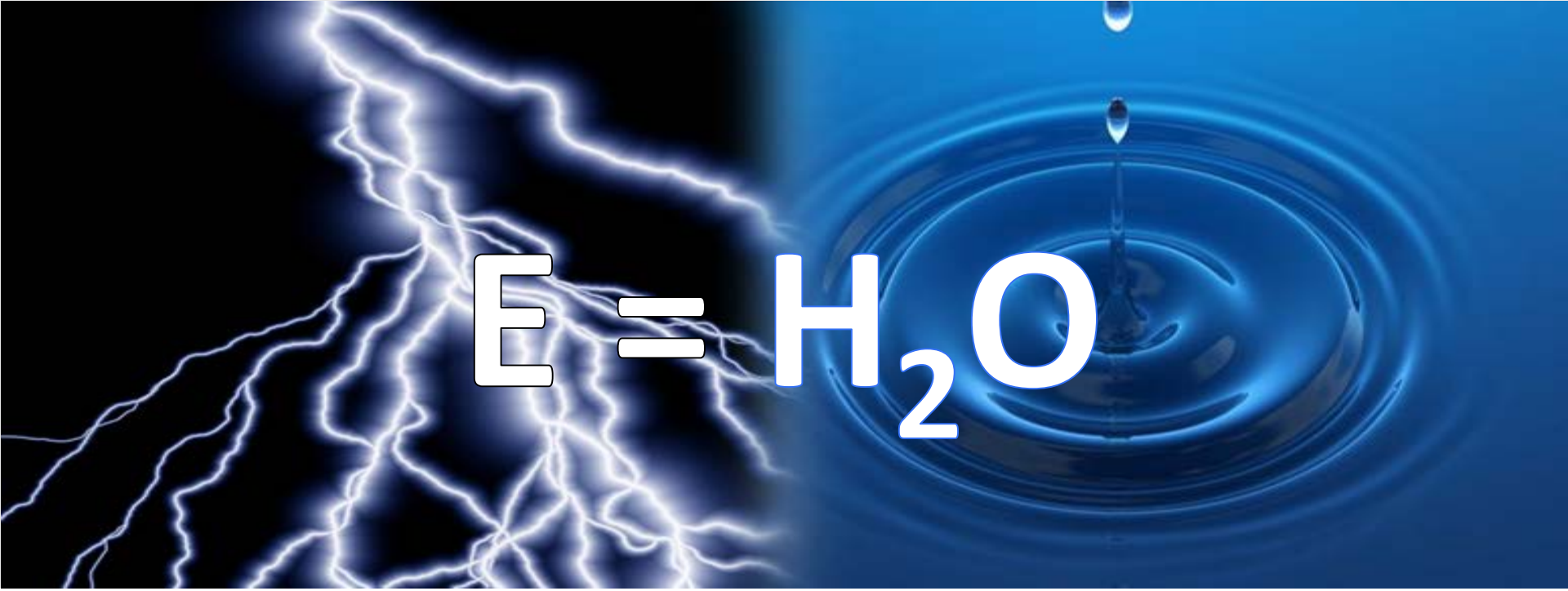

Operating an Efficient District Cooling Plant in Water-Stressed Regions

Part 1: The Energy-Water Nexus

WILL START ON THE HOUR

5:00 pm GST

8:00 am EST

1:00 pm GMT

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Johnson Controls

Welcome

- Webinar Duration: 1 hour 30 minutes

- Panelists: Please mute when not talking and silence /shut-off cell phones.

- Questions to Presenters: Please type in **Questions** in the **Q&A box** at the lower right hand corner of screen. **Questions will be answered after the end of the presentation.** (If you are just dialed in with audio, send questions to jill.h.woltkamp@jci.com)

- Moderator will hand **questions to presenters.** *Responses to unanswered questions will be provided by Jill Woltkamp after the webinar.*

- Webinar (function) questions: Please chat with Cheryl. Use the Chat box in the middle right hand section of the screen and choose - **"Chat privately to Cheryl."**

- Survey: Please complete the survey following the webinar

- Webinar Download: Recording and Presentation slides will be available at **www.districtenergy.org**

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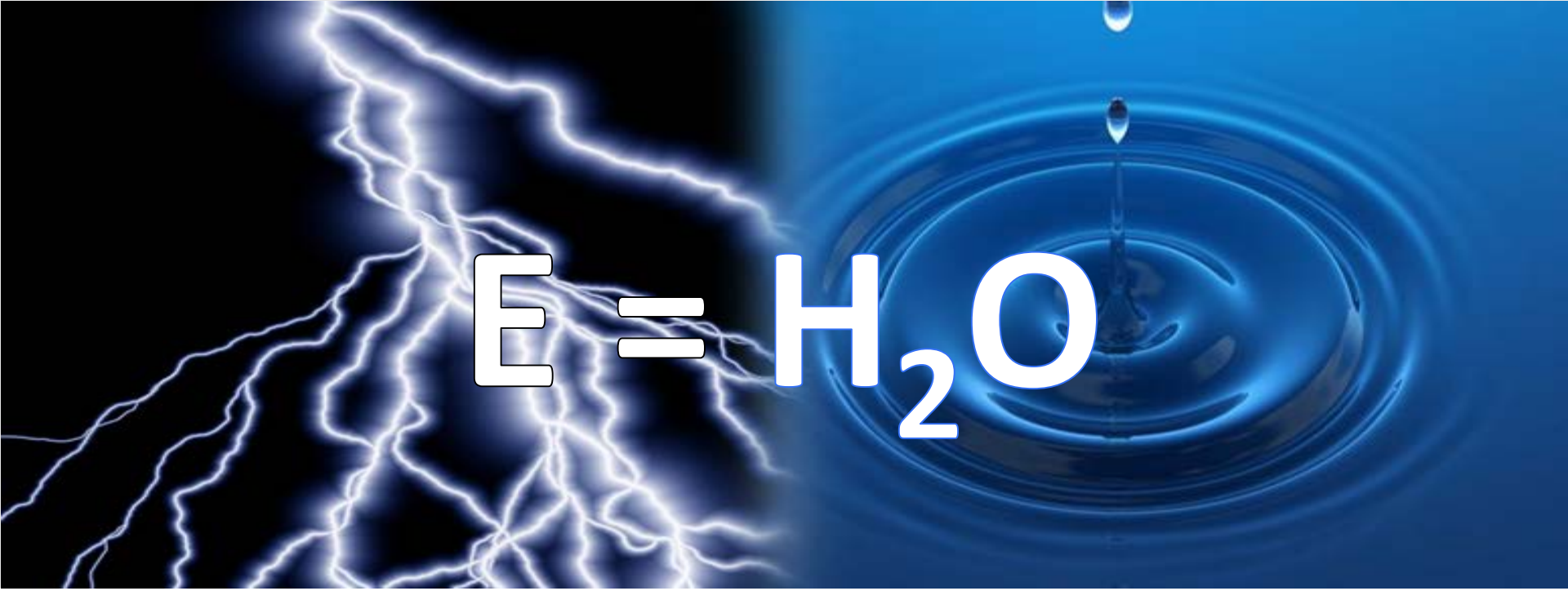


Operating an Efficient District Cooling Plant in Water-Stressed Regions

Part 1: The Energy-Water Nexus

International District Energy Association
November 19, 2014
Roy Hubbard
Johnson Controls, Inc.

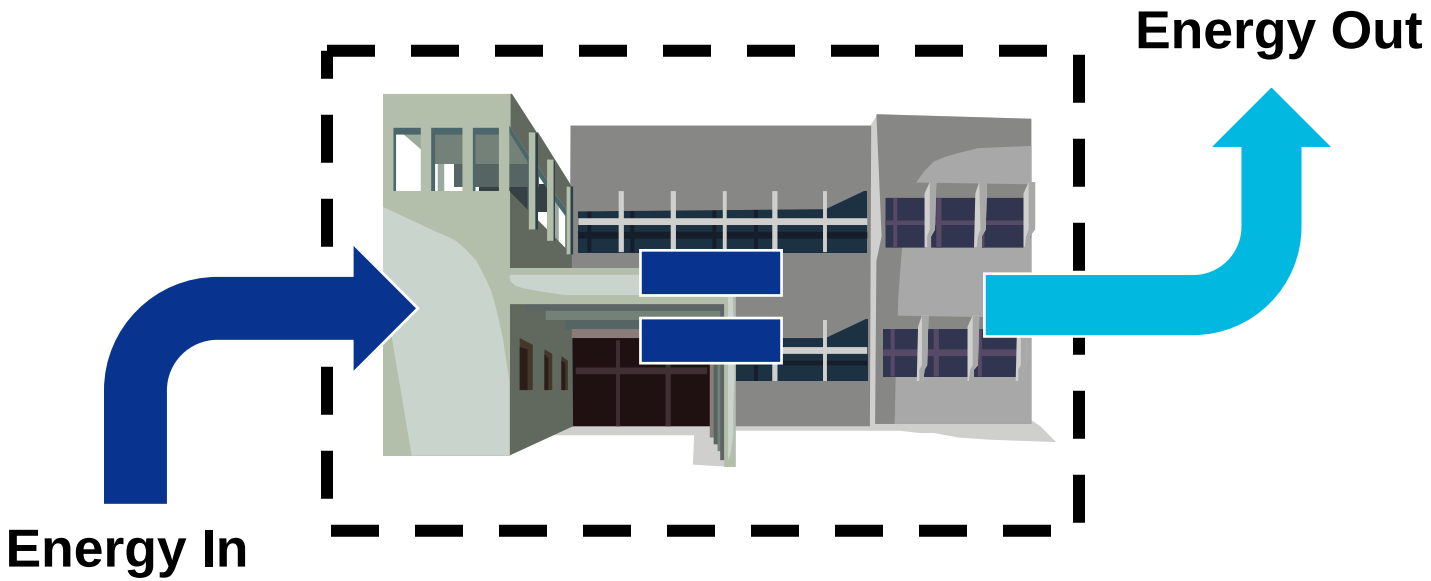
Agenda

- Why do we need air conditioning?
- How does air conditioning work?
- How does water play a role in air conditioning?
- What roles do weather and climate play in air conditioning?
- How can saving energy save water?
- What can we do to save energy?
- What are the two main choices in air conditioning heat rejection systems?

