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EERC Dry Cooling Technology for Power Plants

EPRI Advanced Cooling Technology Webcast Follow-up
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Introduction

A new technology to lower dry cooling costs

- Wet recirculating cooling is typically the best design choice in terms of cost and performance but, **the need for water is becoming a liability**.
- The EERC, under a cooperative agreement with the U.S. Department of Energy, has developed a novel dry cooling technology applicable to Rankine-based power plants and similar heat rejection loads.
- The technology does not require cooling water, and it is estimated to have a lower ratio of cost versus performance compared to conventional dry cooling.

"Whiskey is for drinking, water is for fighting."
– Mark Twain

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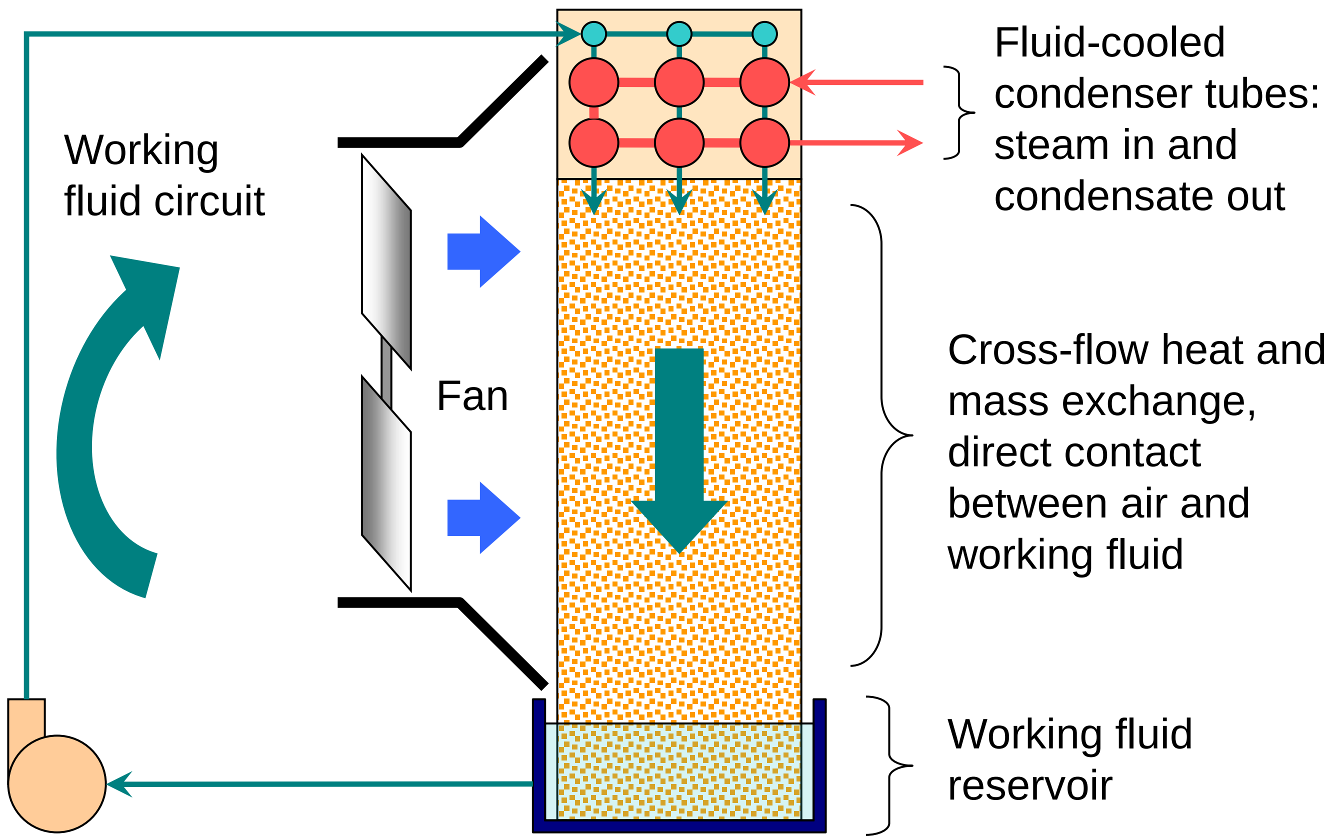
EERC Cooling Technology

Using a unique working fluid to enhance heat transfer

- The EERC concept uses a hygroscopic working fluid to cool the steam condenser and dissipate the thermal energy directly to the atmosphere.
- Because the working fluid is hygroscopic, it does not completely evaporate and there is no need for makeup water.
- Compared to a wet evaporative cooling system, the bulk of heat transfer with the EERC system is sensible, but transient latent heat transfer is also possible.



