





# **Water Conserving Cooling Status and Needs**

**Energy-Water Needs  
Western Region Workshop  
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# We're here to talk about....

- ✓ **Water-Energy trade-offs**
  - **A big, multi-faceted problem**
- ✓ **More people/more water/more energy**
- ✓ **My intent**
  - **Take a narrow slice and simplify it**
- ✓ **Use less water to generate electricity**

# Why is this easy?

- ✓ We know where the water gets used
  - Cooling: condense steam from the turbines
- ✓ We know how we do it now
  - Usually wet cooling towers
- ✓ We have technologies that use less water
  - Commercially available, proven technologies
  - Can reduce plant water use by 80 to 90+%

# So what's the problem?

- ✓ It almost always costs more
- ✓ How much more depends on
  - Type of plant
  - Climate at plant site
  - Cost of fuel
  - Price for electricity (especially at peak times)

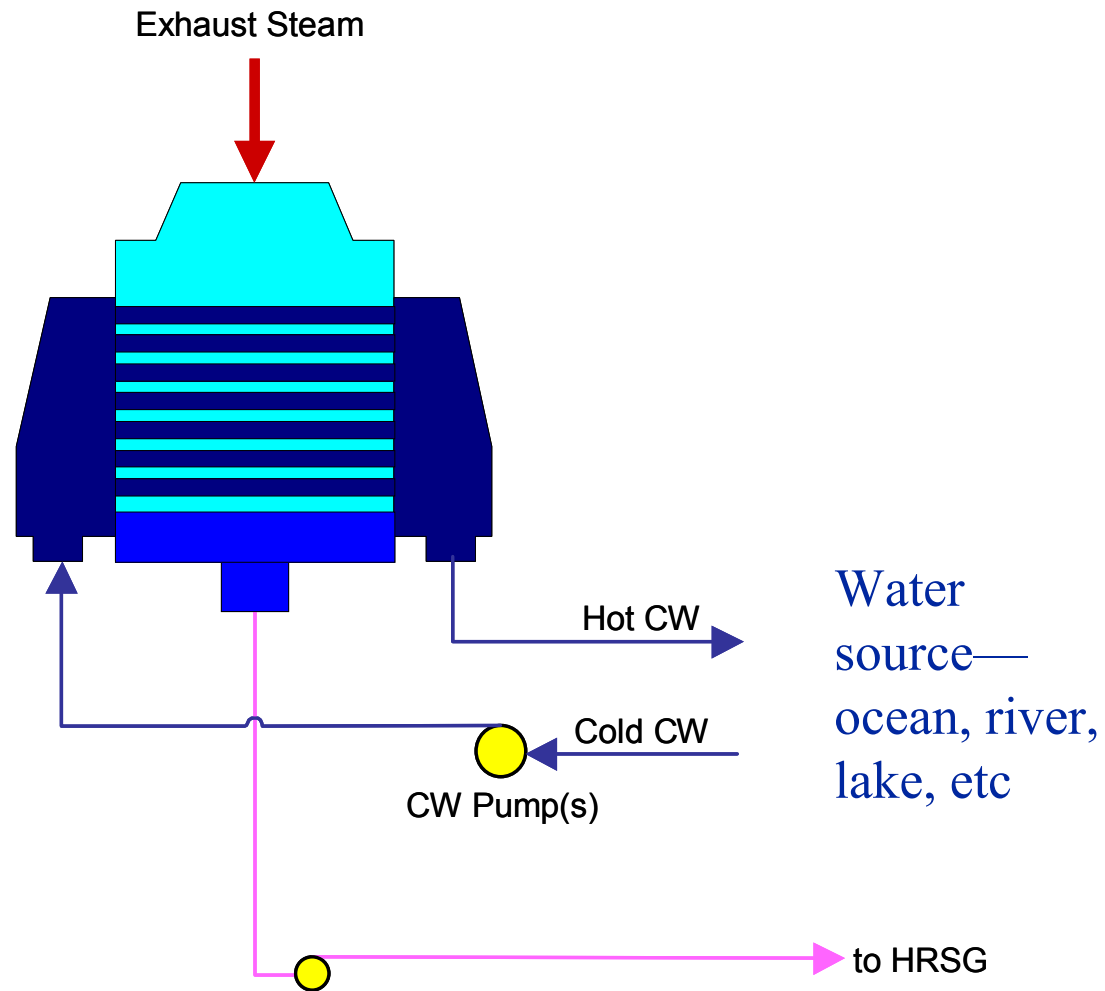
# The rest of the talk

- ✓ Show you some cooling systems
- ✓ Present some cost comparisons
- ✓ Show some advancements that may help reduce cost