Definition: Energy Balance

Thermodynamics Law #1

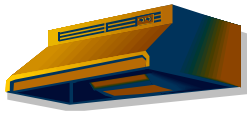
The flow of heat is a form of energy transfer



Definition: Sources of Energy in a Building

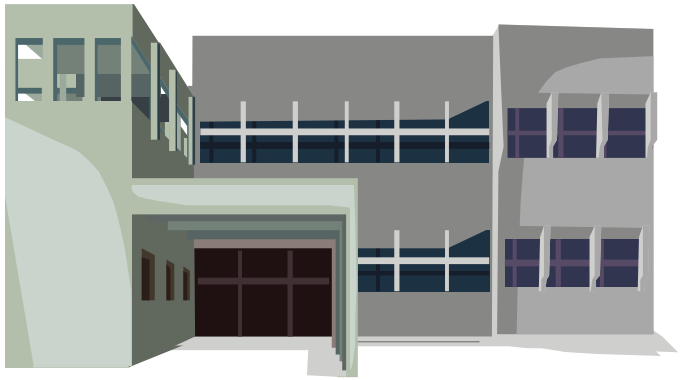
PEOPLE

SOLAR HEAT GAIN

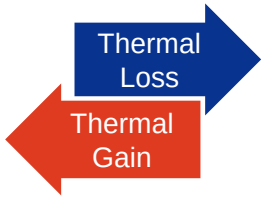


VENTILATION

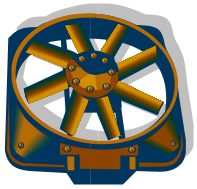
EQUIPMENT / PLUG LOAD



HVAC EQUIPMENT



BUILDING ENVELOPE



INFILTRATION / EXFILTRATION

LIGHTING

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

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Definition: Sources of Energy in a Building

PE

LATION

EQUIPMI
PLUG L

UIPMENT

Air conditioning allows buildings to be habitable

BUILDING ENVELOPE

INFILTRATION /
EXFILTRATION

LIGHTING

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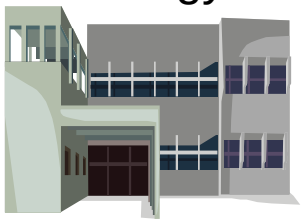
KEY CONCEPT

The purpose of Air Conditioning is to move unwanted heat from one area (building) to a location less objectionable (outside)

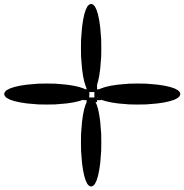
How Air Conditioning Systems Move Energy / Heat

AIR-COOLED

Building Energy



Air Handler Fan



Air Handler Coil

Air-Cooled Chiller

Atmosphere

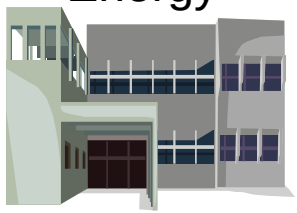
= air transfer

= water transfer

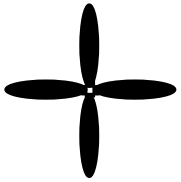
= refrigerant transfer

WATER-COOLED

Building Energy



Air Handler Fan



Air Handler Coil

Water-Cooled Chiller

Cooling Tower

Atmosphere

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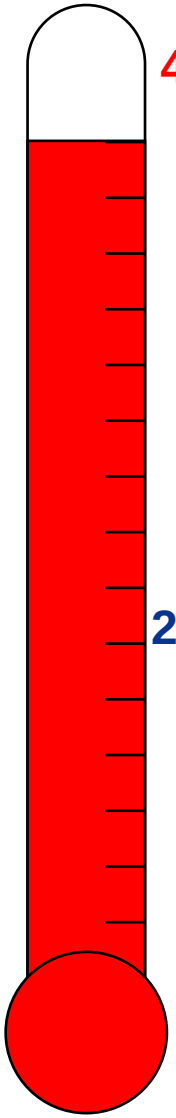
Definition: Dry Bulb and Wet Bulb



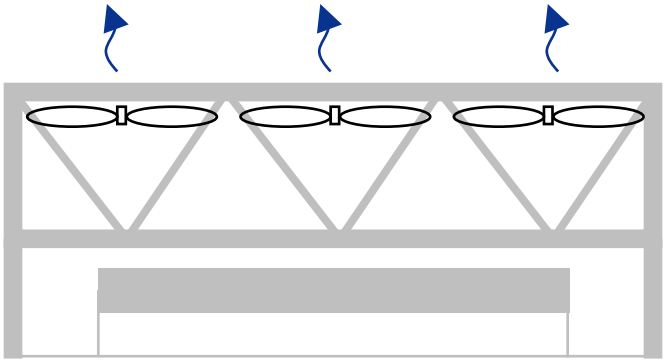
DRY BULB (DB)

- Temperature of air measured by a thermometer
- Exposed to the air but shielded from radiation and moisture

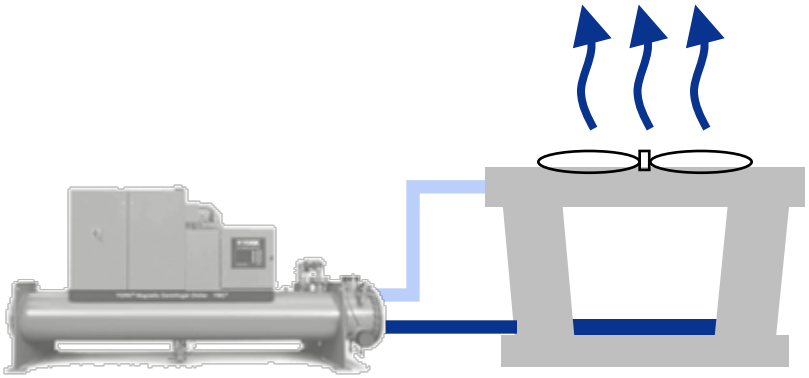
WET BULB (WB)

- Minimum temperature achieved by ***evaporative cooling***
- Largely determined by the DRY BULB temperature and HUMIDITY (moisture)

Air-Cooled System



Water-Cooled System



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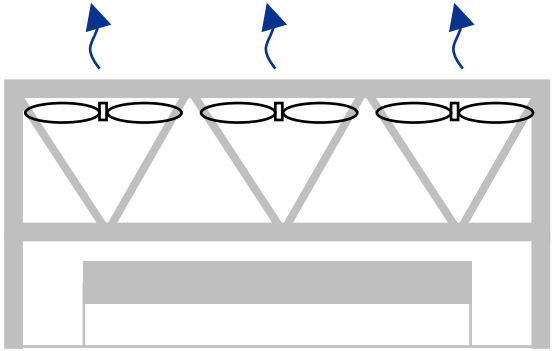
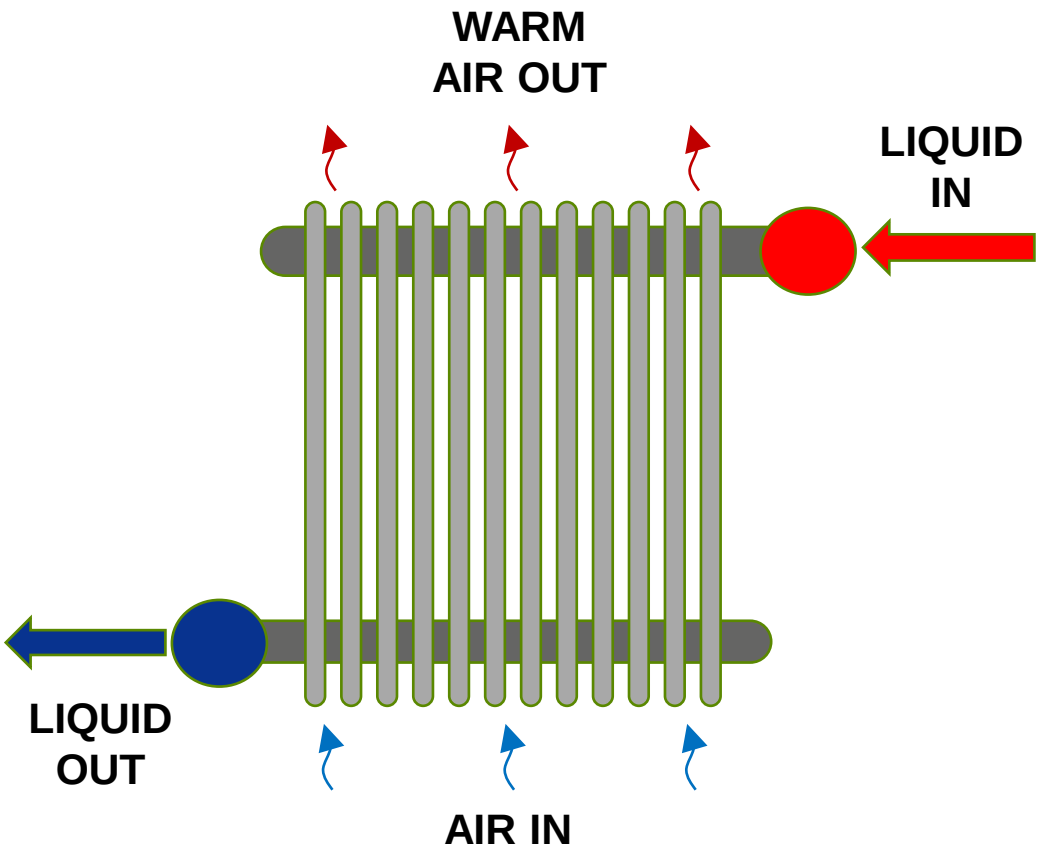
Definition: Air-Cooled Heat Rejection

Air-Cooled System



Air-Cooled Radiator



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Definition: Evaporative Cooling

Heat Energy
+
Water Vapor Molecules

When ***EVAPORATION*** occurs, heat is removed from an object that is being cooled.

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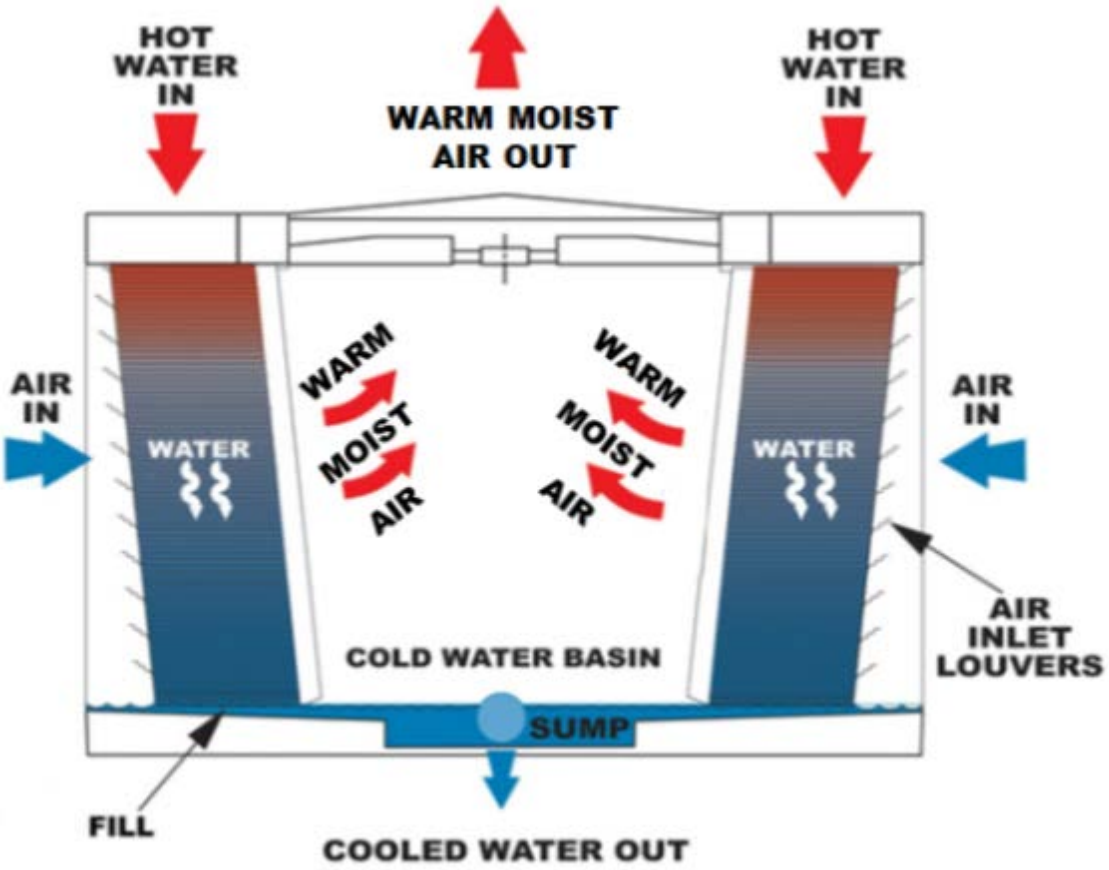
Definition: Water-Cooled Heat Rejection