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Direct Contact Heat Exchange

A feature that enables improved dry cooling performance

- **Direct contact heat exchange with ambient air has important implications for heat dissipation:**
  - Inexpensive, wetted packing structures can be used to create large heat transfer surface areas.
  - Heat transfer is partially driven by vapor pressure gradients, thereby increasing overall heat transfer efficiency and potentially resulting in lower air-side pressure drop.
  - Transient absorption and desorption of ambient moisture adds a component of latent heat transfer to the system that acts as integrated thermal storage.

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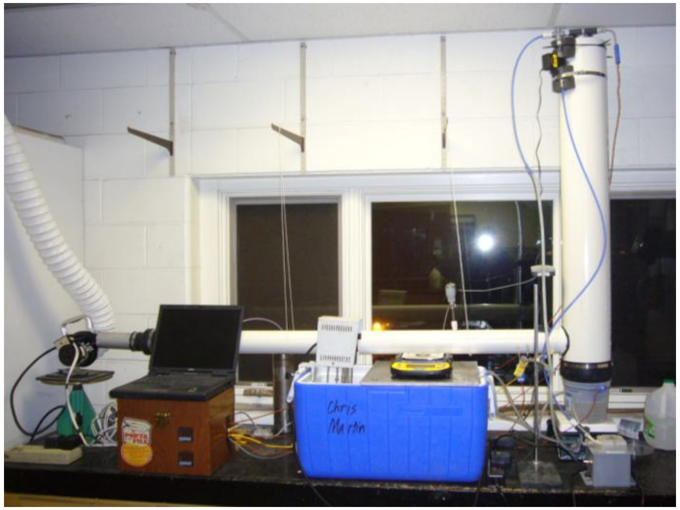
Dynamic Performance and Applications

Integrated thermal storage allows the system to be optimized for specific applications

- The unique design of the system enables integrated thermal storage in response to daily cycles in ambient temperature. This transient effect can be used to counteract the daytime performance degradation that hinders conventional dry cooling technology.
- Within load and climate constraints, performance of the EERC's cooling system can be "tuned" for specific applications and/or locations:
  - Constant thermal load with daily ambient temperature cycling, e.g. base-loaded coal or nuclear plants
  - Significant daily cycling of thermal load and ambient temperature, e.g. solar thermal power plant
  - Higher frequency thermal load switching, e.g. air conditioning and refrigeration systems

Development Status

Laboratory-scale experiments used to validate concept and support case study calculations



- The laboratory-scale system was used to validate key process operations and serve as the basis for the performance model.
- The model was used to estimate large-scale system performance in the case study.

Case Study Summary:

- **Application:** 316 MWth steam condensation load/170 MWe plant output (bottoming cycle of a 500 MWe combined cycle plant, EPRI 2004 case study).
- **Systems compared:** EERC, wet recirculating, and ACC.
- **Location:** Omaha, NE
- **Simulation time:** June 1 to August 31, 2008
- **Other assumptions:**
  - Constant load, 100% capacity factor for the 3 month duration.
  - Plant efficiency was derated as a function of steam condensation temperature.
  - Ambient temperature and humidity input only, no site-specific effects included, e.g. wind.