# Cooling systems

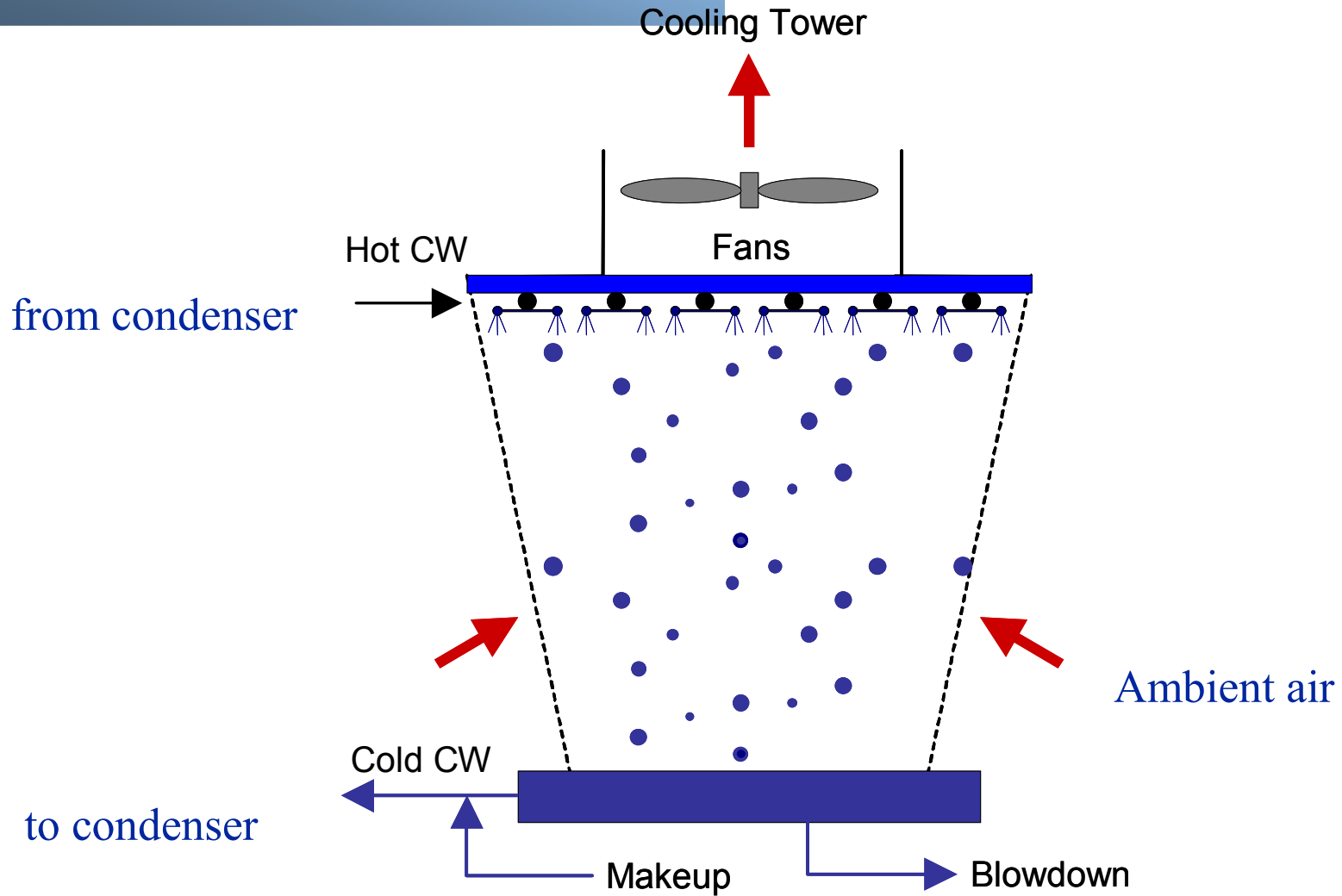
- ✓ **The old movie**---once-through cooling
- ✓ **Common practice**---wet cooling towers
- ✓ **Water conservers**---dry cooling/air-cooled condensers