Body Evaporation

Heat energy
+
water vapor molecules

Evaporative Cooling Tower



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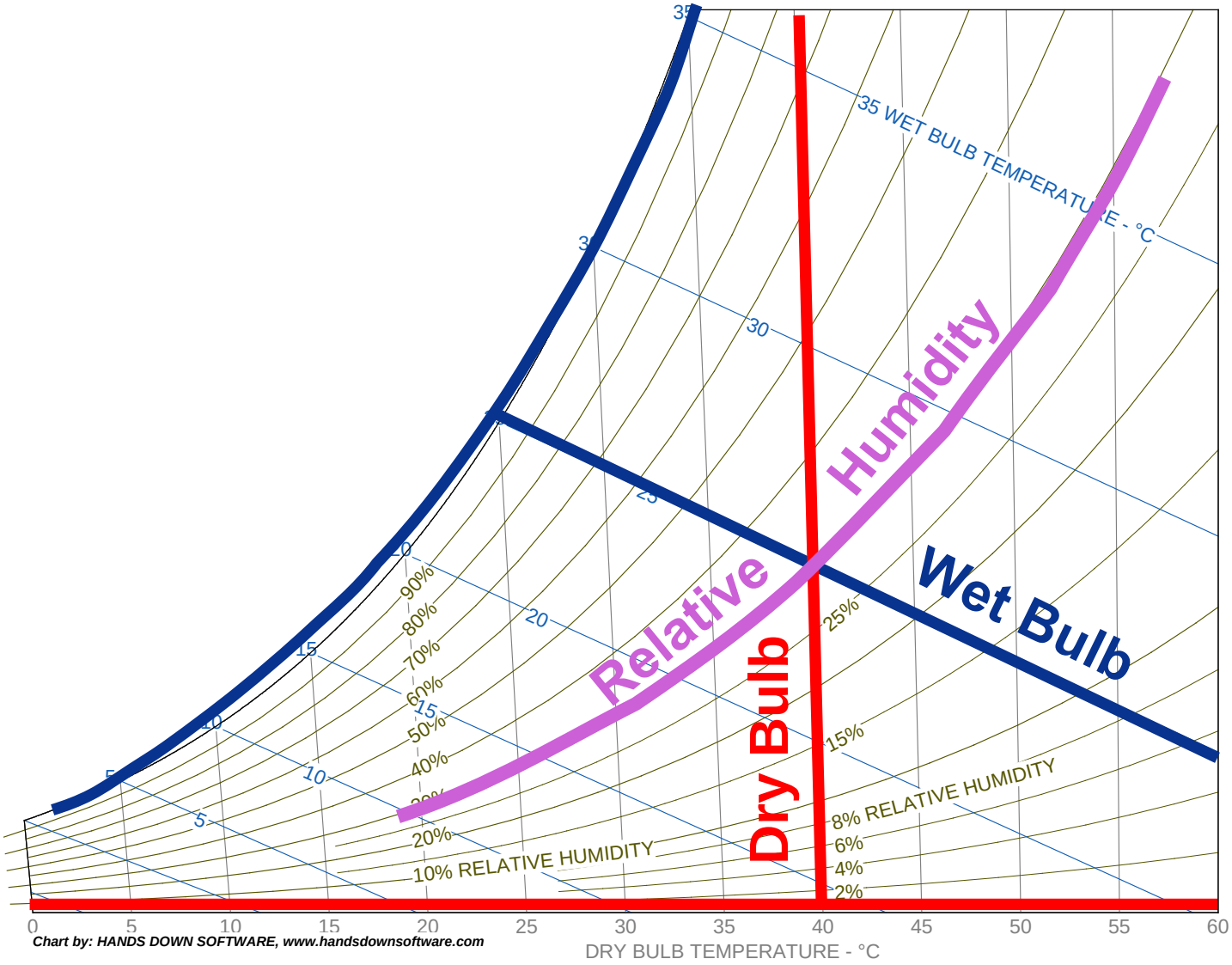
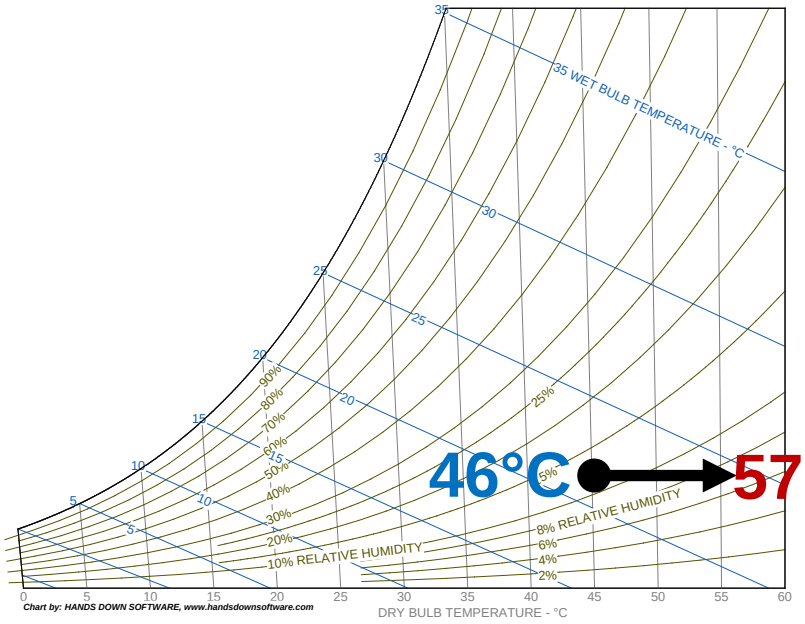
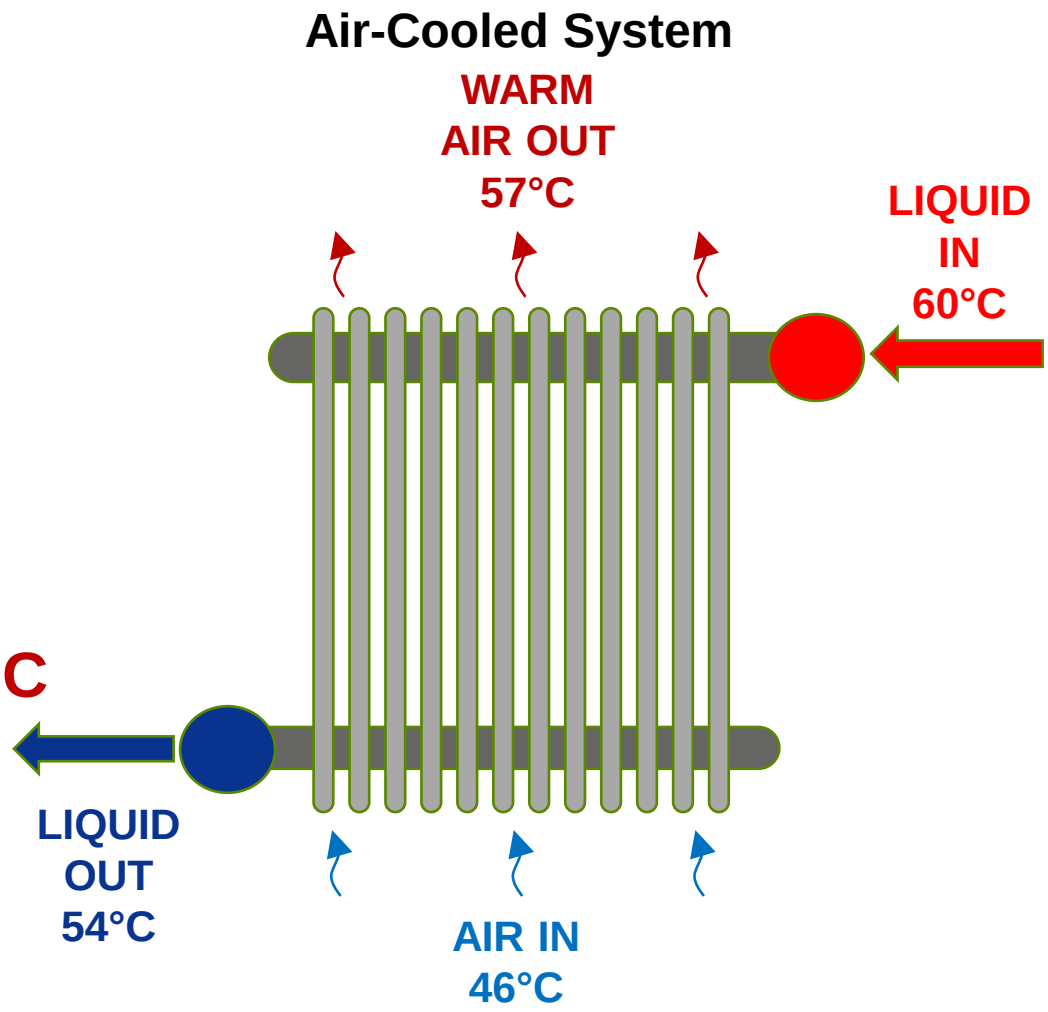
Definition: Psychrometric Chart

