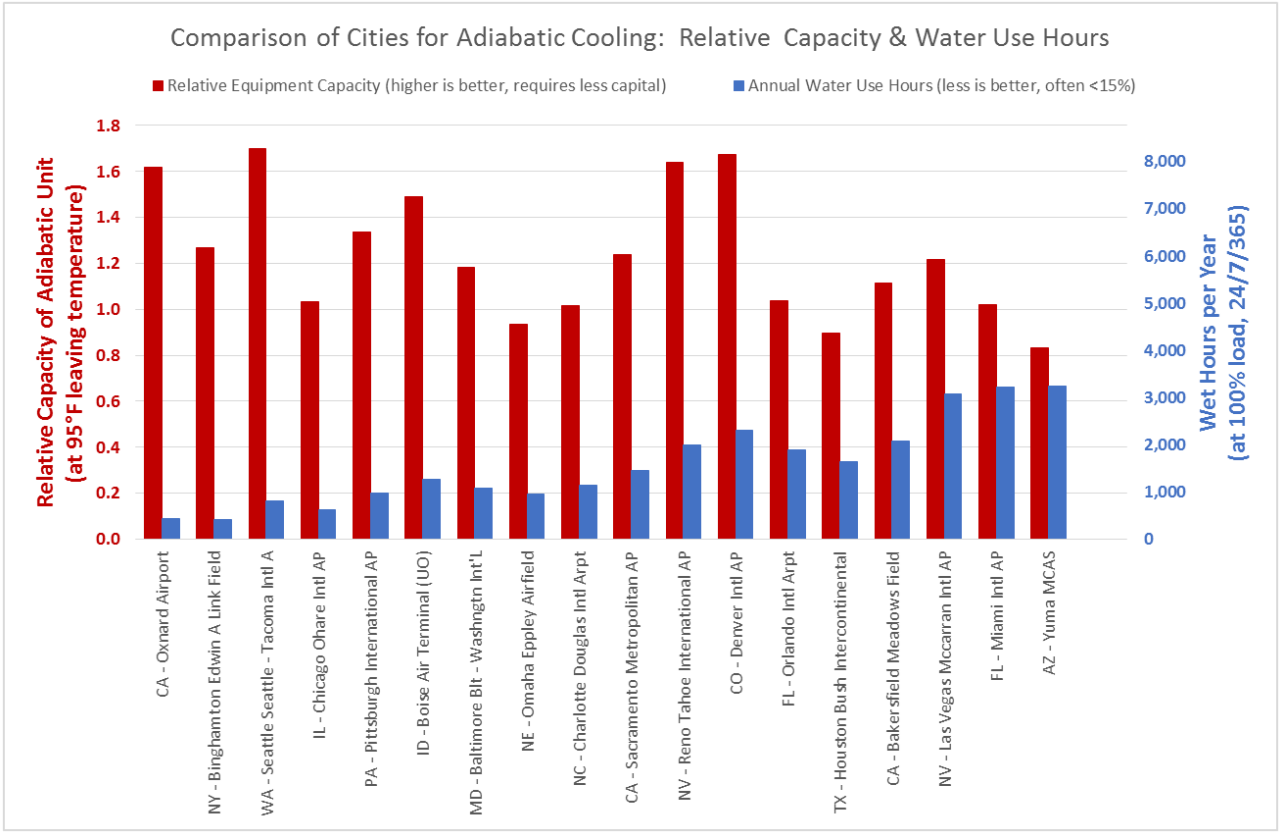
Operating Location

- Wet Bulb Depression
- Amount of time below switch point



ADIABATIC COOLING SYSTEM

Operating Location



ADIABATIC COOLING SYSTEM (ACS)