# Once-through



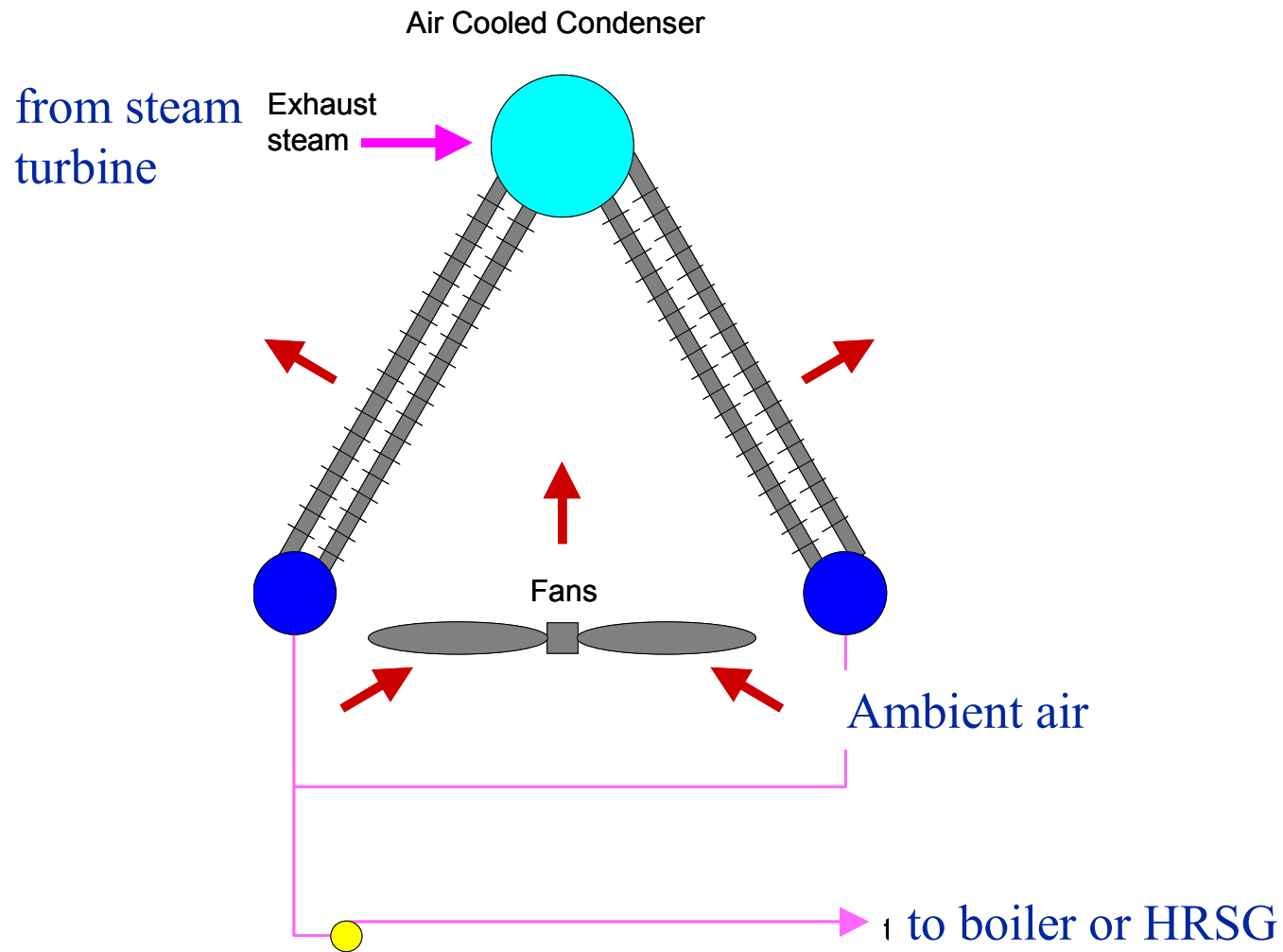


# Wet cooling tower





# Air cooled condenser

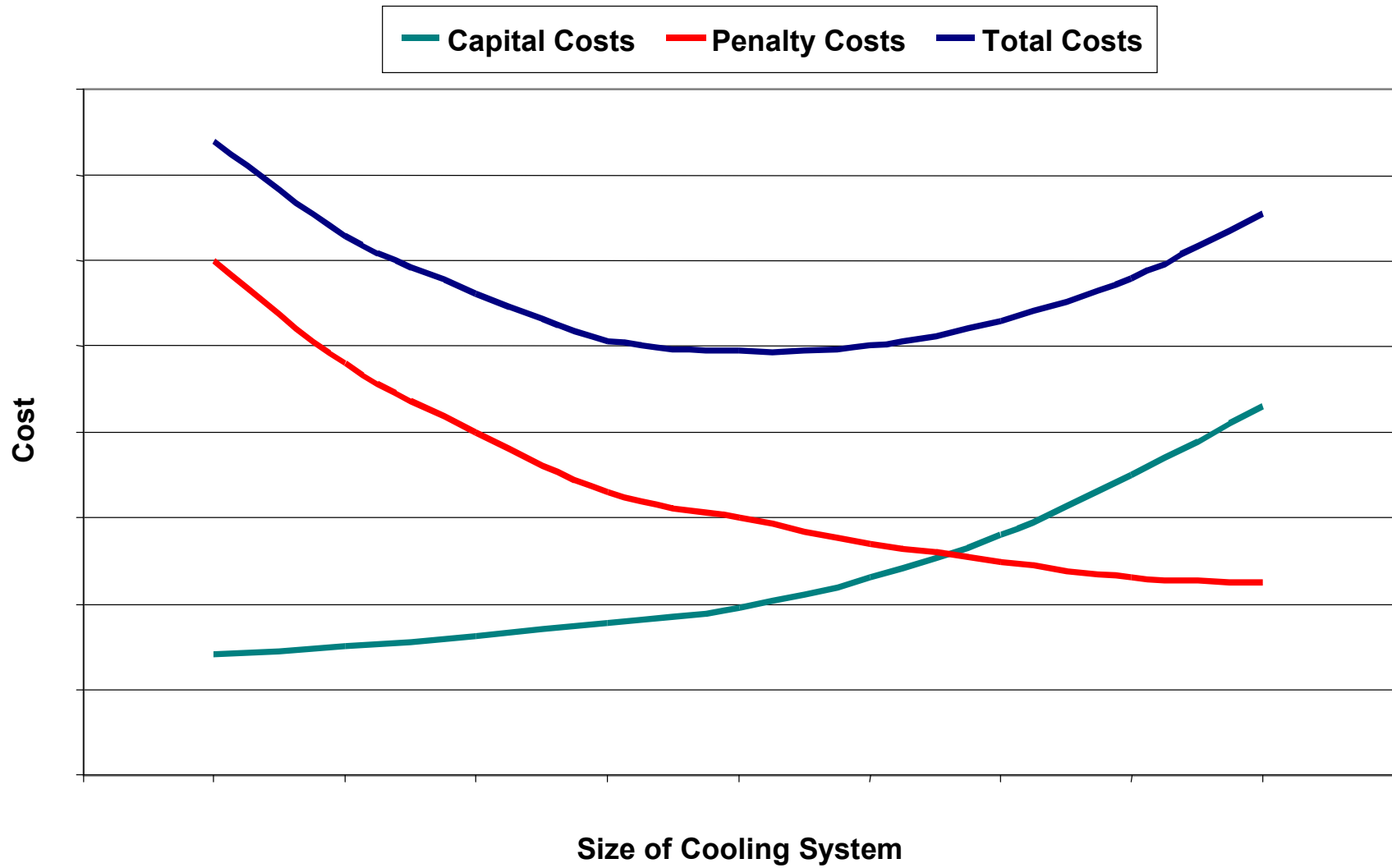




# Cooling system costs

- ✓ Capital costs
- ✓ Operating costs
  - Cost of power for pumps and fans
  - Cost of water
  - Cost of maintenance
- ✓ Penalty costs
  - Effect on plant efficiency
  - Cost of reduced output on hot days

