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EPRI Technology Innovation Water Conservation Program Overview

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NSF-EPRI Joint Workshop on Advancing Power Plant Water Conserving Cooling Technologies

ASME 2012 International Mechanical Engineering Congress and Exposition
Hilton America, Houston, Texas

Nov. 13, 2012

Outline

- Overview of EPRI and Program
- Request for Information (RFI) (**Max $500k for a three year project**)
  - 114 Proposal Summary
- Technologies under Development
- Next Steps

Recordings about our Webcasts can be found here (at the right bottom).

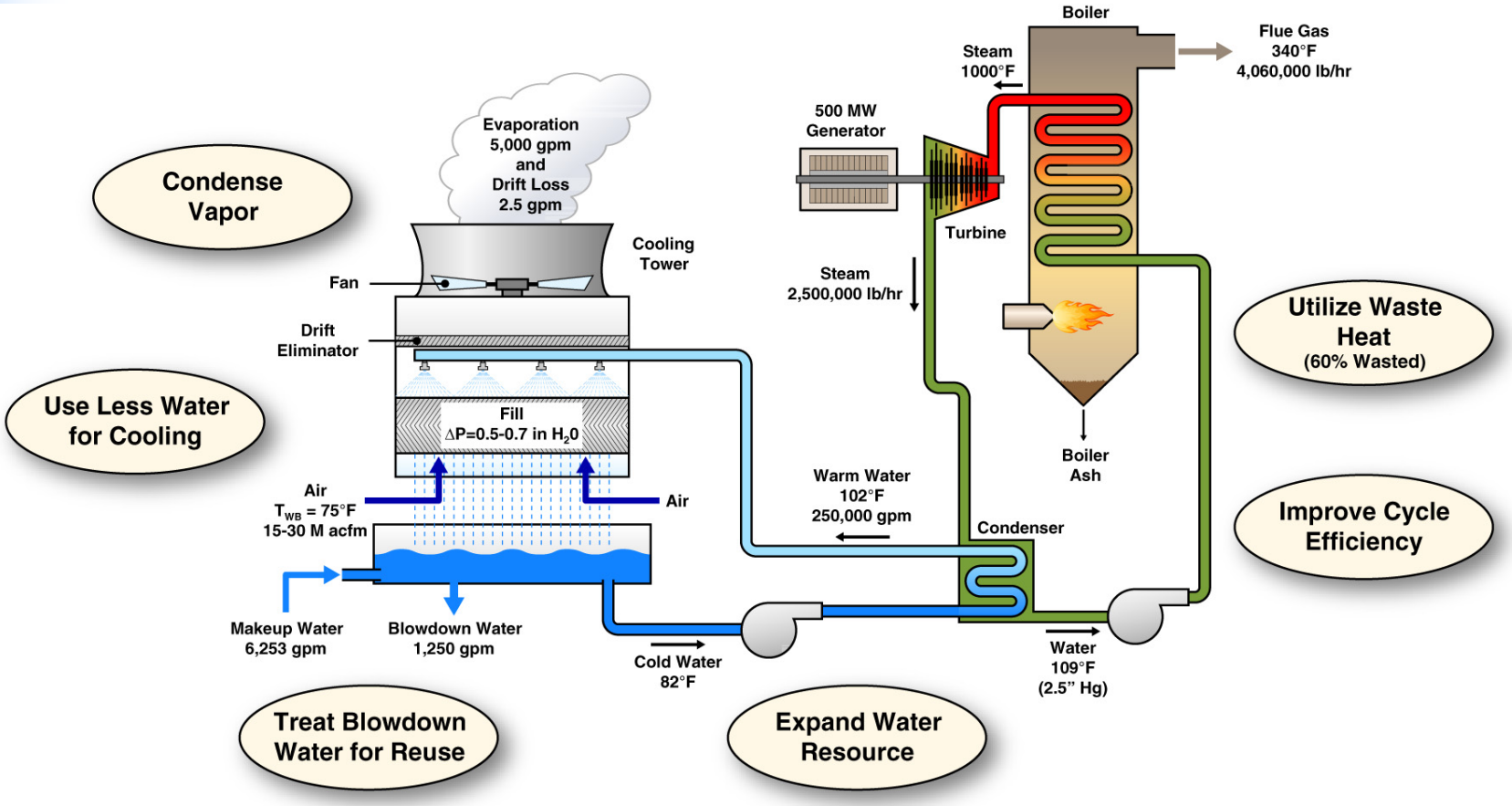
TI Water Conservation Program Overview and Objective

- Initiated in early 2011
- Funded by EPRI Office of Technology Innovation
- Collaborated by all EPRI Sectors (Environment, Nuclear, Generation, and Power Distribution Unit)
- Broadly distributed Request for Information (RFI) to solicit top technologies for development in Feb., 2011 and June 2012

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 water consumption reduction.