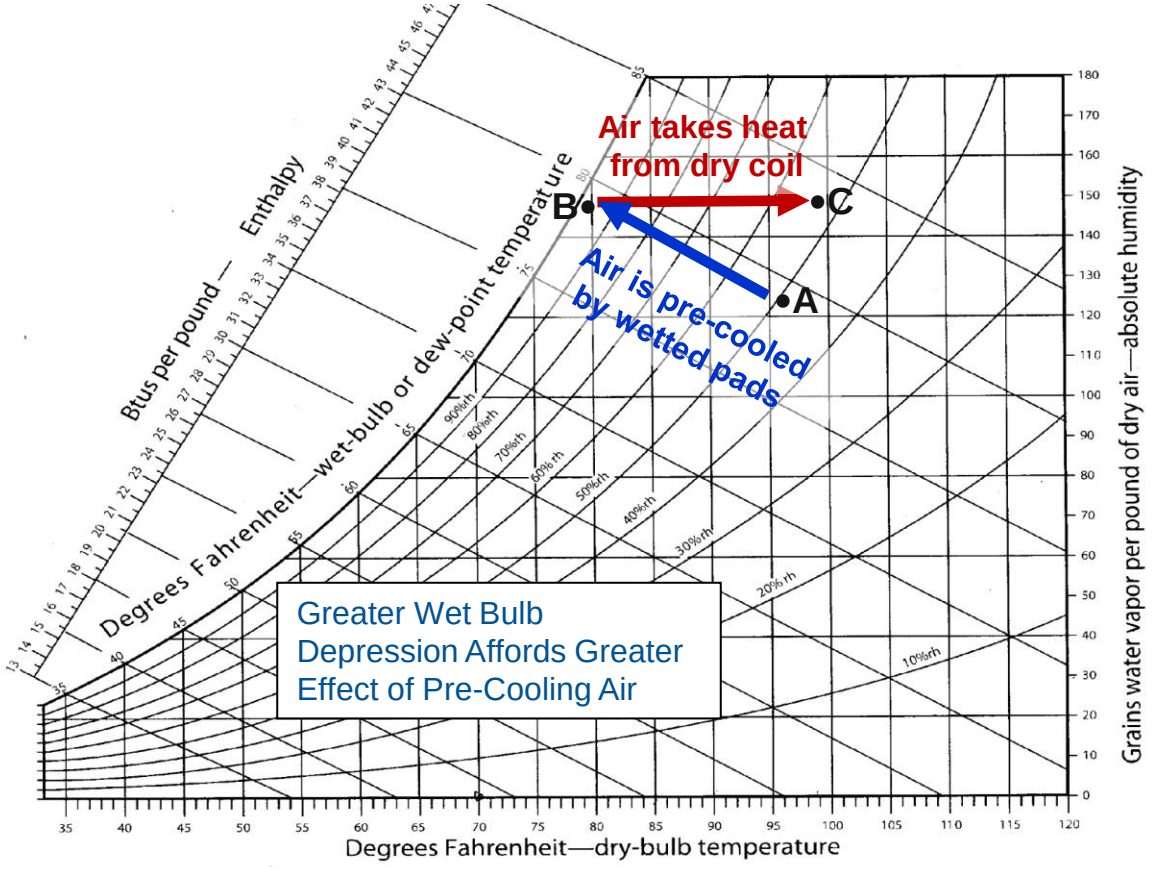
PSYCHOMETRICS

Example:

A. 95°F (35°C) dry bulb
78°F (25.6°C) wet bulb

B. 82°F (27.8°C) dry bulb
78°F (25.6°C) wet bulb

C. 98°F (36.7°C) dry bulb
83°F (28.3°C) wet bulb



ADIABATIC COOLING SYSTEM (ACS)

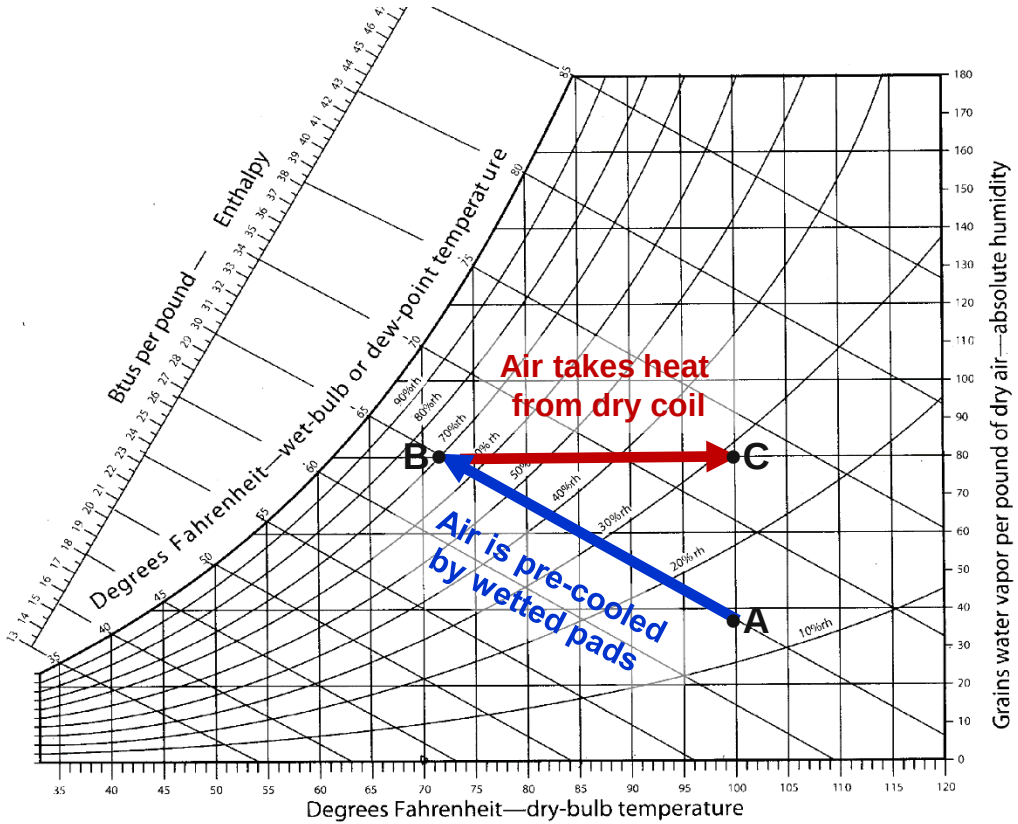
PSYCHOMETRICS

Example:

A. 100°F (37.8°C) dry bulb
65°F (18.3°C) wet bulb

B. 72°F (22.2°C) dry bulb
65°F (18.3°C) wet bulb

C. 100°F (37.8°C) dry bulb
73°F (22.8°C) wet bulb

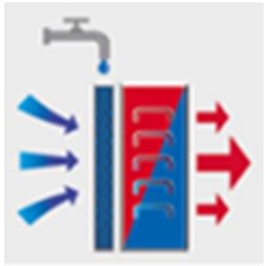


ADIABATIC COOLING DELIVERY SYSTEM

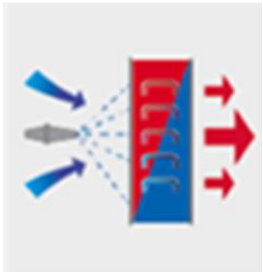
Water Management

- Away from coil

- On medium



- In coil direction

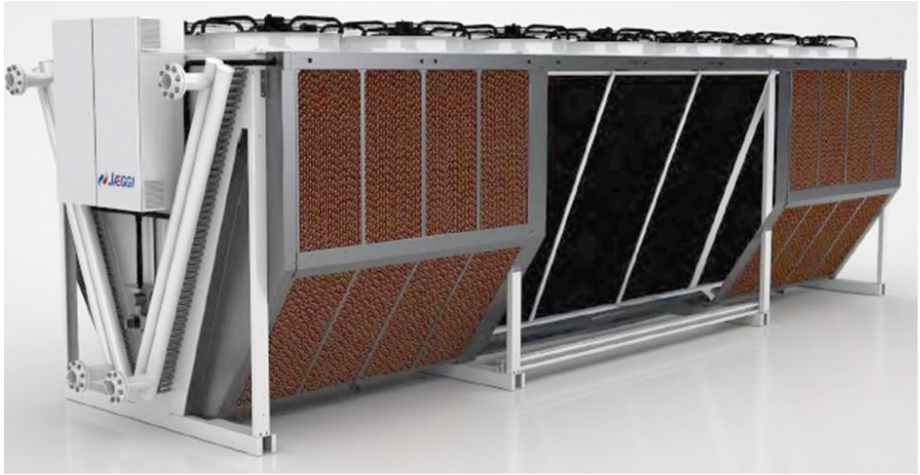


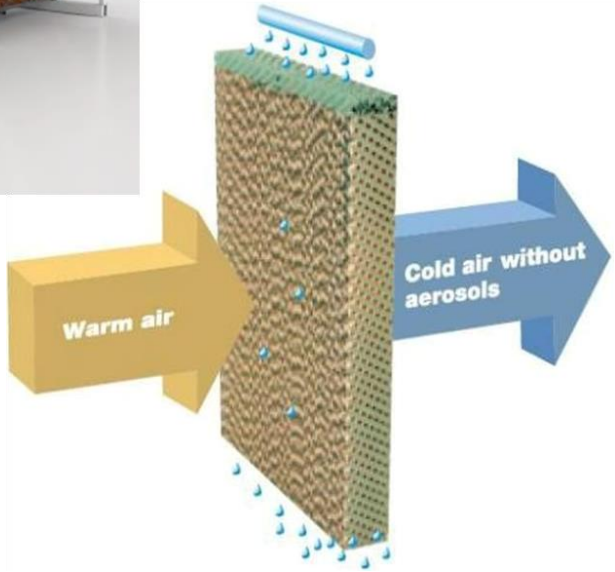
ADIABATIC COOLING DELIVERY SYSTEM

Misting

ADIABATIC COOLING DELIVERY SYSTEM

Wetting Pads