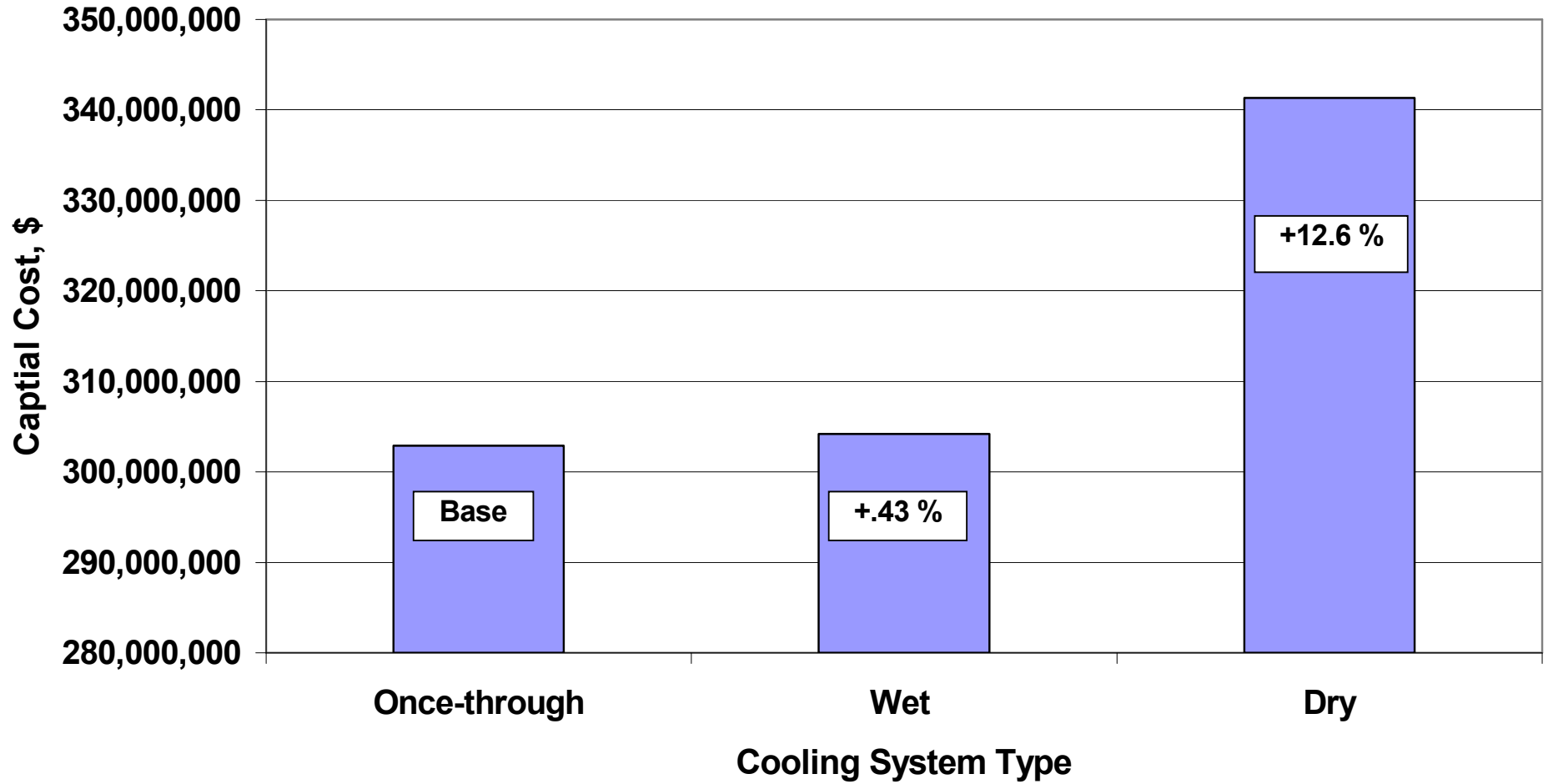
# Trade-off/ optimization



# Cost differentials

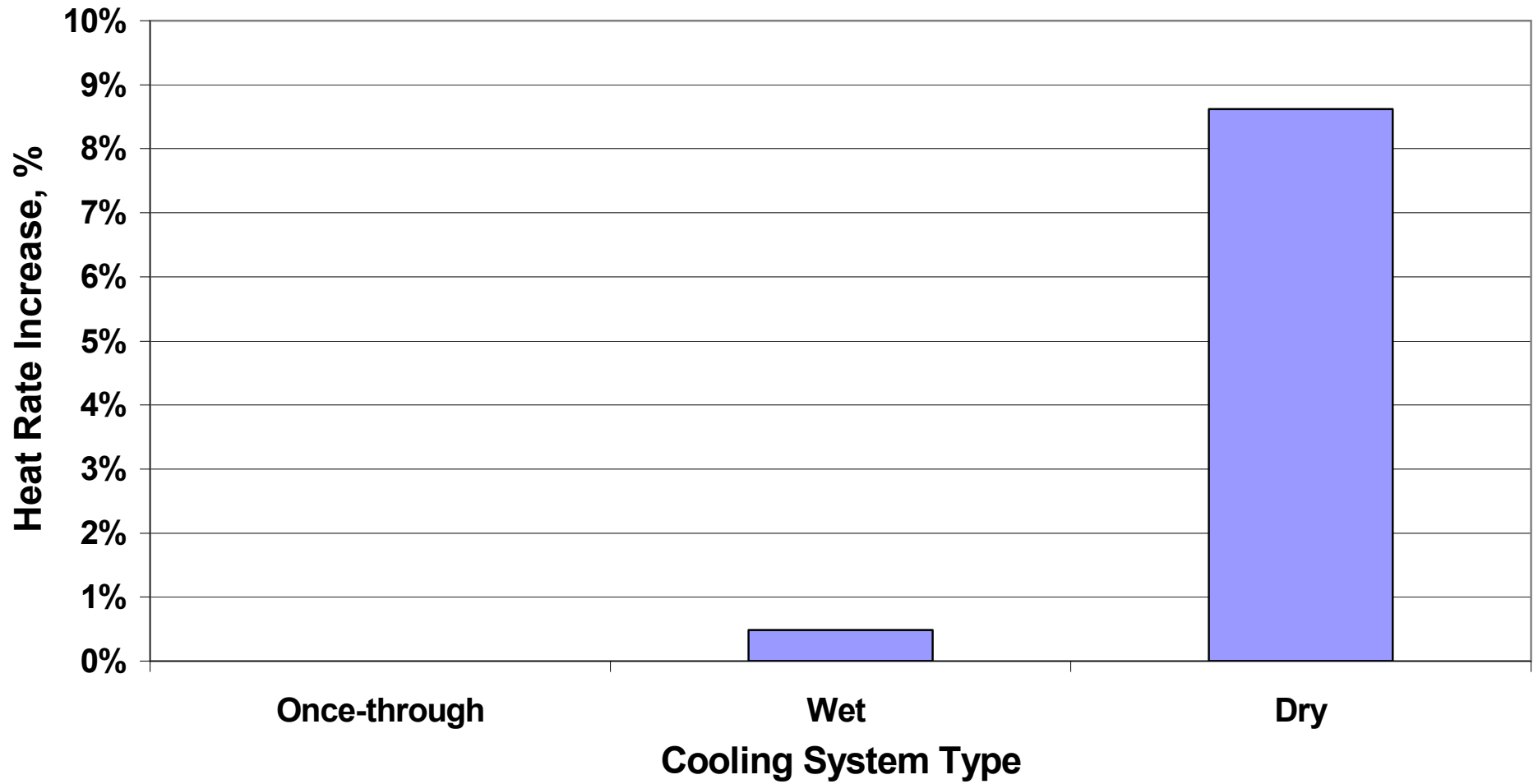
- ✓ **Increased capital cost---500 MW plants  
0.4% to 12.5%**
- ✓ **Increased cooling system power  
0.5 to 3.0 MW**
- ✓ **Increased plant heat rates  
0.4 to 4.0 %**
- ✓ **Increased power production costs  
1.9 to 4.9%**