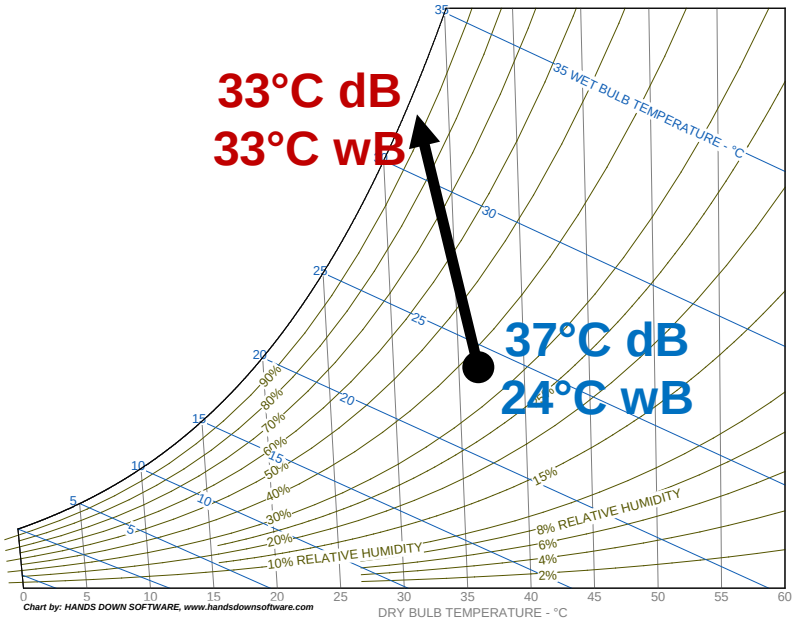


Psychrometric Chart for Air-Cooled Systems

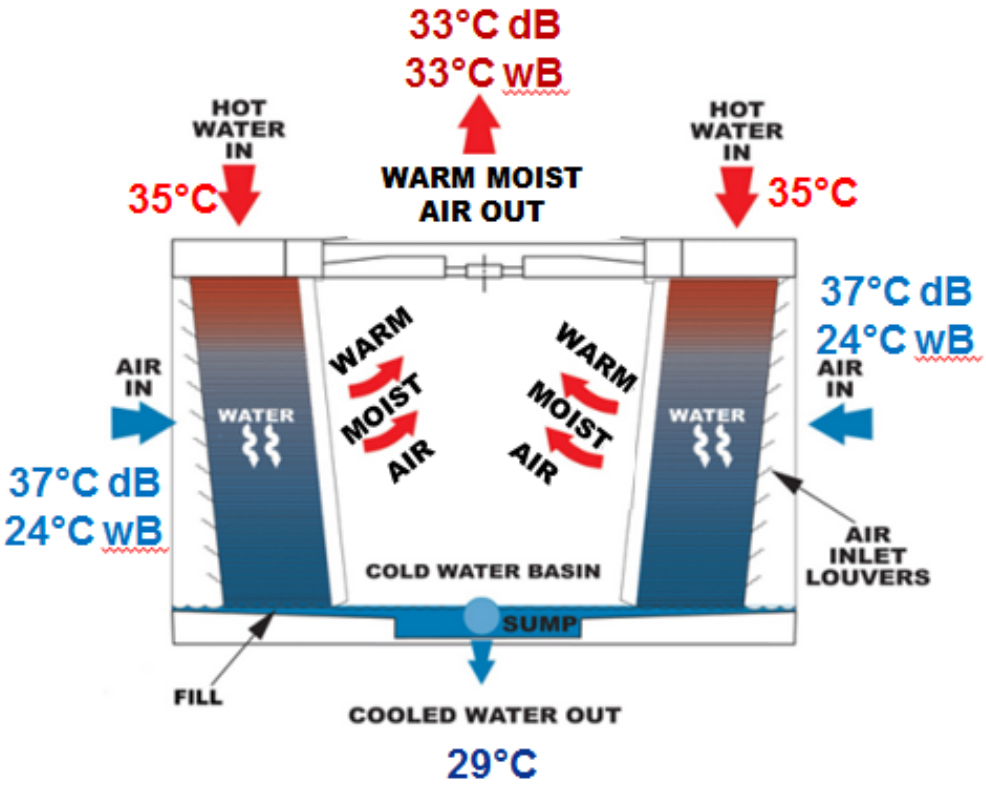




Psychrometric Chart for Water-Cooled Systems



Water-Cooled System



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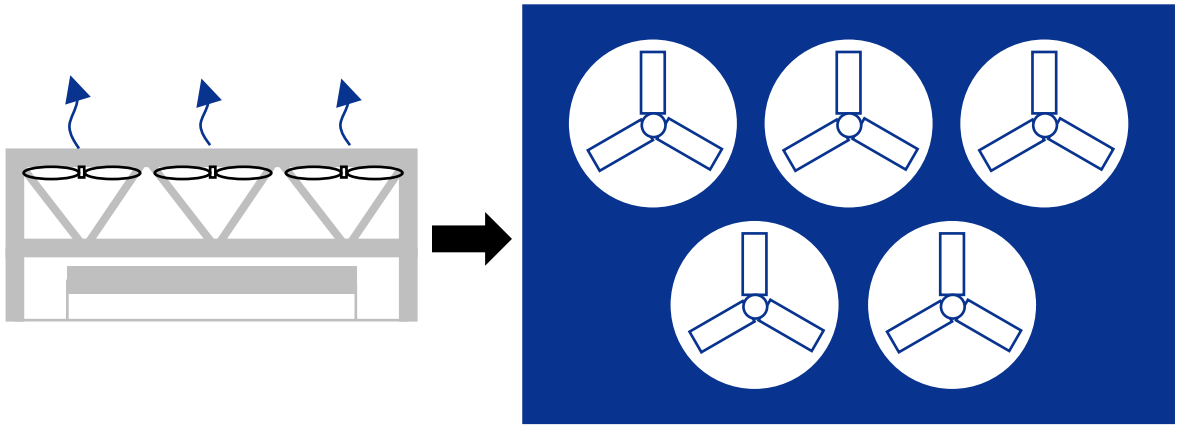
Air-Cooled vs. Water-Cooled Heat Rejection

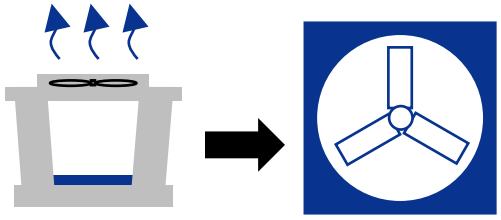
Air-Cooled System

- Design day is based on **DRY BULB** temperature
- Consumes no water (no evaporative cooling)
- Large footprint



Water-Cooled System

- Design day is based on **WET BULB** temperature
- Consumes water (evaporative cooling process uses water)
- **80% LESS AIR FLOW**



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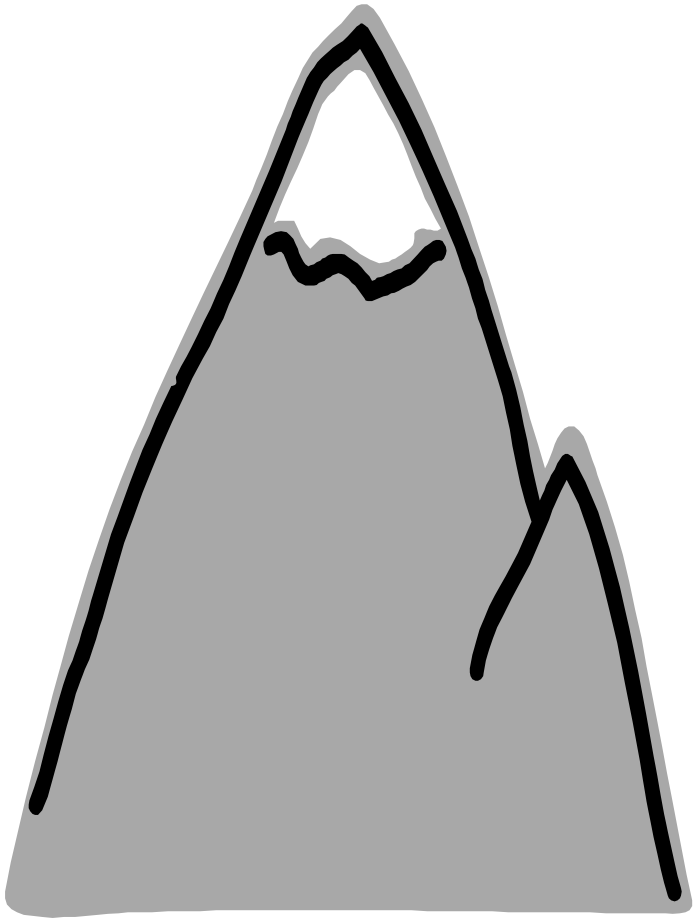
KEY CONCEPT

Evaporative cooling enables water-cooled systems to use less energy at the cost of water consumption.

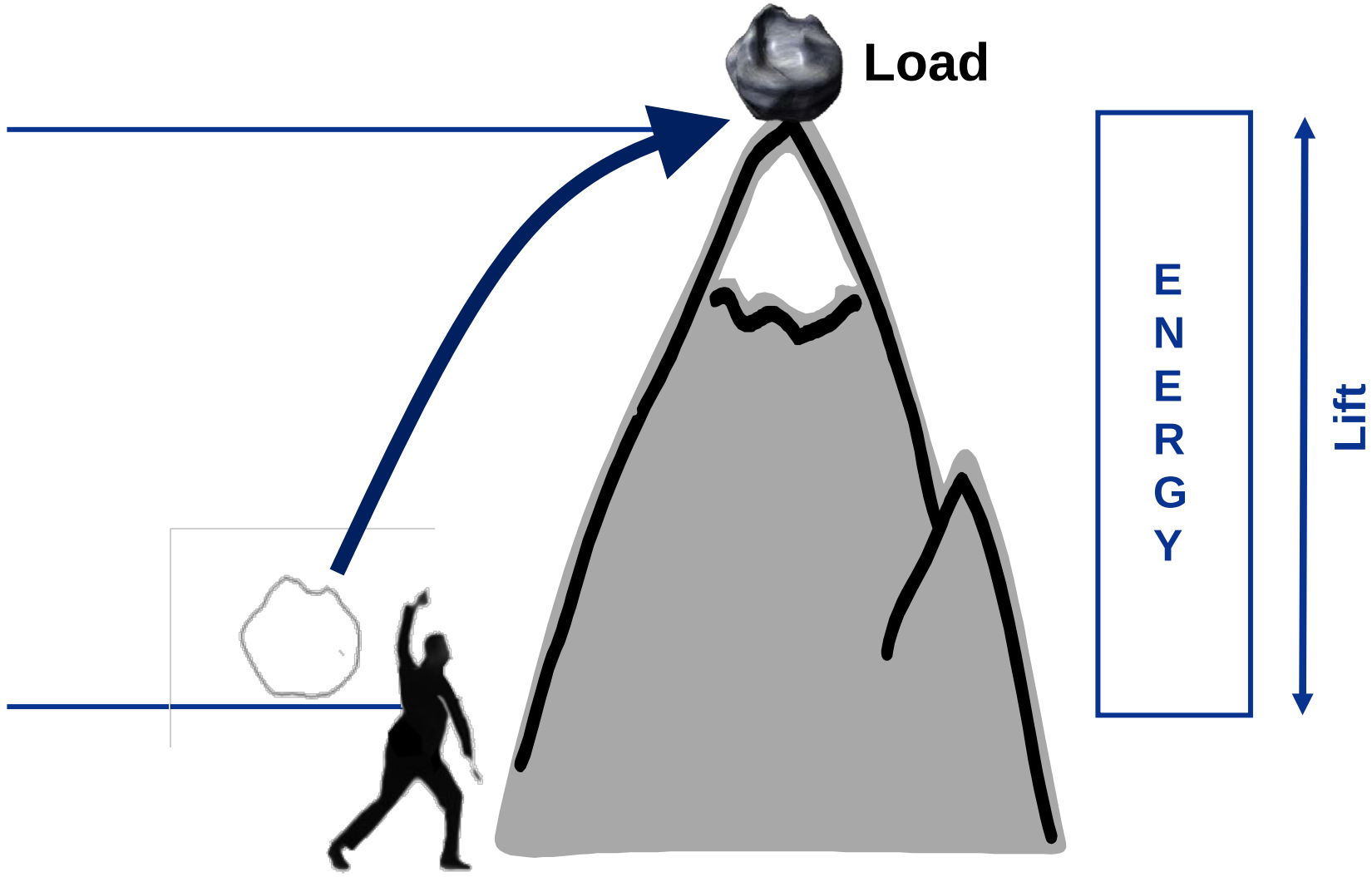
Definition: Energy Use and System Lift

Load
(weight of the rock)