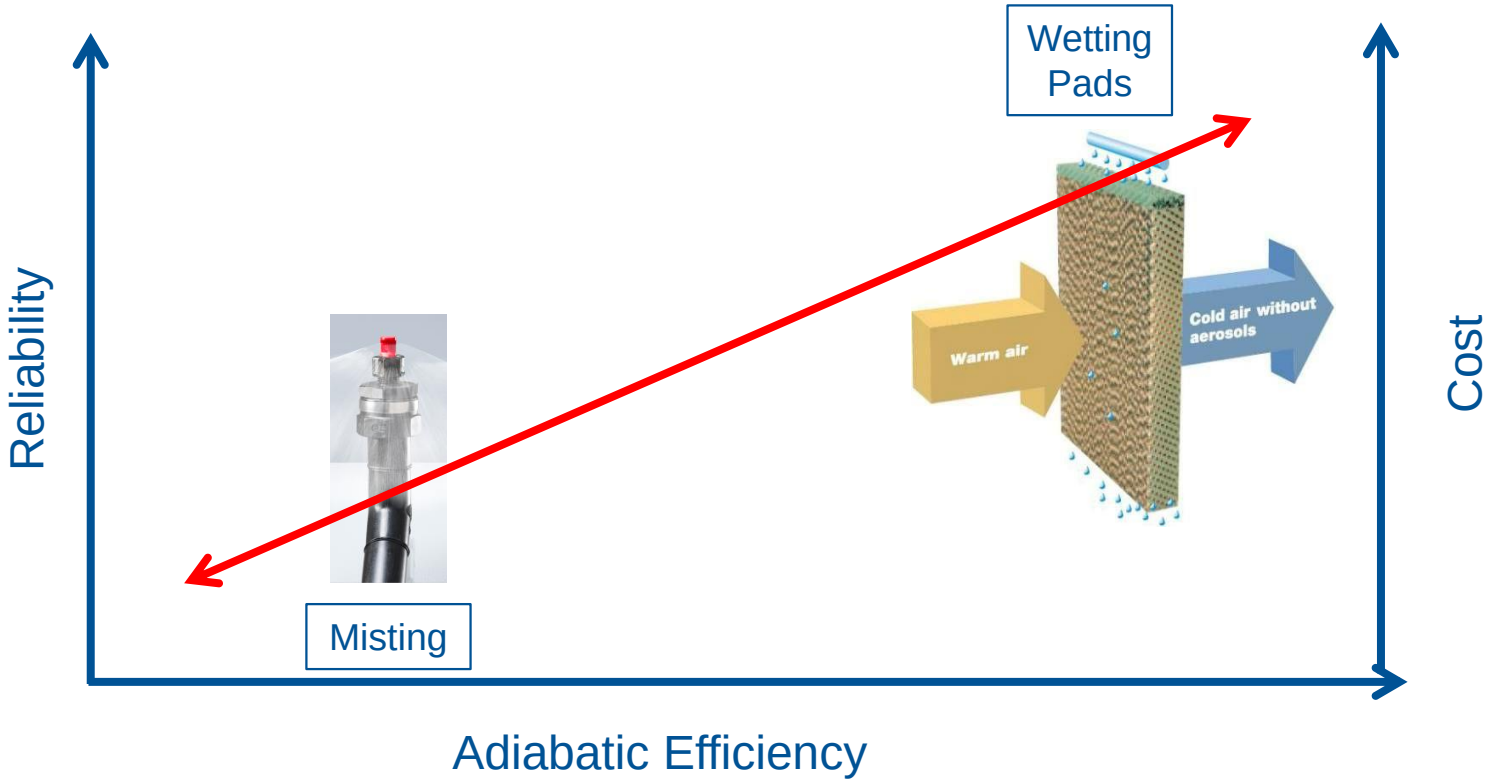




ADIABATIC COOLING DELIVERY SYSTEM

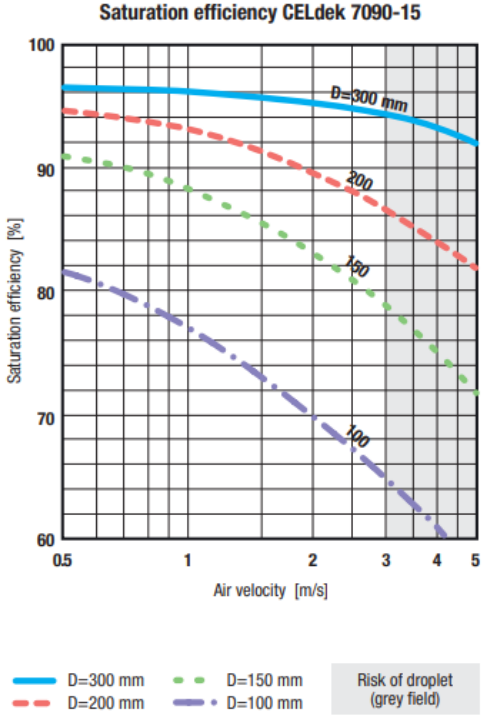
- Adiabatic Efficiency
  - Air approaching wet bulb temperature
- Water Management
  - Misting
  - Pads
  - Combination
  - Water evaporation / collection

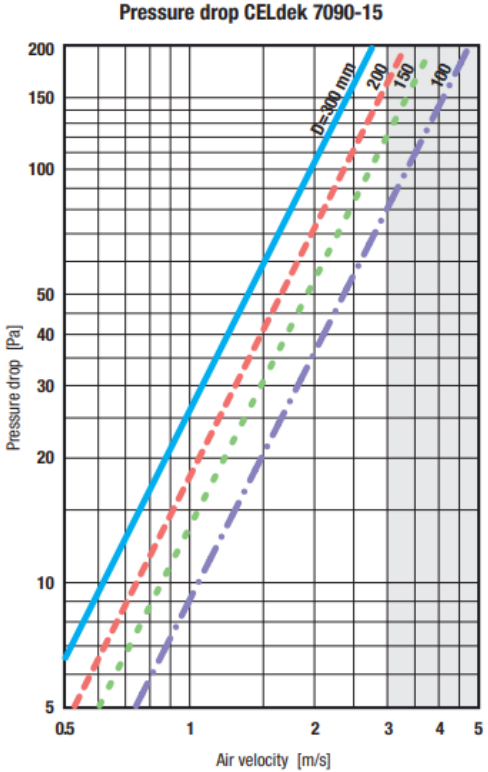
ADIABATIC COOLING DELIVERY SYSTEM



ADIABATIC COOLING

Pad Efficiency



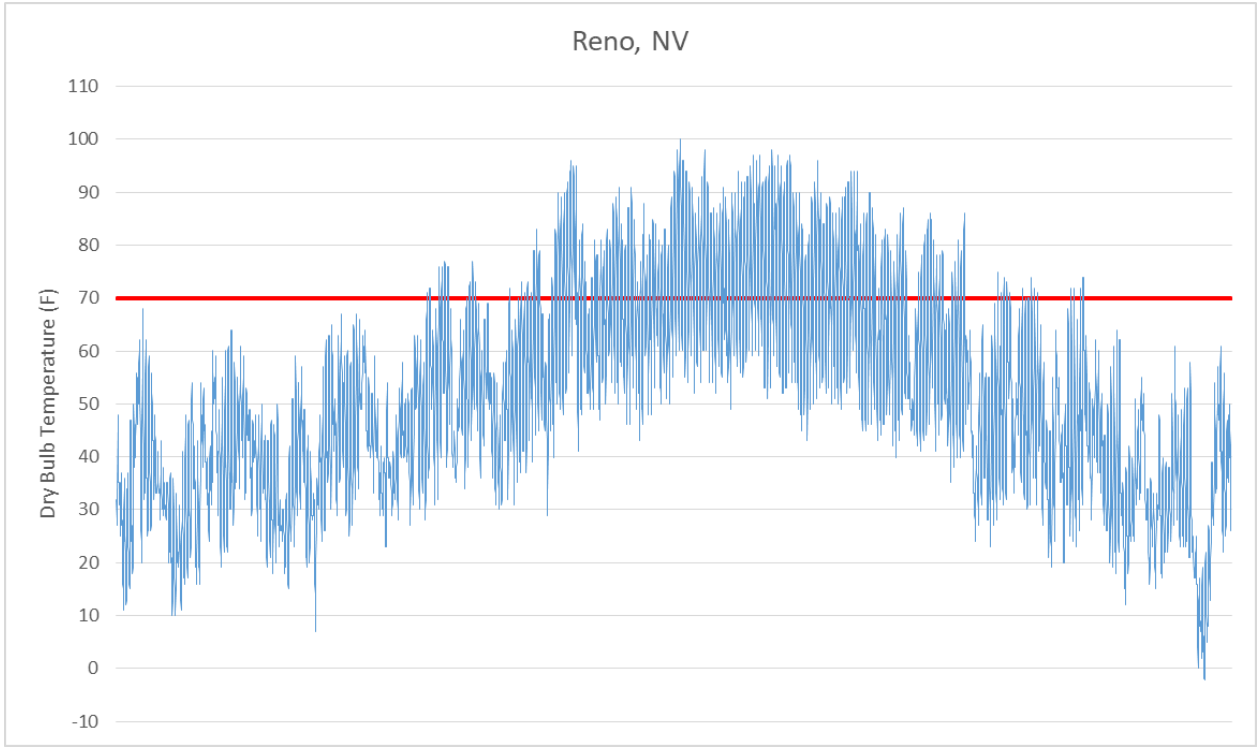


https://www.munters.com/globalassets/inriver/resources/products/coolers--humidifiers/1782-celdek-7090_15_gb.pdf

