EPRI Power Plant Cooling Technology Innovation Research and Water Resource Center Overview

Russell Noble
Power Generation R&D Manager
Southern Company

Dr. Jessica Shi
Sr. Technical Leader/Manager
EPRI

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

DOE ARPA-E Alternative Power Plant Cooling Workshop
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Hotel Chicago, Chicago, IL
EPRI’s Approach

- Initiated water conservation technology innovation research in early 2011
- Collected 168 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.
Current Cooling Projects excluding projects funded through NSF-EPRI Collaboration Program

1. Water Spray to Enhance Air Cooled Condensers (Collaboration with University of Stellenbosch in S. Africa)
2. Nearly 100% Vapor Capturing Technology (Collaboration with UMD)
3. Waste Heat/Solar Driven Green Adsorption Chillers for Steam Condensation (Collaboration with Allcomp)
4. Thermoelectric Cooling and Waste Heat Recovery Technology (Collaboration with Purdue)
5. Thermosyphon Cooler Technology (Collaboration with Johnson Controls)
6. Advanced M-Cycle Dew Point Cooling Tower Fill (Collaboration with Gas Technology Institute)
7. Heat Absorption Nanoparticles in Coolant (Collaboration with Argonne National Lab)
8. Parametric Evaluation of Effects of Nanofluid on Cooling Tower Evaporation Loss Reduction (Collaboration with GTI)
EPRI’s Advanced Cooling Technology Pipeline

**Dew Point Cooling**
- Proof of Concept Validated

**Hybrid Dephlegmator**
- System Validated

**Thermosyphon Cooler**
- Early Demonstration

<table>
<thead>
<tr>
<th>TRL 1</th>
<th>TRL 2</th>
<th>TRL 3</th>
<th>TRL 4</th>
<th>TRL 5</th>
<th>TRL 6</th>
<th>TRL 7</th>
<th>TRL 8</th>
<th>TRL 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploratory Research</td>
<td>Concepts Formulated</td>
<td>Proof of Concept Validated</td>
<td>Subsystem Validation</td>
<td>System Validated</td>
<td>Early Demonstration</td>
<td>Demonstration</td>
<td>Early Commercial Deployment</td>
<td>Commercialization</td>
</tr>
</tbody>
</table>

**EPRI Water TI Program**

**EPRI Water Management Technology Program**

- **Dry/Wet Cooling Addition**
- **Drill eliminator**
- **Spray nozzles**
- **Collecting troughs**
- **Finned tubes (1st stage)**
- **Fan drive**
- **Fan**
- **Inlet air flow**

**Dry Bulb Temperature**
- \( t_{DB} = 85^\circ F \)

**Saturation line**
- **t_{WB} = 65^\circ F**

**Absolute humidity**
- **t_{DP} = 53^\circ F**

**Conventional fill**
- **Warm water**

**Advanced fill**
- **Air outlet**

**Dry Channel**
- **Wet Channel**

**Wet Channels**
- **Air outlet**
- **Warm water**

**Air outlet**
- **Warm water**
Status/Update: Water Research Center (WRC) at Georgia Power’s Plant Bowen

Russell Noble
Power Generation R&D Manager
Southern Company

Presented by Jessica Shi, EPRI Sr. Technical Leader/Manager
Focus Areas

- Water Management Modeling
  - Cooling Water
  - Moisture Recovery
  - Zero Liquid Discharge (ZLD)
  - Solid Landfill
  - Wastewater Treatment (WWT)
  - Carbon Technology Effects
Pilot-Scale Model

Generic Infrastructure for Testing
1. WRC Lab (evaporator, crystallizer, lysimeters, etc.)
2. Wet ESP / Moisture Recovery
3. Heartland Evaporator/Concentrator
4. EVAPCO Eco Wet-Dry Cooler
5. JCI Thermosyphon Cooler
7. Wastewater Treatment Bldg
Example Projects

- Johnson Controls’ Thermosyphon Cooler (TSC)
- EVAPCO Eco Wet-Dry Cooler (Eco-WD)
- Atlantis Technologies’ Radial Deionization (RDI)
- Wet Electrostatic Precipitator (Wet ESP)
- Heartland Evaporator/Concentrator
- Wastewater Treatment Research (WWT Building)
- Solids Management Research
Thermosyphon Cooler (TSC) – Advanced Cooling
TSC – Hybrid System Configuration

GPC Bowen Unit 4 NDCT

Hot Water

Cold Water

Courtesy Johnson Controls
TSC Hybrid System

GPC Bowen U4 Hyperbolic Natural Draft Cooling Tower

Small Pilot Cooling Tower
Evapco: Eco-WD Cooler

- Upper Coil (Dry Cooling)
- Lower Coil (Indirect evaporative cooling)
- Make up
- Bleed
- Cooling Loop
- Cooling Pump
- Spray Loop
- Spray Pump
- Smart Shield
Evapco Eco-WD Cooler
Wet ESP and Water Reuse

Evaluate New Design

- Performance & Durability
  - SO$_3$ and fine filterable particulate matter
  - Trace metals (Hg, Se, etc..)
  - Fabric membranes and coated carbon steel

Explore Water Recovery

- Characterize condensate
- Treatment strategies
- Water reuse potential
Tech Transfer from Oil & Gas (ZLD)

• Portable brine concentrator
• Proven on 250,000+ ppm brines
  – “Frac” waters
  – Landfill leachate
• Alternative ZLD for FGD wastewater
• Project commence 2nd quarter 2014
WWT Research Area

Completed and Ongoing Projects

- Atlantis Radial Deionization
- VSEP Vibrating Membrane
- Evoqua Pironox Zero-Valent Iron Process Demo
Solids Management Research

- Characterization of new WWT and ZLD solids/residuals
  - Baghouse, spray-dryer, thermal ZLD, etc
  - Significant fractions of RCRA metals
- Solidification/Stabilization and long term leachate characterization
- Lysimeter on-site and being installed
- Evaporator/Crystallizer being installed
End Results…

• Establishment of a world-class R&D center
  – Industry resource for R&D
  – Generic infrastructure for testing
  – Accelerate water technology R&D

• Prove, disprove, and improve
Concluding Thoughts

• EPRI’s research indicates that with more engagement of the research community and more funding, there is a high potential to dramatically reduce water use in power plant cooling.

• Water Research Center is poised to host more field demonstration projects.
Together…Shaping the Future of Electricity

Contacts:
Morgan French, Research Engineer
dmfrench@southernco.com

Jessica Shi
jshi@epri.com