## Capital Cost---500 MW Steam Plant





## Hot Day Heat Rate Increase---500 MW Steam Plants



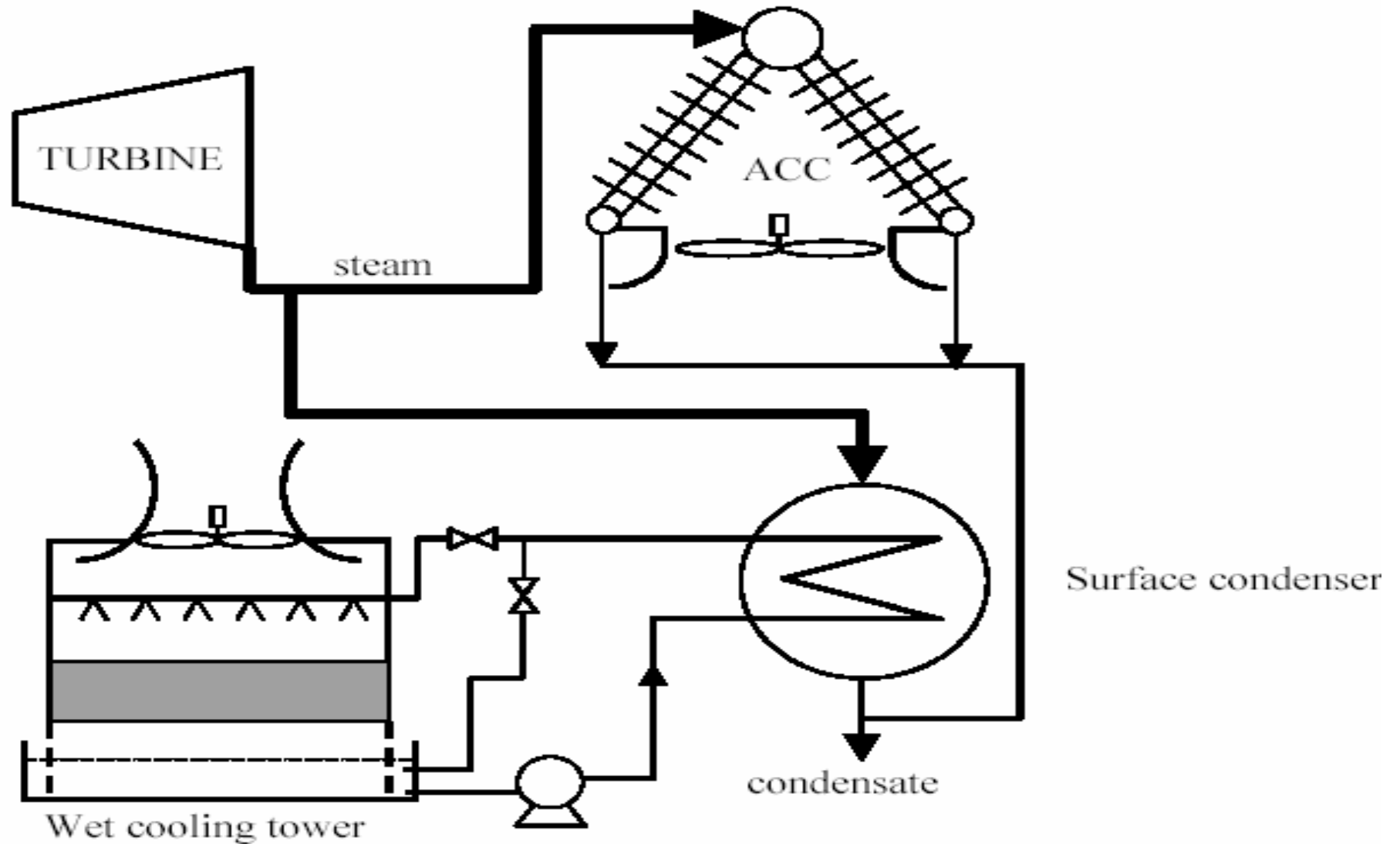
## “Equivalent” cost of water

- ✓ **\$3.50 to \$6.00 per 1,000 gallons**
- ✓ **\$1,000 to \$2,000 per acre-foot**

# Some things that might help....

- ✓ **Use a little bit of water a little bit of the time**
  - Hybrid (wet/dry) systems
  - Spray enhancement
- ✓ **Recover some of the water from wet systems**
  - ✓ **Marley's Air-to-Air<sup>®</sup> concept**