Opportunities for Power Plant Fresh Water Use Reduction



<u>Innovation Priorities</u>: Advancing cooling technologies, and applying novel water treatment and waste heat concepts to improve efficiency and reduce water use

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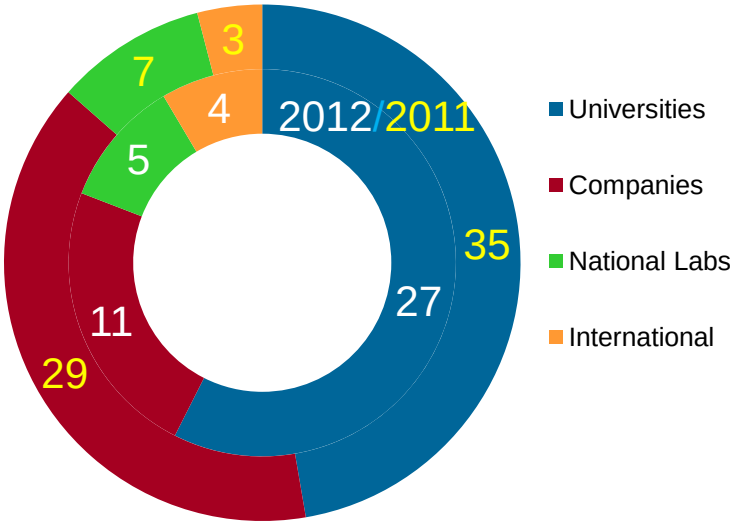
Received 114 Proposals