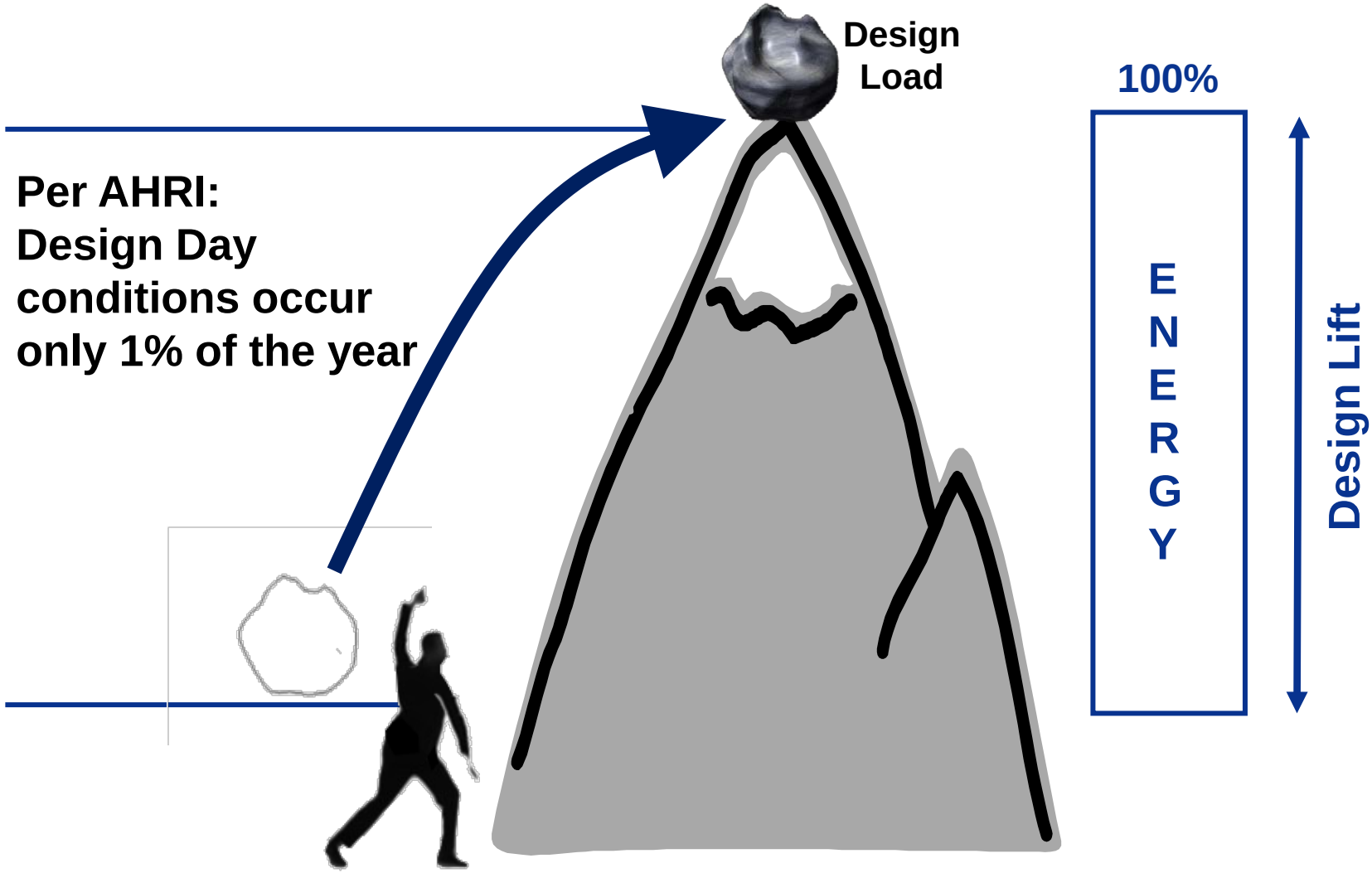


Lift
(height of the mountain)