ADIABATIC COOLING SYSTEM

Weather Bin Analysis

70.0°F switch point
1,495 hours wet operation; 17% of the year



ADIABATIC COOLING SYSTEM

Weather Bin Analysis

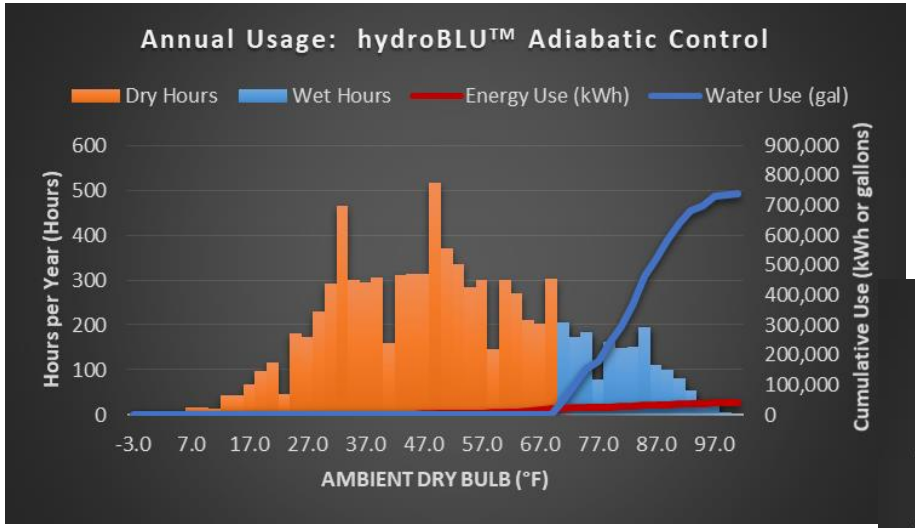
Hours/yr	WBT (°F)	DBT (°F)
2	-4.5	-3.0
6	-2.7	-1.0
5	-0.7	1.0
7	1.1	3.0
3	3.0	5.0
15	4.8	7.0
16	6.6	9.0
14	8.8	11.0
43	10.6	13.0
42	12.5	15.0
67	14.7	17.0
98	16.6	19.0
116	18.3	21.0
45	20.0	23.0
182	21.8	25.0
174	23.6	27.0
231	25.4	29.0
291	26.9	31.0
465	28.7	33.0
299	29.8	35.0
295	31.6	37.0
305	32.7	39.0
160	34.6	41.0
311	36.1	43.0
314	37.5	45.0
313	39.0	47.0
516	40.5	49.0
370	41.8	51.0
336	43.3	53.0
283	44.7	55.0
301	45.8	57.0
147	47.4	59.0
300	48.5	61.0
270	49.3	63.0
211	50.5	65.0
204	51.8	67.0
302	52.6	69.0
206	53.0	71.0
173	54.0	73.0
184	54.8	75.0
79	55.9	77.0
161	56.9	79.0
148	57.5	81.0
150	58.1	83.0
194	58.5	85.0
110	59.1	87.0
101	59.5	89.0
80	60.4	91.0
53	60.9	93.0
23	61.9	95.0
32	62.3	97.0
6	64.0	99.0
1	64.4	101.0

- Typical Meteorological Year (TMY) Data
- Determine switch point based on:
  - Hours of water use
  - Temperature requirements
  - Size constraints
  - Adiabatic efficiency

Dry Bulb (F)		Wet Bulb (F)
From	To	Average
100	102	64.4
98	100	64
96	98	62.3
94	96	61.9
92	94	60.9
90	92	60.4
88	90	59.5
86	88	59.1
84	86	58.5
82	84	58.1
80	82	57.5
78	80	56.9
76	78	55.9
74	76	54.8
72	74	54
70	72	53
68	70	52.6
66	68	51.8
64	66	50.5
62	64	49.3