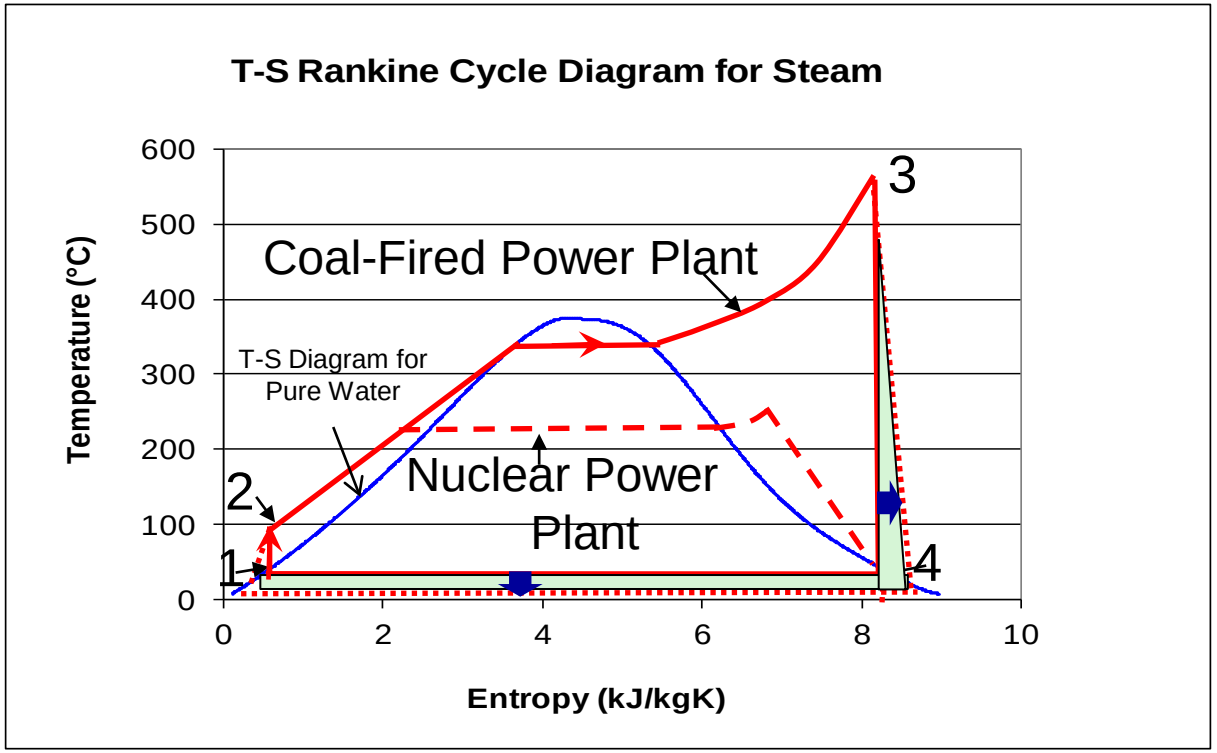
Responding Organization Summary



- **Five 2011 cooling proposals funded.**
- **Success rate of 1 out of 7 for 2011 cooling proposals.**
- **Many respondents unfamiliar with power**
- **industry.**
- **Funding four or more projects form 2012 collection**

Technology Type	No. of 2011 Proposals	No. of 2012 Proposals	Total
Cooling	**33**	**25**	**58**
Air Cooled Condensers	1	2	3
Aquatic Life Protection	1	0	1
Cooling Tower	1	0	1
Energy Storage	2	1	3
Evaluation Study	1	0	1
Flue Gas Moisture	0	2	2
Green Chiller	3	4	7
Heat Transfer Enhancement	0	1	1
Hybrid	2	2	4
Other Condensers	1	0	1
Radiator Fields	1	2	3
Thermal Integration	5	2	7
Thermal Transport	1	0	1
Vapor Loss Reduction	1	4	5
Waste Heat Utilization	2	1	3
Water Cooled Condenser	6	2	8
Water Use Integration	2	0	2
Wet Cooling Tower	3	0	3
Coating	**0**	**2**	**2**
Water Treatment	**38**	**18**	**56**
CO2 Capture	4	0	4
Scrubber Water	5	0	5
Water Treatment	6	3	9
Water Treatment- Bio	1	4	5
Water Treatment -FO	2	3	5
Water Treatment- Membrane	5	2	7
Water Treatment- Membrane Distillation	3	2	5
Water Treatment- MFC	1	1	2
Water Treatment- RO	8	2	10
Water Treatment- Thermal Desalination	3	1	4
TOTAL PROPOSALS	**71**	**43**	**114**

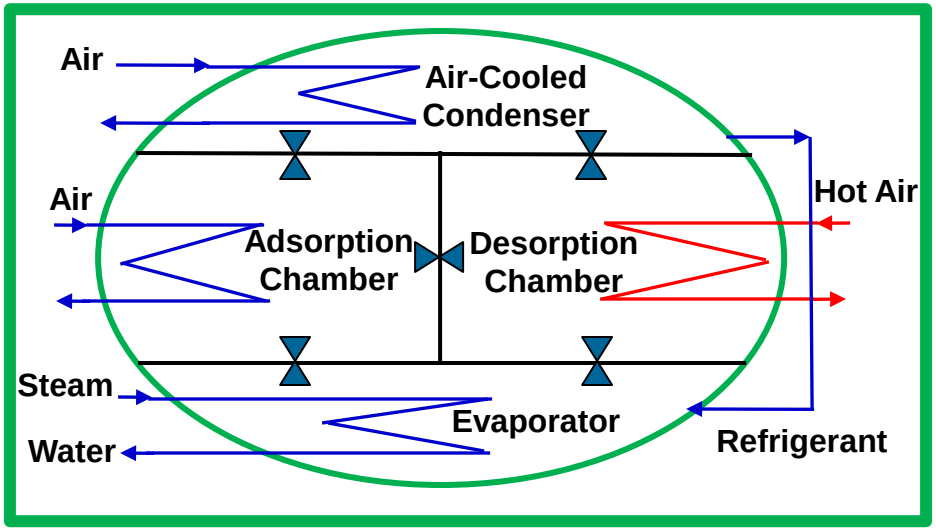
Effect of Reducing Condensing Temperature on Steam Turbine Rankine Cycle Efficiency



Potential for 5% (1st Order Estimate) more power production or $11M more annual income ($0.05/kWh) for a 500 MW power plant due to reduced steam condensing temperature from 50 °C to 35 °C.

Project 1: Waste Heat/Solar Driven Green Adsorption Chillers for Steam Condensation (Collaboration with Allcomp)

Schematic Illustration of a Typical Adsorption Chiller



Key Potential Benefits

- Dry cooling system
  - **Near Zero** water use and consumption
- Reduced condensation temperature
  - As low as **35 ℃**
  - Potential for annual power production increase by up to 5%
- Full power production even on the hottest days compared to air cooled condensers.

