ELECTRIC POWER RESEARCH INSTITUTE

# EPRI Power Plant Cooling Technology Innovation Research Overview


**Dr. Jessica Shi**
Sr. Technical Leader/Manager
EPRI

**Dr. Sean Bushart**
Director/Cross-Sector Lead of
EPRI Water Programs

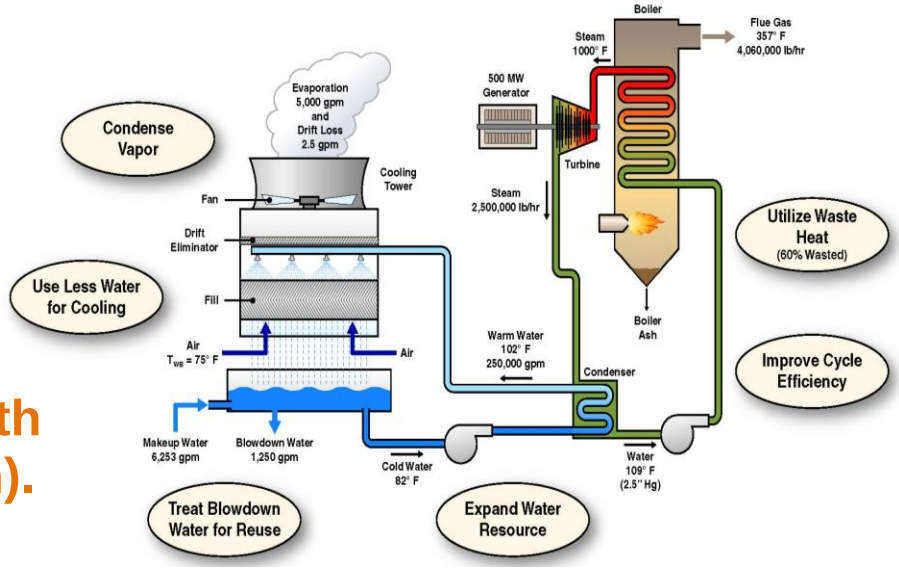

**Webinar on Dry vs. Wet Cooling**

Organized by Mcilvaine Company

June 5, 2014

# EPRI's Approach

- Initiated water conservation technology innovation research in early 2011
- Collected168 proposals/white papers from 3 solicitations
  - Feb., 2011
  - June, 2012
  - May, 2013 **($6 M Collaboration with The National Science Foundation).**
- Funded 14 projects including 4 water treatment projects
- Funding 6 more projects in 2014



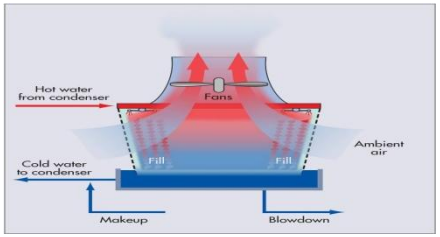

## Objective

*Seek and develop "out of the box", game changing, early stage, and high risk cooling and water treatment ideas and technologies with high potential for significant water consumption reduction.*

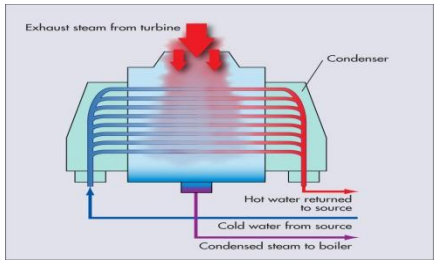
# What Cooling System Options are Currently Deployed in the Industry?

## Water Cooling

### Cooling Tower[1] (42% in US)[2]




### Once Through Cooling[1] (43% in US)[2]

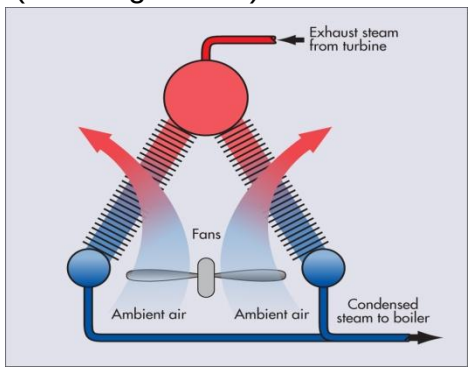



### Cooling Pond (14% in US)[2]

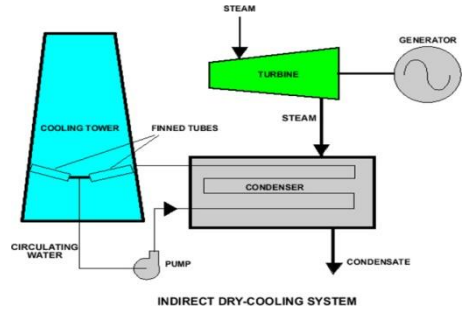
## Dry Cooling

### Direct Dry Cooling[1]:

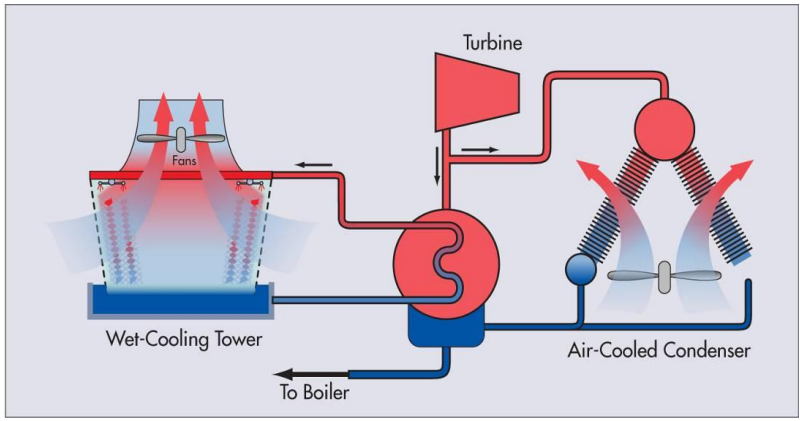
Air Cooled Condenser (1%Usage in US)[2]