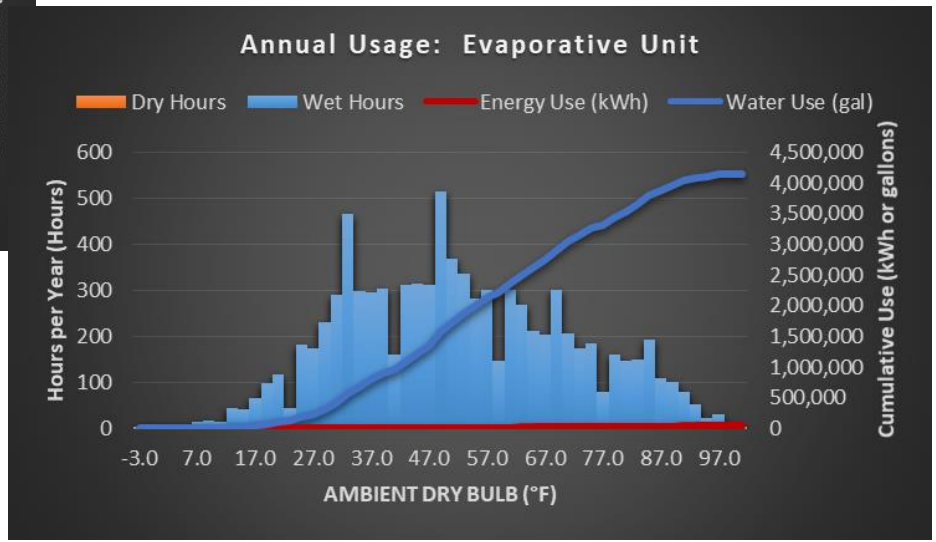
COMPARISON WITH EVAPORATIVE COOLING

Resource Consumption



400 Ton System – Reno, NV
Annual water and energy cost:

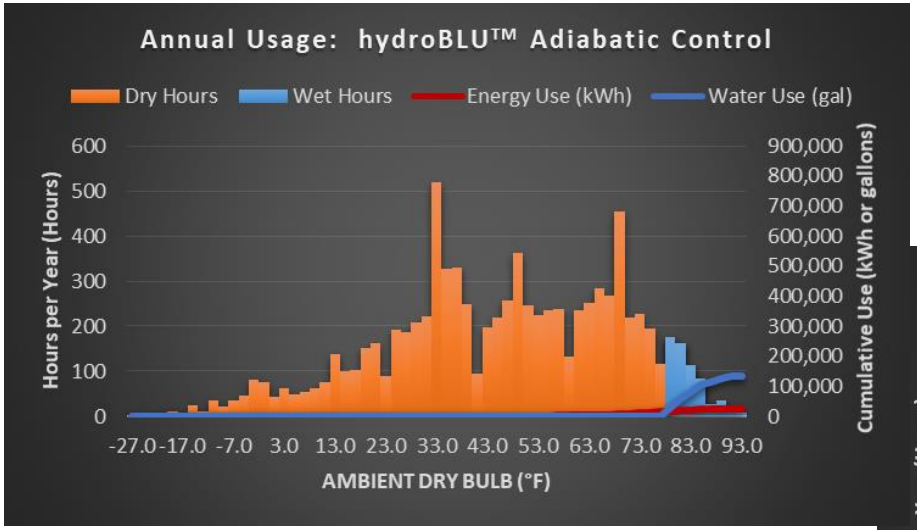
Adiabatic: $12,200
Evaporative: $46,500



Power and Water Rates:

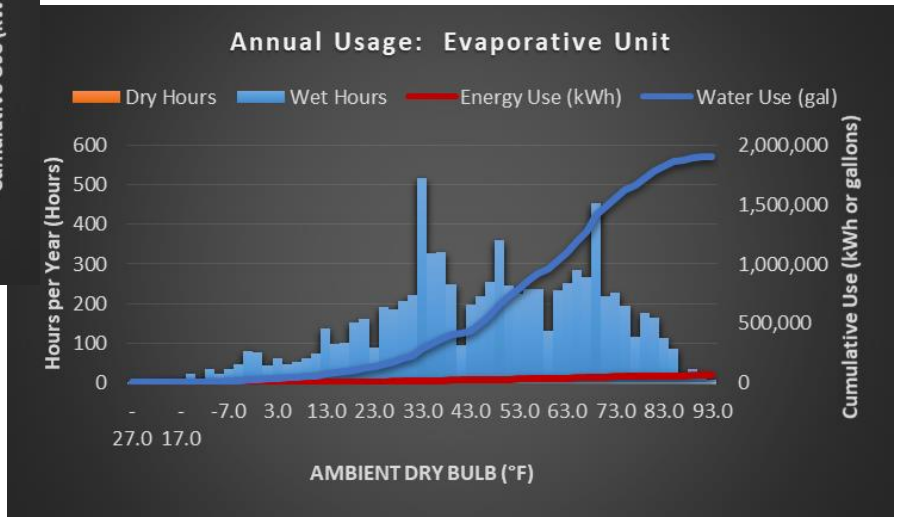
Electricity rate	$0.09	$ / kWh
Demand charge	$9.25	$ / kW / mo.
Water & sewage	$9.47	$ / kgal
Water treatment	$4.00	$ / kgal

COMPARISON WITH EVAPORATIVE COOLING RESOURCE CONSUMPTION



Madison 200 Ton System
Annual water and energy cost:

Adiabatic: $8,665
Evaporative: $29,196



Power and Water Rates:		
Electricity rate	$0.11	$ / kWh
Demand charge	$11.03	$ / kW / mo.
Water & sewage	$9.47	$ / kgal
Water treatment	$4.00	$ / kgal

COMPARISON WITH EVAPORATIVE COOLING

Water Consumption

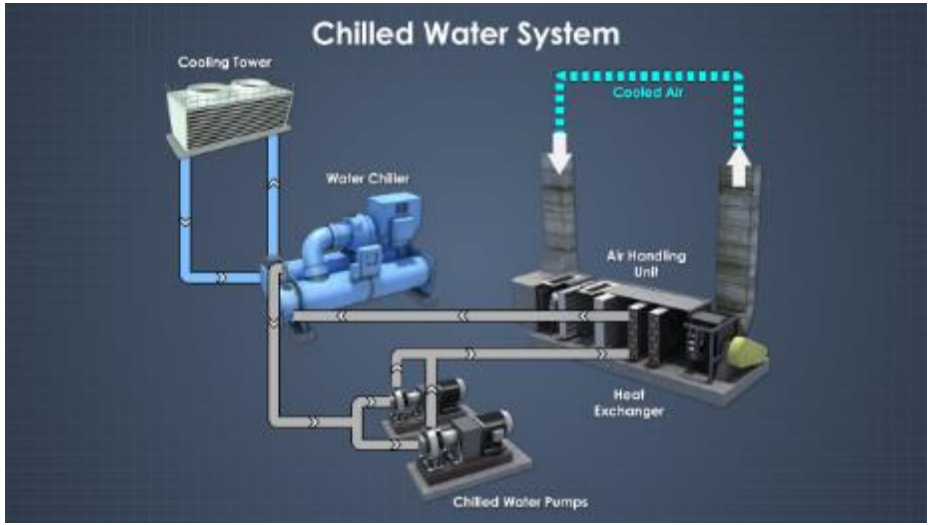
Evap Cooling: 1.9 Million Gallons of Water

Adiabatic Cooling: 0.12 Million Gallons of Water

APPLICATIONS

CHILLED WATER SYSTEM

Water cooled chillers and remote air cooled chillers (condensers) are popular options



APPLICATIONS

FREE COOLING / PROCESS COOLING

Adiabatic dry coolers are an efficient method to free cooling and process cooling.