Phase 1 Project Scope (EPRI Patent Pending)

- Explore best power plant system level approaches to utilize waste heat or solar heat for desorption
- Perform system integration energy and mass flow balance analysis for a 500 MW coal-fired power plant
- Perform technical and economic feasibility study

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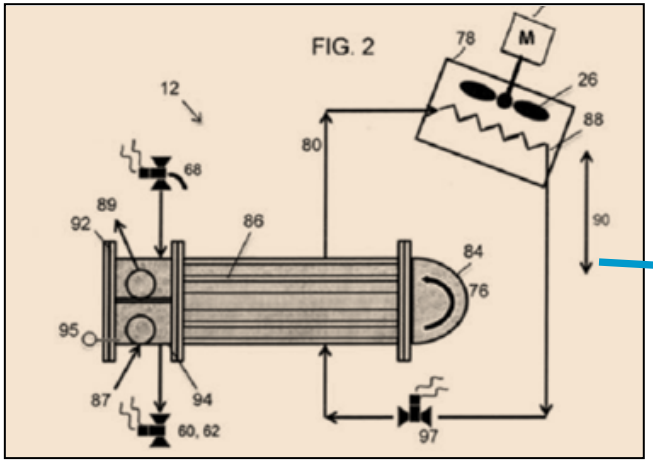
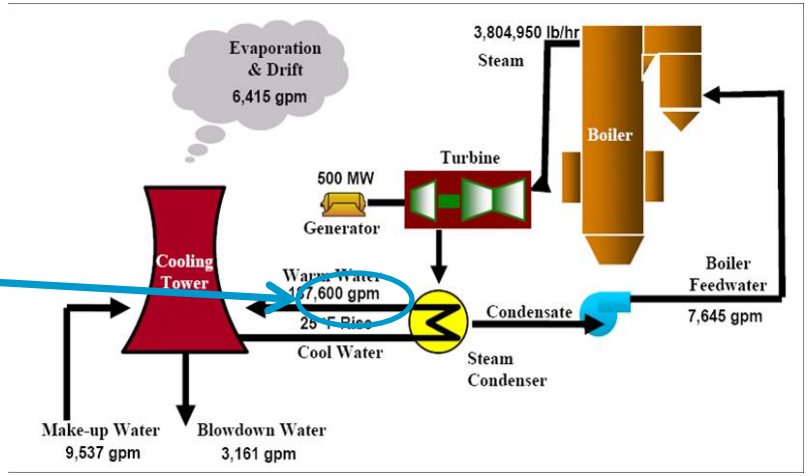
Project 2:Thermosyphon Cooler Technology (Collaboration with Johnson Controls)





Project Scope

- Perform a thorough feasibility evaluation of a hybrid, wet/dry heat rejection system comprising recently developed, patent pending, thermosyphon coolers (TSC).
- Make comparisons in multiple climatic locations, to standard cooling tower systems, all dry systems using ACC's, hybrid systems using parallel ACC's, and air coolers replacing the thermosyphon coolers.
- Determine the most effective means to configure and apply the thermosyphon coolers .

Key Potential Benefits

- Potential annual water savings up to 75%
- Compared to ACC, full plant output is available on the hottest days
- Ease of retrofitting
- No increase in surface area exposed to primary steam
- Reduced operating concerns in sub freezing weather
- Broad application (hybrid, new, and existing cooling systems)