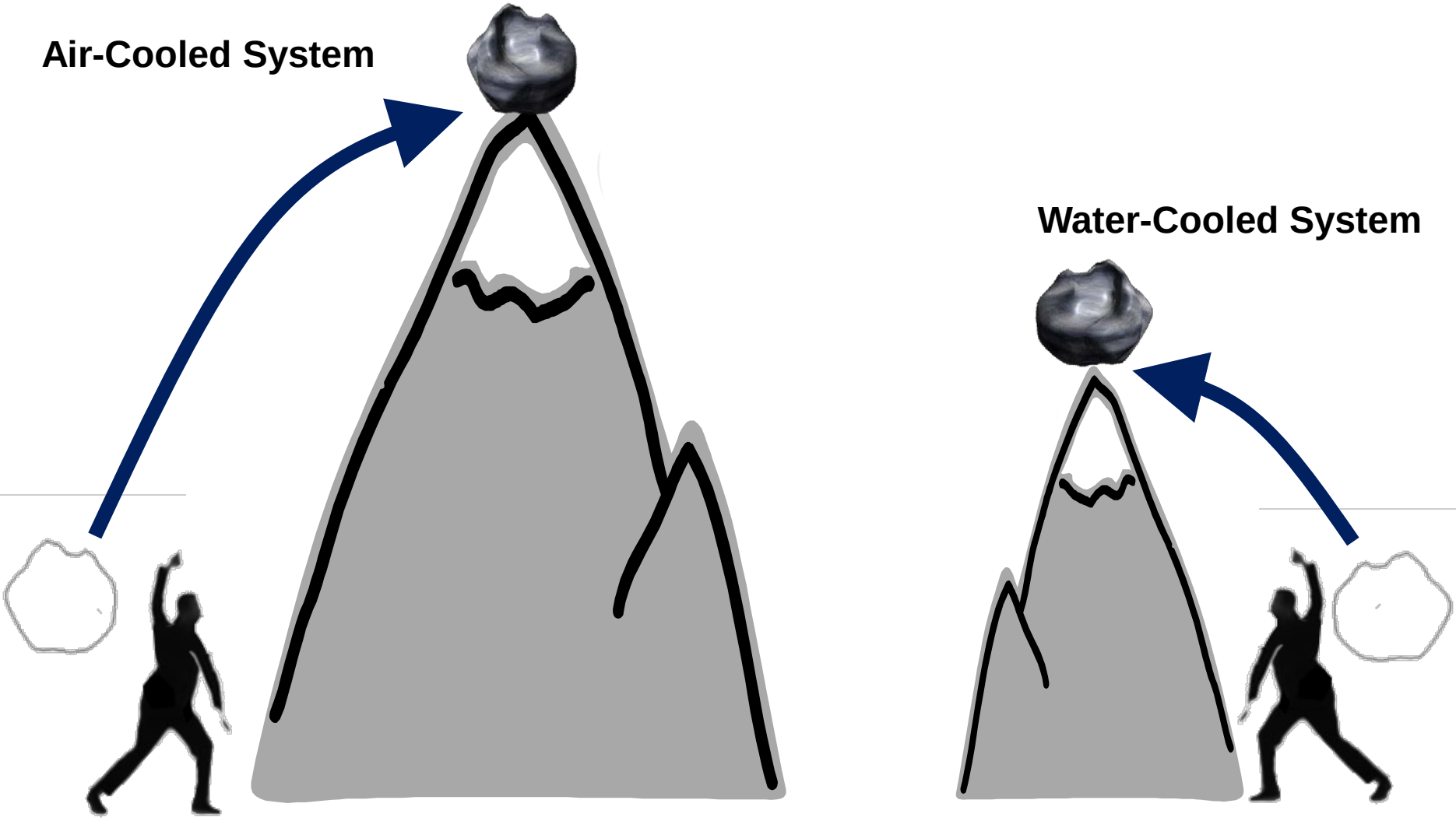
Definition: Energy Use and System Lift



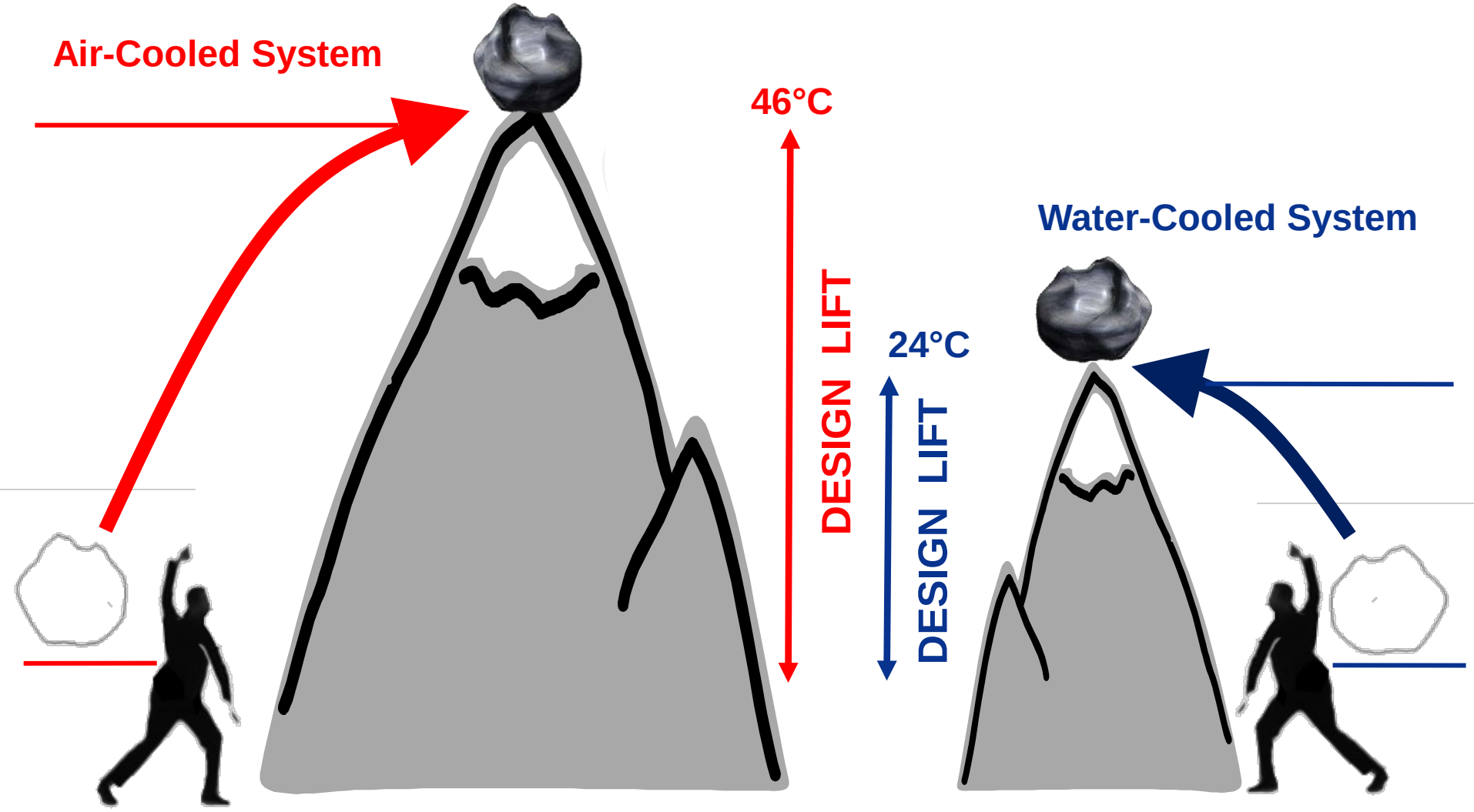
Energy Use and System Lift - DESIGN DAY



Energy Use and System Lift - DESIGN DAY



Energy Use and System Lift - DESIGN DAY



KEY CONCEPT

There are multiple ways to save energy in a chiller plant that are weather related:

1. Reduce the size of the load

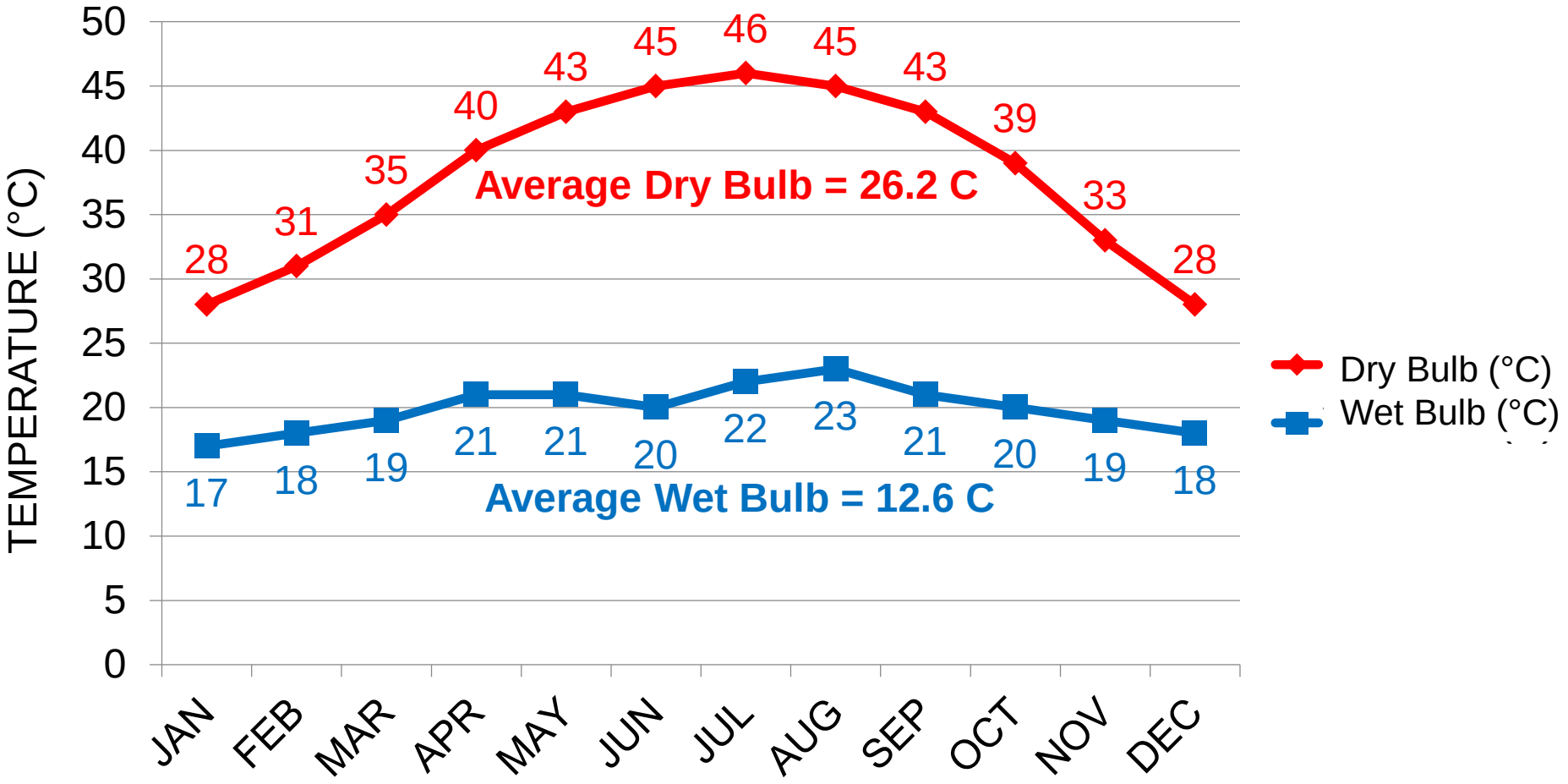
(weight of the rock)

2. Reduce the system lift

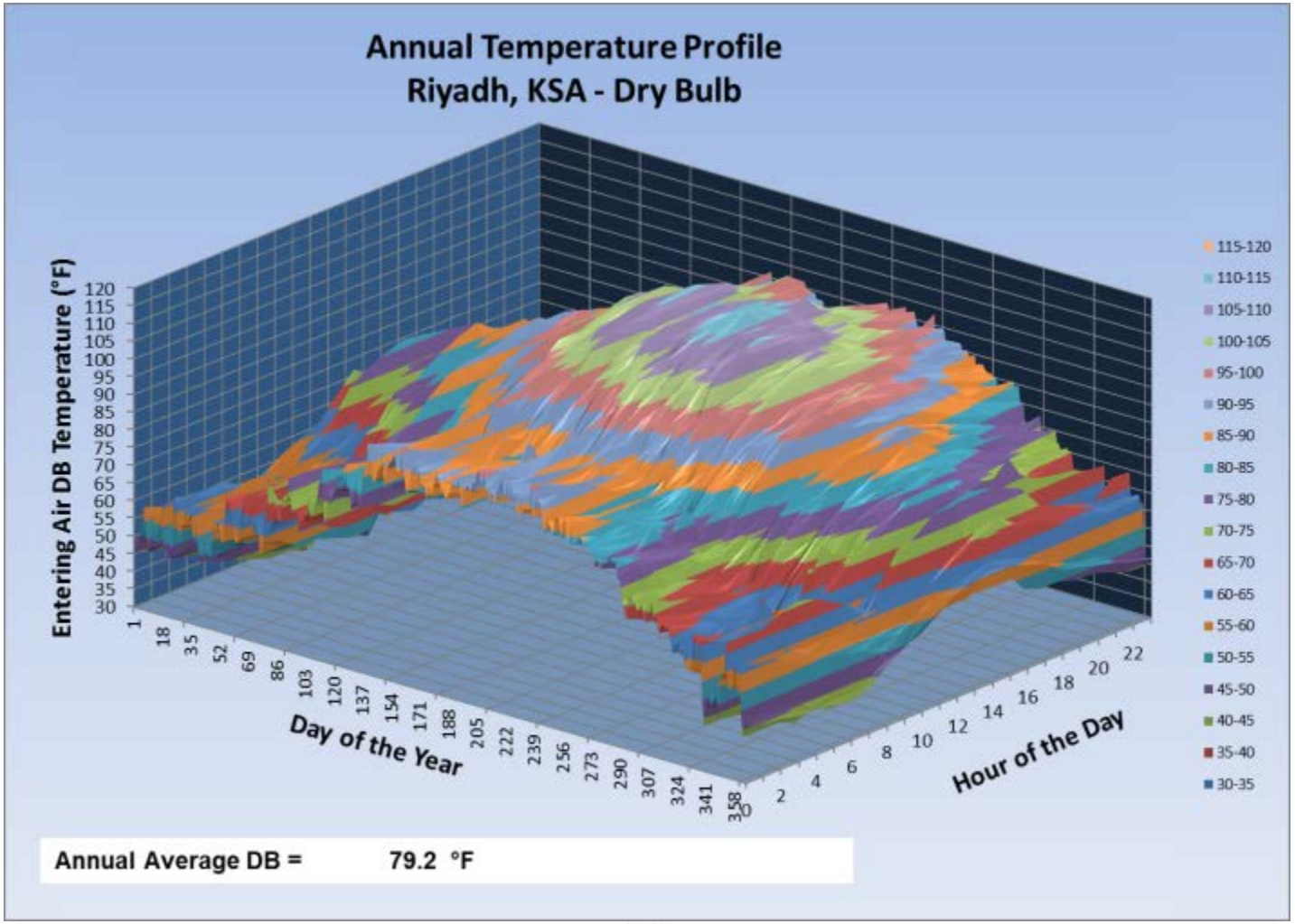
(height of the mountain)