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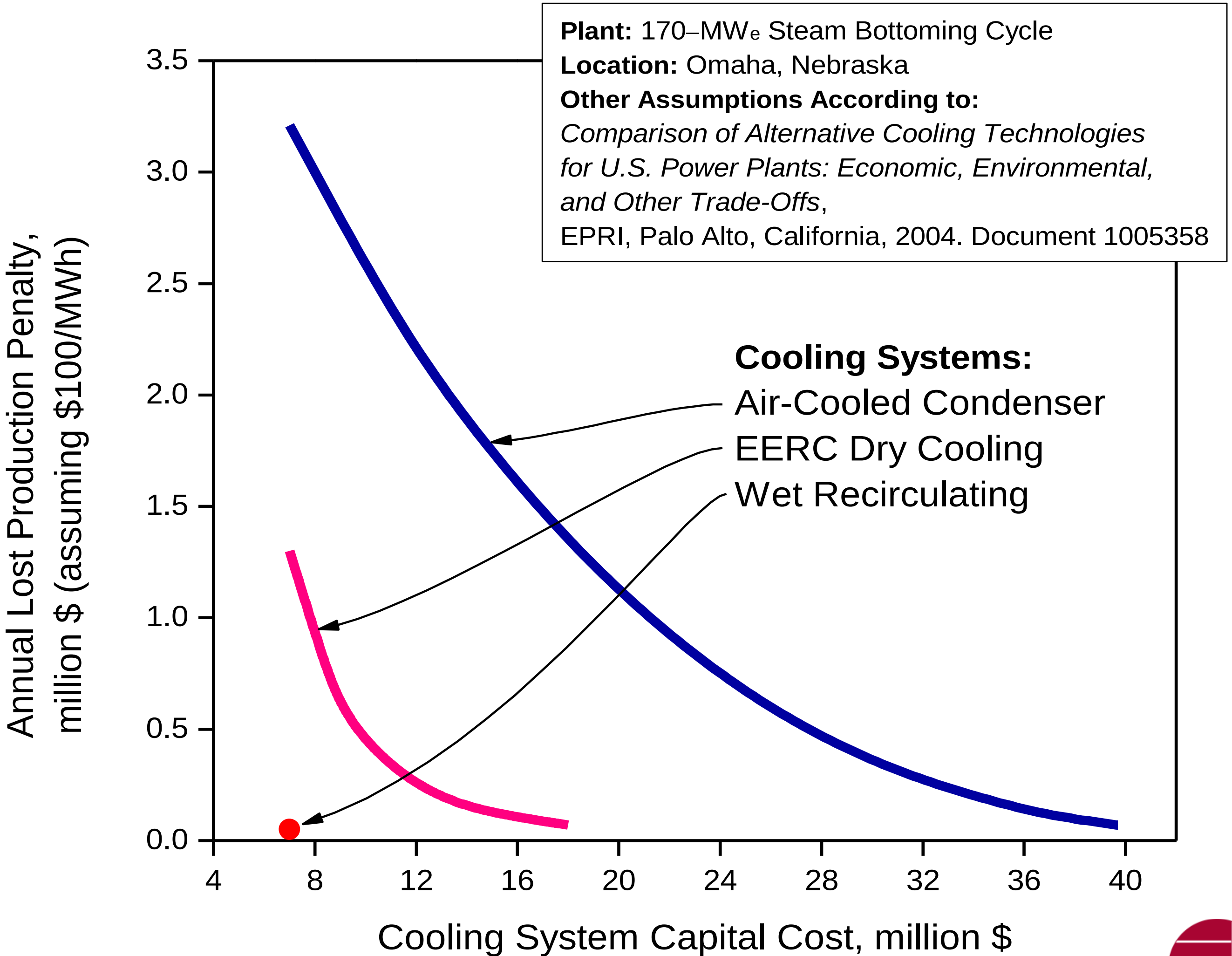
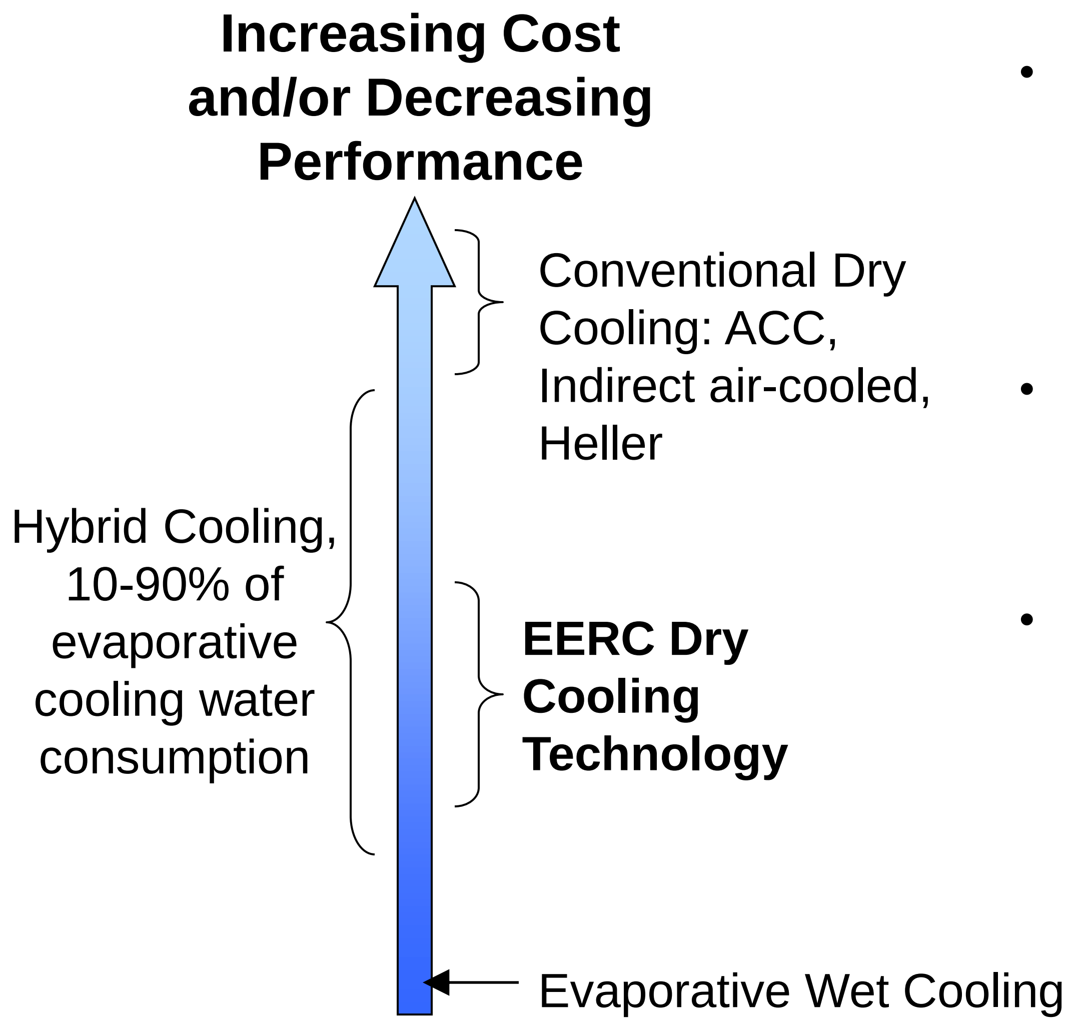
Case Study Results

EERC-based system estimated to be significantly lower cost than an equivalent performance ACC



EERC Technology Potential

Performance comparable to hybrid designs, but without water consumption



- Key evaluation parameters:
  - Wet or dry
  - Performance
  - Cost
- Where water is available, evaporative cooling will typically be the best choice for cooling.
- For locations without adequate water, the EERC concept offers improved cost vs. performance, **without compromising water consumption** as with hybrid systems.

Proposed Project Summary

Determine the technical and economic viability of the dry cooling technology

Project Tasks:

- Fabricate and test a prototype cooling circuit including steam condensation and air heat dissipation.
- Conduct optimization and performance tests under ambient conditions of interest to the project sponsors.
- Perform a detailed cost and performance evaluation with assistance from EPRI and SPX Cooling Technologies.

Outcome:

- Recommend if further development is warranted—i.e. field demonstration of a pilot system.

Project partners include:

- **U.S. Department of Energy**
- **WY Clean Coal Technologies Research Program**
- **EPRI**
- **SPX Cooling Technologies**

Project Total: $1,100,000
EPRI Request: $300,000

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