Reaching 10F of the ambient for a dry cooler is one option. Using adiabatic systems enable the solution to cool at even closer approaches since evaporative cooling uses an approach associated with the wet bulb.

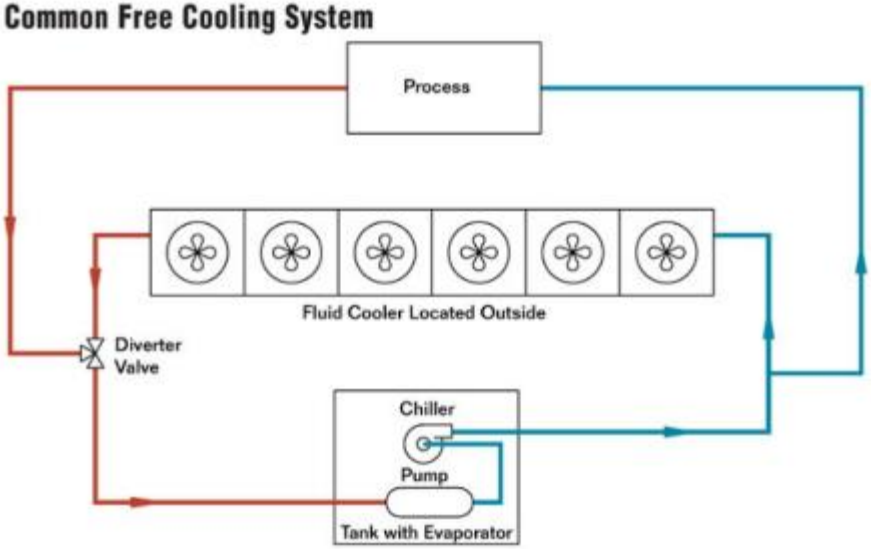
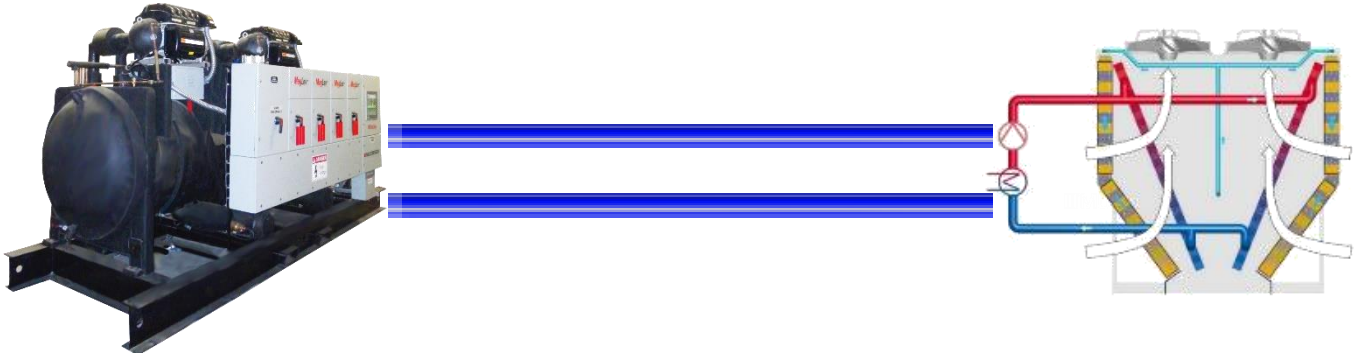


Figure 2. Employing a free cooling process design a facility can save money by reducing utility consumption and saving energy.

APPLICATIONS

SPLIT CHILLERS

Using an adiabatic condenser (direct refrigerant) simplifies system installation and offers excellent system efficiency.



APPLICATIONS

DATA CENTERS

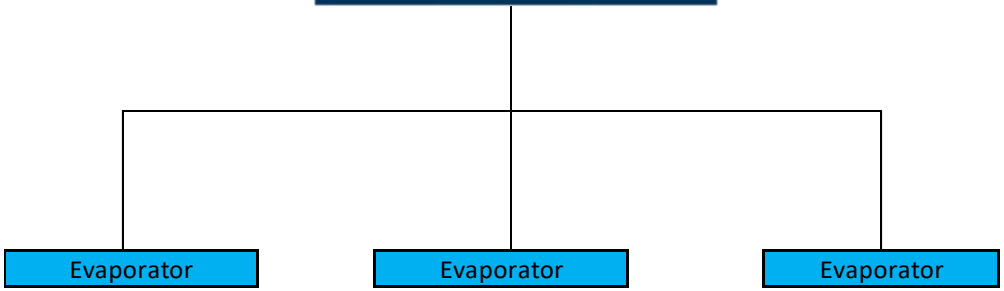
Dry coolers are an excellent back up to traditional data center cooling. In the event the data center loses water, then a dry cooler ensures some cooling performance.

Adiabatic coolers are able to reach server cooling temperatures due the wetting of the adiabatic pads reaching approaches closer to the wet bulb.