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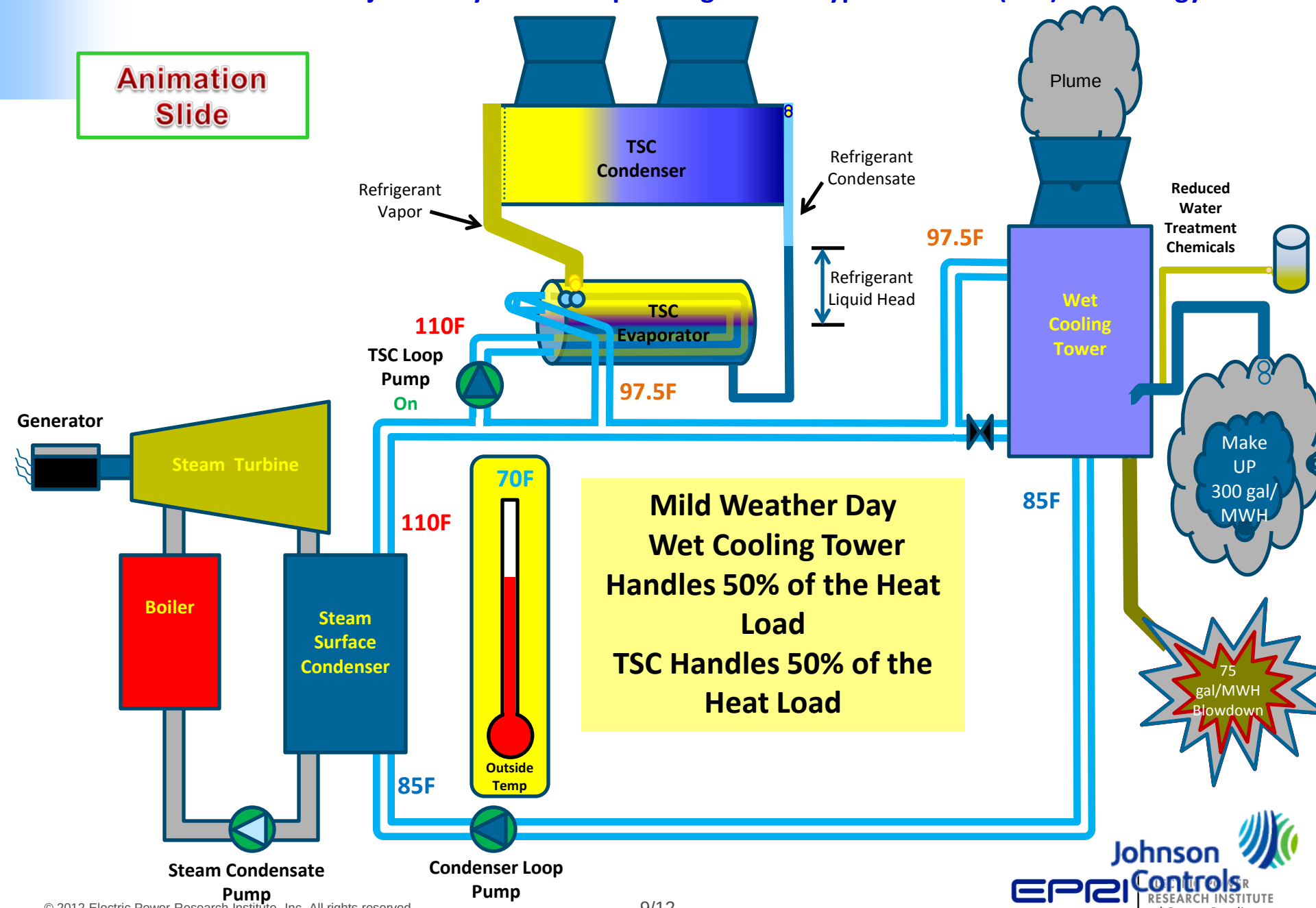
Power Plant Heat Rejection System Incorporating Thermosyphon Cooler (TSC) Technology*



Johnson Controls

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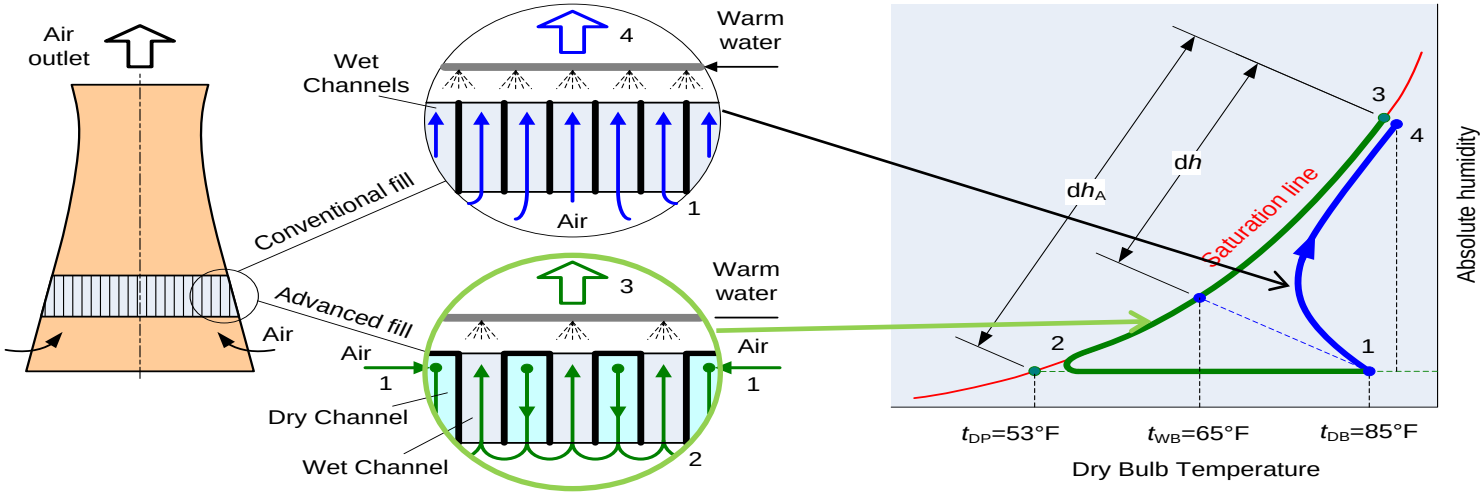
* Patent Pending