### Indirect Dry Cooling[3]




## Hybrid Cooling[1]




**Increasing demand for dry cooling in water scarcity regions.**

1. *EPRI Report, "Water Use for Electric Power generation", No. 1014026, 2008.*
2. *Report of Department of Energy, National Energy Technology Laboratory, "Estimating Freshwater Needs to Meet Future Thermoelectric Generation Requirements",* DOE/NETL-400/2008/1339, *2008*
3. *http://www.globalccsinstitute.com/publications/evaluation-and-analysis-water-usage-power-plants-co2-capture/online/101181*





EPRI ELECTRIC POWER RESEARCH INSTITUTE

# Air Cooled Condenser Pros/Cons

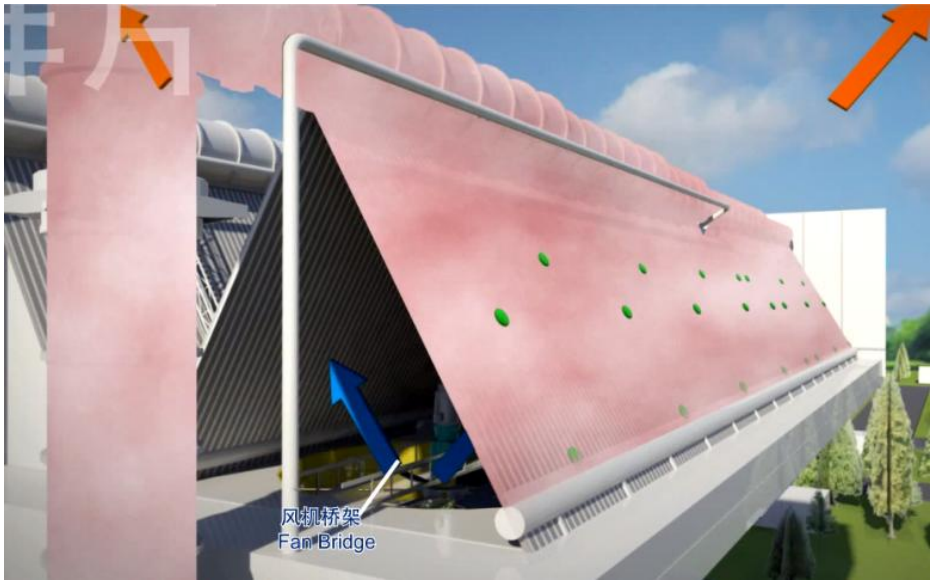
Pros:

- Dry system
  - ➢ Zero water consumption and water supply needed

➢ Cons:

- Up to 10% less power production on hot days due to higher steam condensation temperature compared to CT and OTC systems
- Up to five times more expensive than cooling tower systems
- Noise, wind effect, and freezing in cold days

**1% Usage in US**




Click Here for Animation

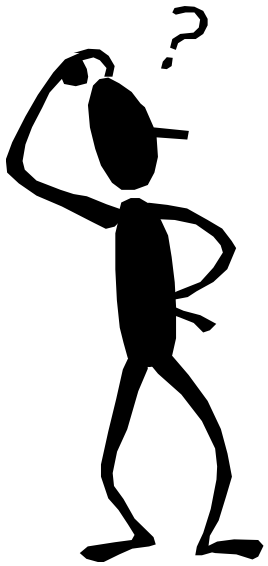
Source: EVAPCO BLCT Dry Cooling

**Challenge: Reduce ITD from 30 ℃ to 10 ℃ >> 6% more Power Production**

# Summary of NSF-EPRI Advanced Dry Cooling Science and Technology Innovation Program Projects with $6 M Total Funding

| Project Title | Orgnization | Funder |
|---|---|---|
| Direct Contact Liquid on String Heat Exchangers for Dry Cooling of Power Plants | UCLA | NSF |
| On-demand Sweating-Boosted Air Cooled Heat-Pipe Condensers for Green Power Plants | U of S Carolina | NSF |
| Ejector Cooling Systems with Evaporation/Condensation Compact Condensers | Univ of Missouri Columbia/SPX | NSF |
| Novel Thermosyphon/Heat Pipe Heat Exchangers with Low Air-Side Thermal Resistance | Univ of Kansas /Univ of Connecticut | NSF |
| Auto Flutter Enhanced Air Cooled Condensers | GaTech/Johns Hopkins/Southern Company/SPX | NSF-EPRI |
| Advanced Air Cooled Condensers with Vortex-Generator Arrays between Fins | UIUC | NSF-EPRI |
| Indirect Dry Cooling Towers with Phase-Change Materials as Intermediate Coolants | Drexel/ACT/Worley Parsons | NSF-EPRI |
| Novel Heat-driven Microemulsion-based Adsorption Green Chillers for Steam Condensation | UMD/Worley Parsons | EPRI |
| Nanostructure Enhanced Air-Cooled Steam Condensers | MIT/HTRI | EPRI |
| Porous Structures With 3D Manifolds For Ultra-Compact Air Side Dry Cooling | Stanford | EPRI |

EPRI | ELECTRIC POWER RESEARCH INSTITUTE



**Contacts:**

Jessica Shi
jshi@epri.com

***Together…Shaping the Future of Electricity***