Weather Data - Riyadh, KSA

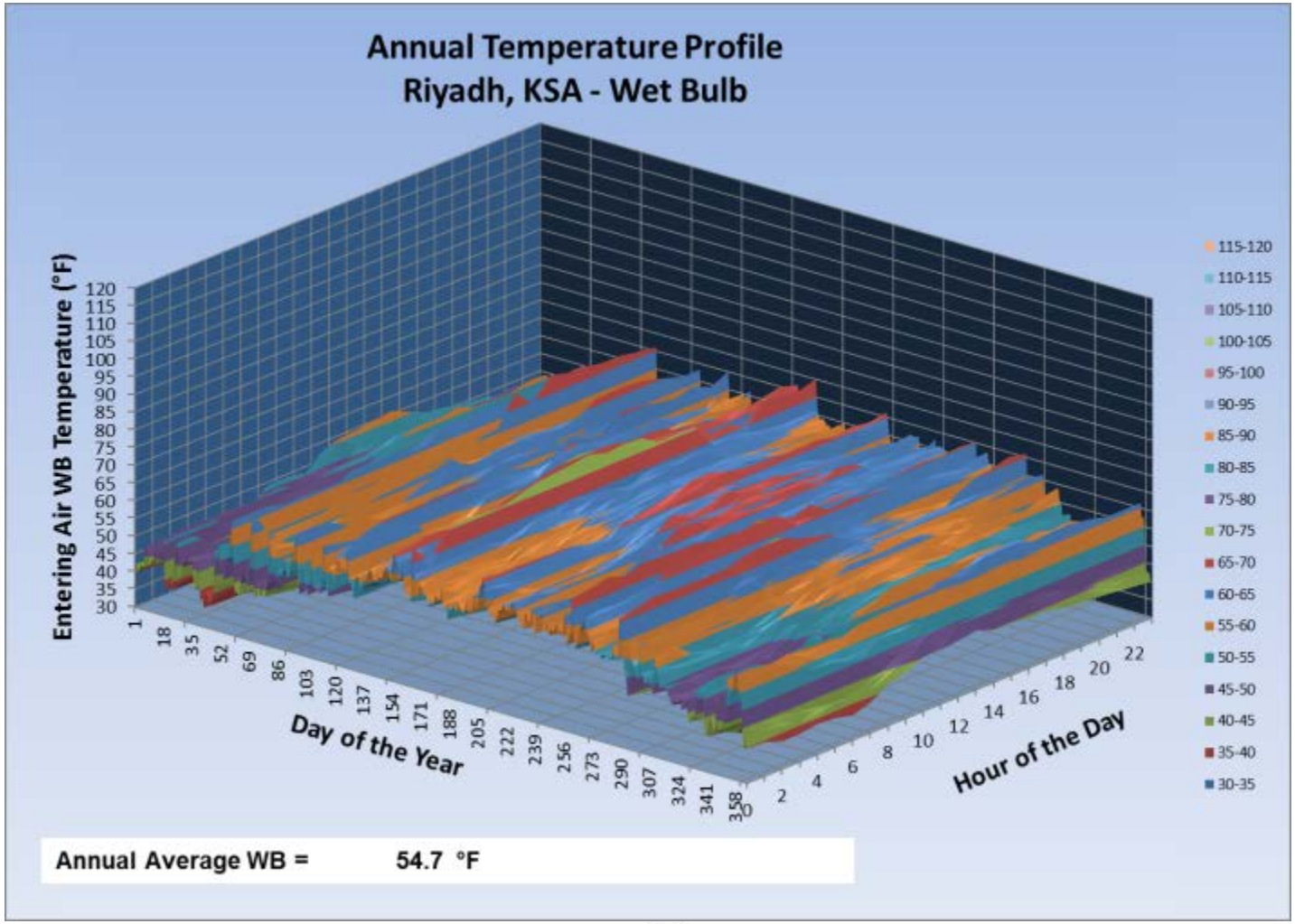
Weather Data - Riyadh, KSA



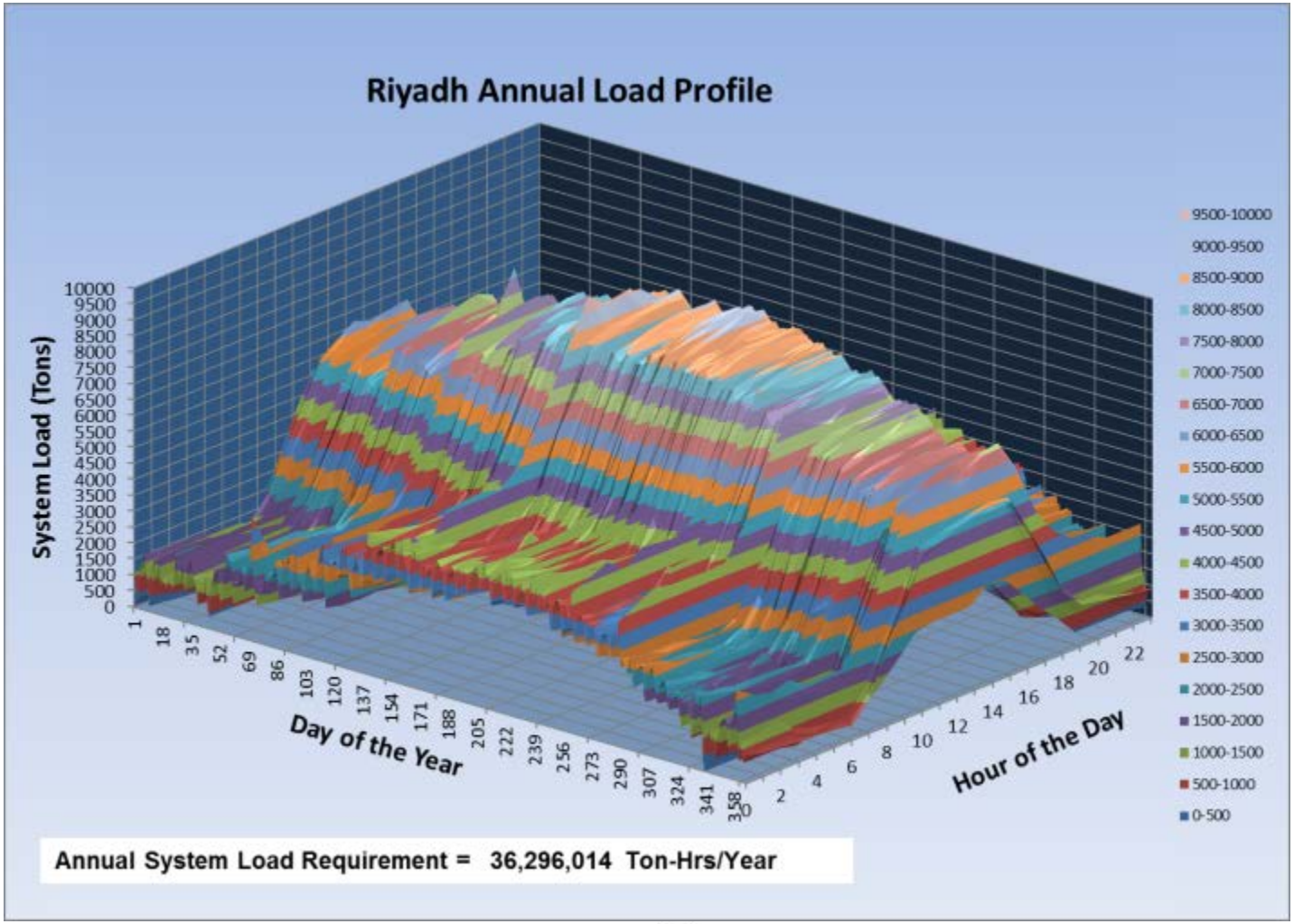
Weather Data - Riyadh, KSA - Dry Bulb Variation by Hour



Weather Data - Riyadh, KSA - Wet Bulb Variation by Hour



Weather Data - Riyadh, KSA - Annual Load Profile



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KEY CONCEPTS

- Air Conditioning moves Energy / Heat.

- Air Conditioning rejects heat through air-cooled or water-cooled systems.

- Weather and seasons impact energy use in these systems.

THE ENERGY WATER NEXUS

SAVING ENERGY
REDUCES
WATER CONSUMPTION

Definition: THE ENERGY WATER NEXUS

ENERGY FOR WATER

Water processing, production, distribution, and end use requires energy

Energy and Water are Linked

WATER FOR ENERGY

Energy and power production requires water.

Water-cooled district cooling plants also require water

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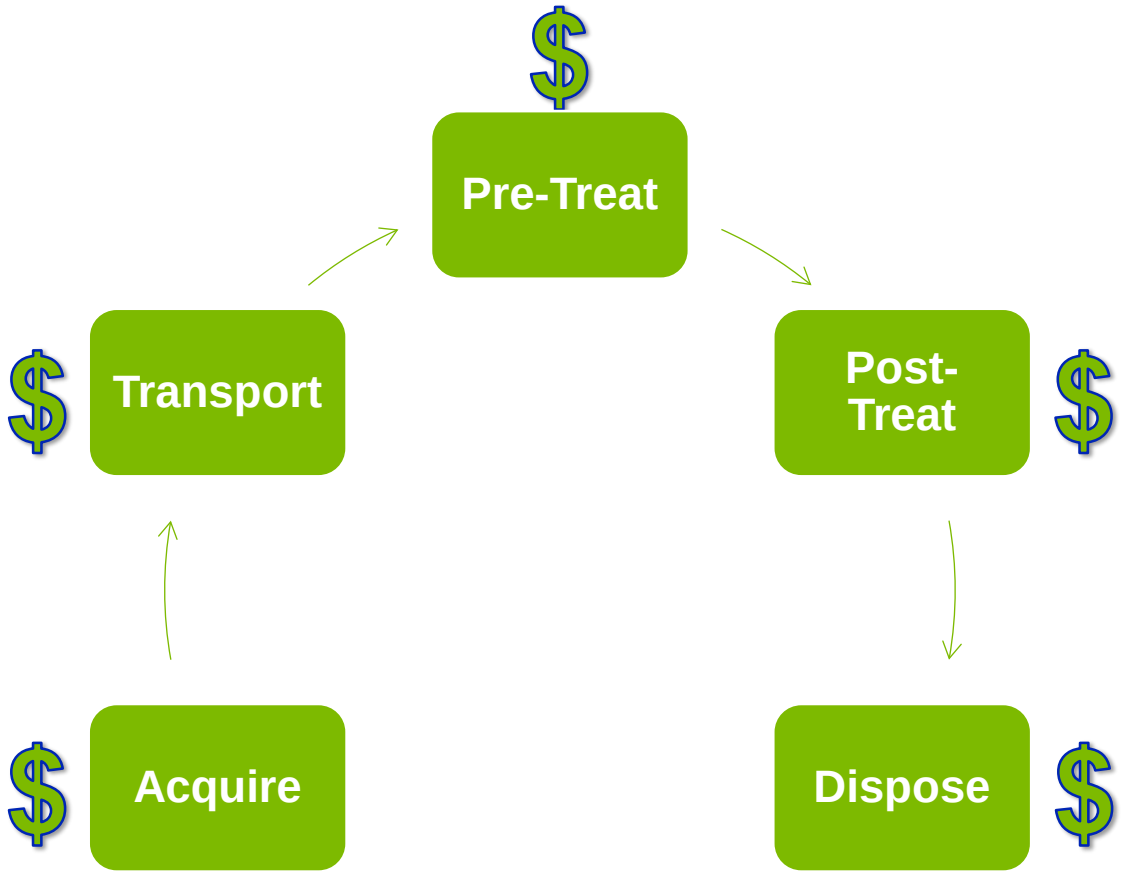
THE ENERGY WATER NEXUS – Water Cost