Project 3 : Advanced M-Cycle Dew Point Cooling Tower Fill (Collaboration with Gas Technology Institute)



Project Scope

- Develop an advanced fill
- Perform CFD and other types of energy, mass, and momentum balance modeling
- Evaluate performance and annual water savings for several typical climates using simulation models
- Perform prototype testing in lab cooling towers
- Perform technical and economic feasibility evaluation

Key Potential Benefits

- Potential for less cooling water consumption by up to 20%
- Lower cooling tower exit water temperature resulting in increased power production
- Ease of retrofitting
- Broad applications

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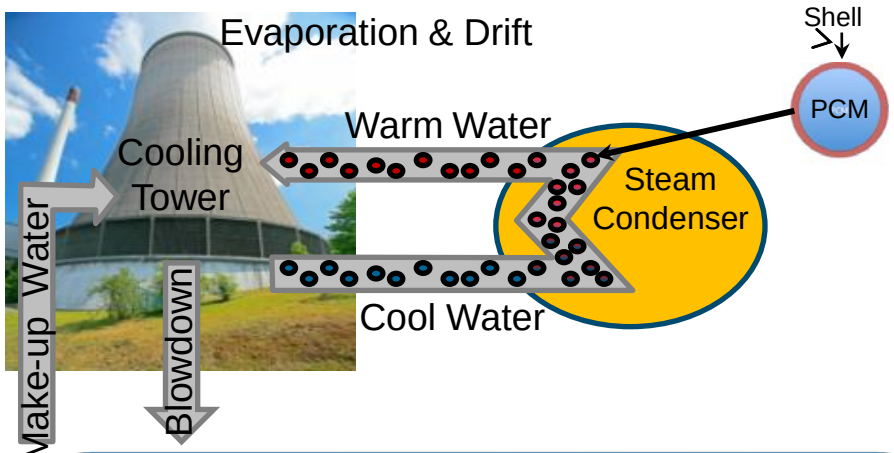
Breakthrough Project: Heat Absorption Nanoparticles in Coolant (Collaboration with Argonne National Laboratory)

Project Scope

- Develop multi-functional nanoparticles with ceramic shells and phase change material cores
- Measure nano-fluid thermo-physical properties
- Perform prototype testing in scaled down water cooled condenser and cooling tower systems
- Assess potential environmental impacts due to nanoparticle loss to ambient air and water source.
- Perform technical and economic feasibility evaluation

Phase Change Material (PCM) Core/Ceramic Shell Nano-particles added into the coolant.



Key Potential Benefits

- Up to 20% less evaporative loss potential
- Less drift loss
- Enhanced thermo-physical properties of coolant
- Inexpensive materials
- Ease of retrofitting
- Broad applications (hybrid/new/existing cooling systems)

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EPRI Water Innovation Program: Summary and Future Plans

Progress Since 2011 Program Initialization

- Received 114 proposals from Request for Information.
- Started seven projects including three more projects on:
  - Thermoelectric Cooling and Waste Heat Recovery Technology (Purdue)
  - Near 100% Vapor Capturing Technology (UMD)
  - Emerging Heat Transfer Enhancement Technology Evaluation (UIUC)

Status/Plan for 2012

- To fund four or more projects on water treatment and cooling
- Publishing two to three reports
- Planning for possible 2013 joint solicitation with the National Science Foundation.

Thank You!

Please feel free to contact us:

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