# Hybrid wet/dry system



**Tucuman 450 MW Combined Cycle (Argentina)  
PAC SYSTEM®  
(Air Cooled Condenser & Wet Cooling System)**

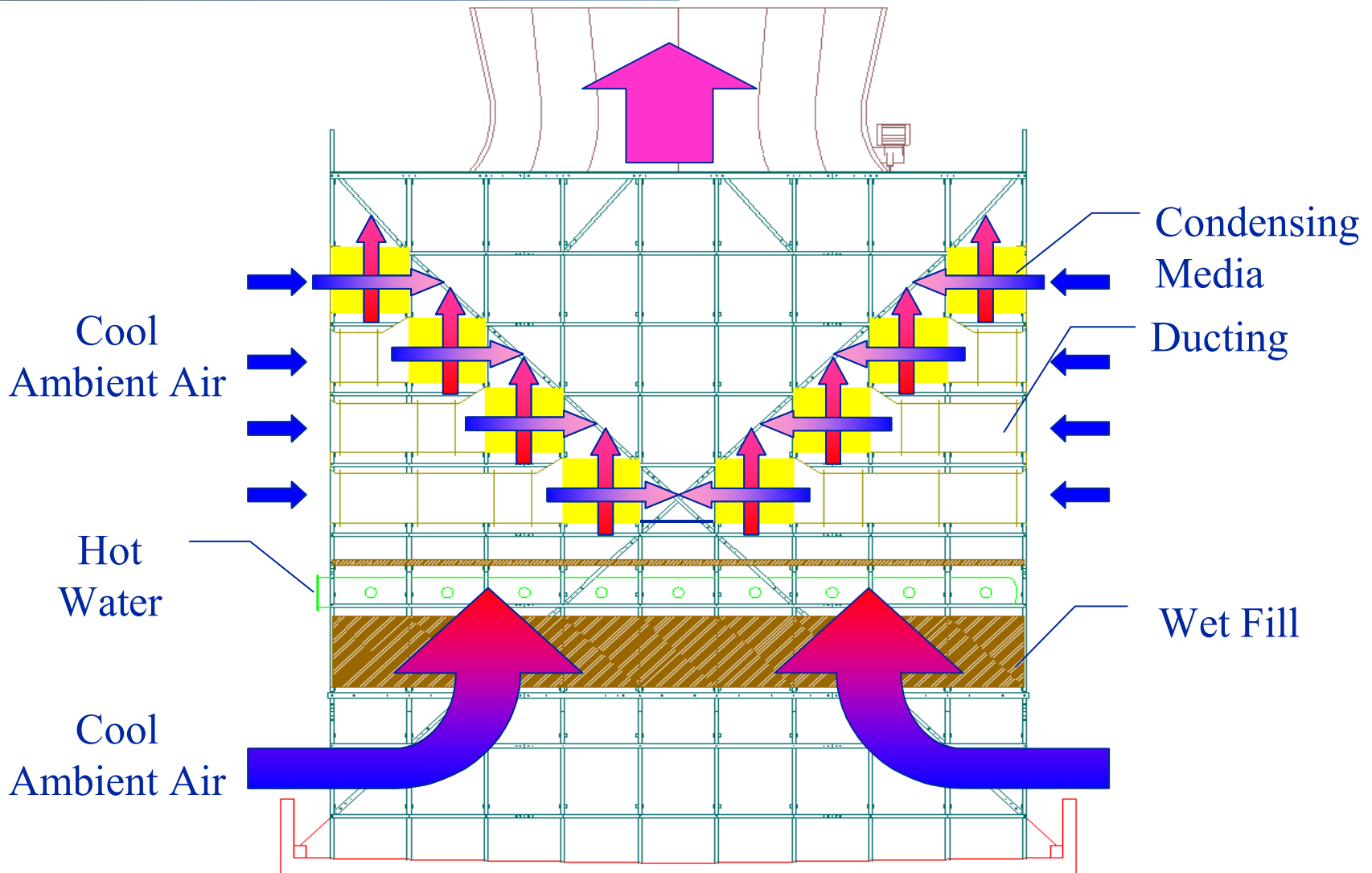


# Spray enhancement

- ✓ Spray water into inlet air stream of air-cooled condenser
- ✓ Low capital cost approach
- ✓ Low annual water use
- ✓ Reduce inlet temperature by 5 to 10 F
- ✓ Restore “hot day” capacity loss

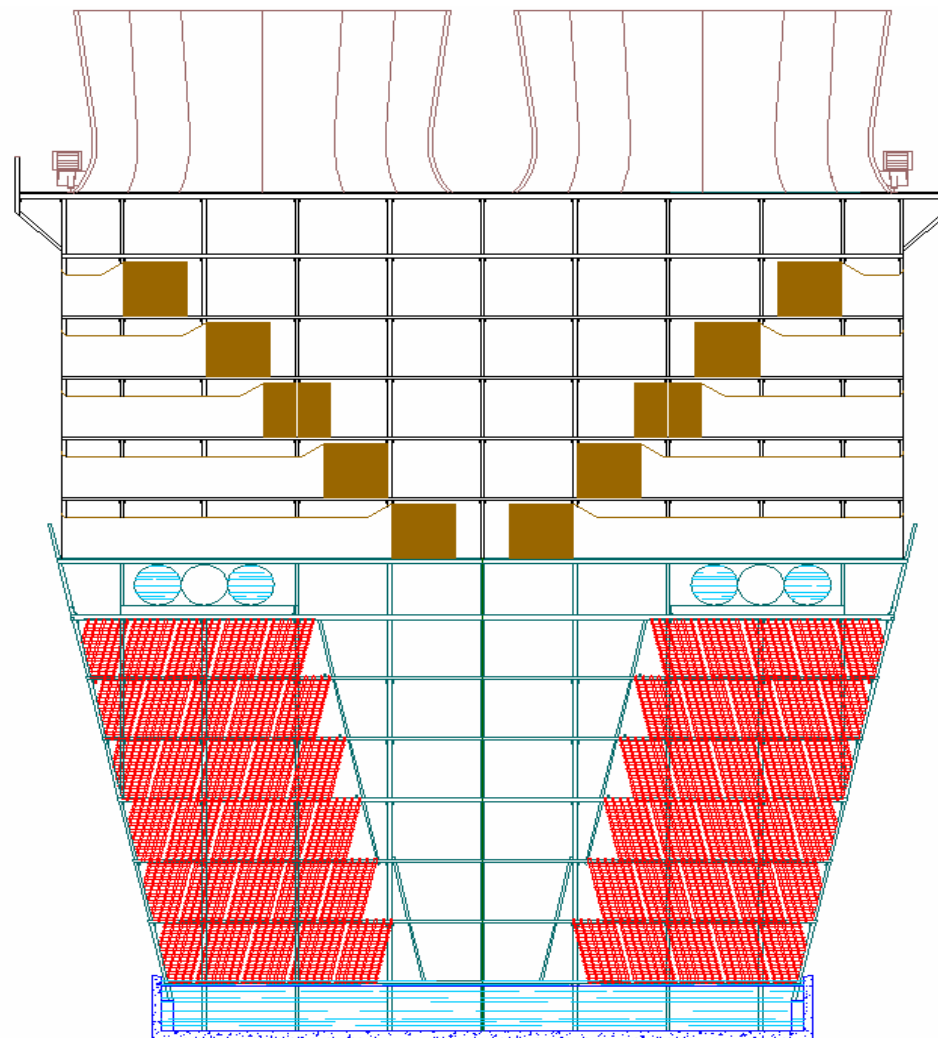


# Marley Air-to-Air<sup>®</sup>





# Possible retro-fit



# Finally....

- ✓ Is the prize worth the price?
  - Your call
  - **Very** site specific
- ✓ Is this a good way to do it?
  - I state without proof
    - About the same as reclaimed water use
    - Cheaper (now at least) than “water-free” renewables (wind or solar)