COMPONENTS OF WATER COST



THE ENERGY WATER NEXUS – Water Cost

WATER COST IS INCREASING

- Population Growth
- Rising Standards of living – more water intensive
- Environmental pressures
- Infrastructure Costs
- Climate Change

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THE ENERGY WATER NEXUS – Ways to Save Energy

SAVING ENERGY = SAVING WATER = SAVING MONEY

Avoidance

- Insulation
- Low-E Glass
- Lighting

Conserve

- Night setback
- Isolate leaks
- Lighting
- CHW Reset

Design

- District Energy
- Highly Efficient and variable speed components, products and systems

Optimize

- Central Plant and System Optimization

Maintain

- Scheduled Service
- Measurement and Verification plan

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THE ENERGY WATER NEXUS – Ways to Save Water

SAVING ENERGY = SAVING WATER = SAVING MONEY

SAVE WATER : Reduce blow-down in the cooling tower
Use well water, river water, sea water, effluent water

SAVE WATER : Use “waste heat” in a heat pump application

SAVE WATER : Collect and re-use cooling coil condensate

SAVE WATER : Use non-evaporative air-cooled heat rejection systems

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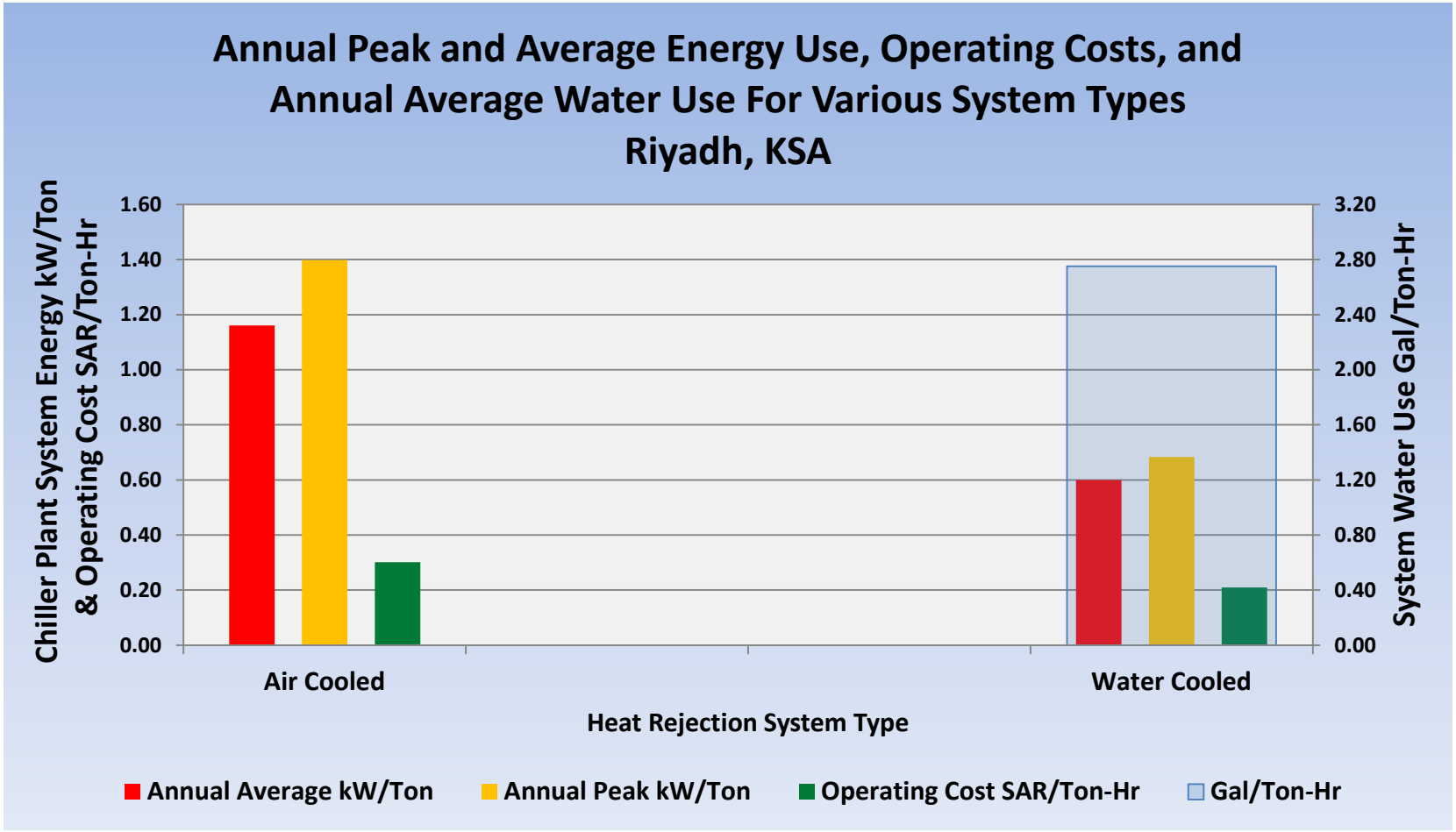
Riyadh, KSA

Air-Cooled System vs Water-Cooled System - Riyadh, KSA



Assumptions

- Energy Evaluated at SAR 0.26/kWh
- Water Evaluated at SAR 4.00/m^3

Air-Cooled & Water-Cooled System Advantages

A-C RADIATOR SYSTEMS

- No water consumption/ reduced chemical consumption
- Simplistic closed loop design
- Lowest maintenance
- Often Standard tubes and tube sheets

WATER-COOLED SYSTEMS

- Lowest kW/ton
- Smaller footprint
- More supplier options
- Lower first cost

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Summary

- Why do we need air conditioning?

Allows building to be habitable.

- How does air conditioning work?

Move unwanted heat from one area (building) to a location less objectionable.

- How does water play a role in air conditioning?

Evaporation of water allows for energy and cost efficient heat rejection to the atmosphere.

- What roles do weather and climate play in air conditioning?

Weather impacts both load and lift and thus energy consumption.

Summary Continued

- How can saving energy save water?

Less energy equals less heat of rejection to the cooling tower.

- What can we do to save energy?

Avoidance > Conserve > Design > Optimize > Maintain

- What are the two main choices in air conditioning heat rejection systems?

Air-cooled systems and water-cooled systems

- What is the Energy-Water Nexus?

Energy Saves Water and Water saves energy! They are intrinsically linked…

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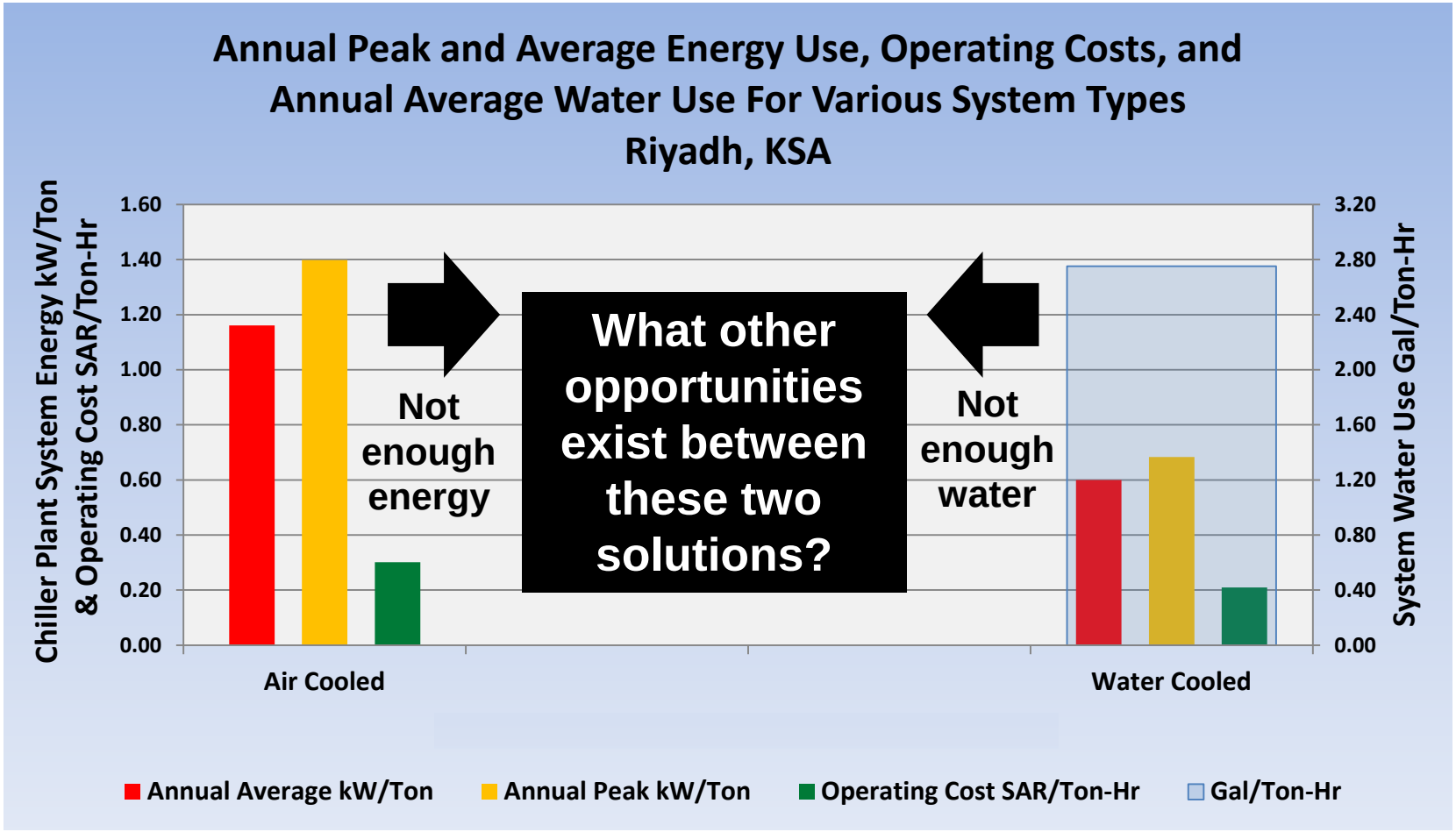
Air-Cooled System vs Water-Cooled System - Riyadh, KSA



Assumptions

- Energy Evaluated at SAR 0.26/kWh
- Water Evaluated at SAR 4.00/m^3

Next Session....Wednesday December 3, 2014

Questions and Answers

- Please type in Q&A box lower right hand corner.

- Moderator will handle questions to presenter.

- Please complete the survey following the webinar

- Webinar will be recorded and available via download or streaming. Presentation slides will be available in pdf format at www.districtenergy.org

- If you are listening to the webinar recording and have questions, send them to jill.h.woltkamp@jci.com

- Register for the second webinar, held at the same time, Wednesday, December 3, 2014.

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Continue the Discussion