APPLICATIONS

VARIABLE REFRIGERANT FLOW

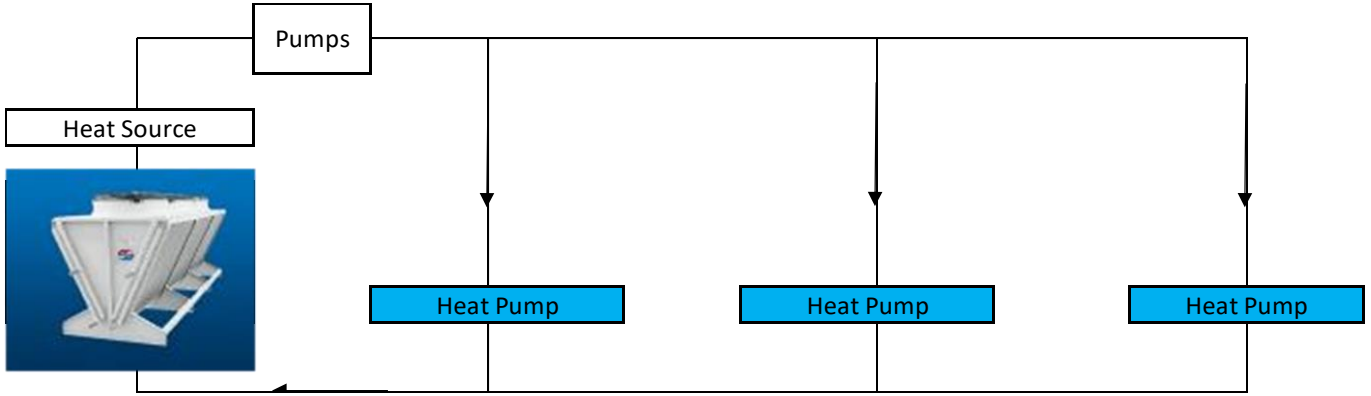
Using adiabatic coolers works well as the heat rejection for a VRF system.



APPLICATIONS

WATER SOURCE HEAT PUMPS

Water source heat pumps are viable applications. Using a source that is dry and/or able to use adiabatic technology is an attractive alternative to traditional cooling towers and other technology.



WHY ADIABATIC COOLING

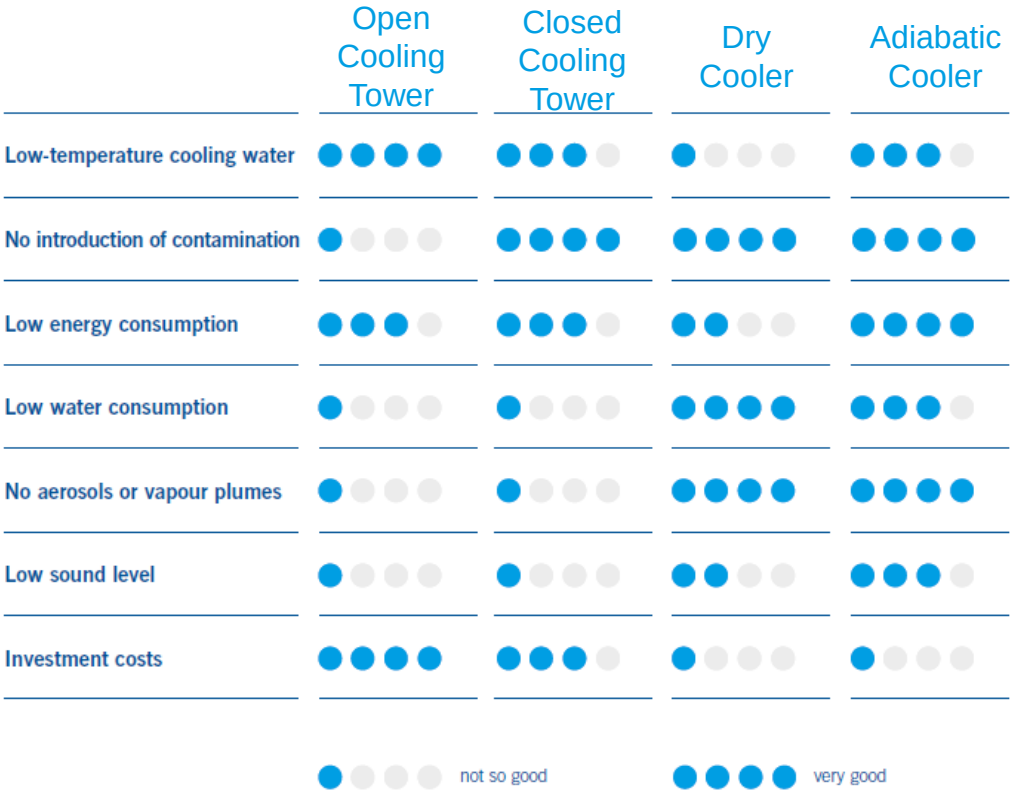
Summary

- Water savings typically 60% to 90% (+) vs evaporative towers/coolers/condensers
- Energy efficiency
- Minimize water usage

- Reliability
- Simple effectiveness of dry cooler
  - → Minimal maintenance
  - → Eliminate water treatment
  - → Minimize winterization concerns
- Mitigate risk of Legionella

WHY ADIABATIC COOLING

Summary



THANK YOU VERY MUCH FOR YOUR ATTENTION

Your contact person:

Alex Schafer
Business Development Manager

Phone: +1 847 230 9728
Mobile: +1 224 407 7289
Email: alex.schafer@guentner.com

Address:

Guntner US LLC
3601 Algonquin Road Suite #925
Rolling Meadows, IL 60008
U.S.A.

Phone: +1 847 781 0900
Fax: +1 847 781 0901
www.guntnerus.com