

NEED AREA: Thermoelectric power generation				
	Today's performance	Near-term Goals	Mid-term Goals	Long-term Goals
Dry cooling improvements	Energy penalty: 2% ann. gen. loss per plant; 25% gen. loss during hottest weather Cost penalty: 2-16%	R&D: Develop estimates of impacts of use of dry or hybrid cooling on capital costs, energy unit costs, extra capacity needs, carbon emissions, and air quality to identify system requirements for future applications of dry or hybrid cooling and overall system impacts R&D: Examine past work/research on extended surface tubes/fins. Demo fabrication solutions.(DOE) R&D: Reduce hot day impacts to generation capability.(DOE) R&D: Examine application to nuclear plants—preliminary design studies, figure out questions to investigate.(DOE)	I: Pilot testing of improved dry cooling concepts to collect performance data	
Hybrid cooling research	Showing signs of minimizing power penalty. Full scale demonstrations lacking.	R&D: Wind/fan impacts. Computational fluid dynamics modeling/detailed data gathering; field-demonstrate solutions. T&E: Engineering research to improve performance(DOE) T&E: Wet surface cooling demonstration.(DOE)		
Improved use of non-traditional water	Not being used.	R&D: Examine compatibility of materials in cooling systems with non-traditional waters(DOE) <ul style="list-style-type: none"> R&D: Impacts of using desal concentrate as cooling medium. R&D: What water quality components are most detrimental when used in hybrid cooling systems, and the mechanisms of adverse impact. Research on cooling tube, etc. materials that can handle produced water chemistries without degradation R&D: Conduct research on membranes for use with waste heat desal processes for upgrading non-traditional waters(DOE/BOR) <ul style="list-style-type: none"> Ceramics, crystalline clays R&D: Conduct health risk assessments of sewage water/effluent use in cooling towers.(WERF/DOE) <ul style="list-style-type: none"> T&E: Demonstrate better drift eliminators to reduce health risks. R&D: Reduce aerosol of reuse water in power plant cooling to reduce health impacts	R&D: Cycles of concentration—characterization of waters, new treatment techs to increase number of cooling cycles. T&E: Couple water quality polishing systems with hybrid cooling systems at demo sites. R&D: Zero discharge processes. GOAL: 25% use of impaired waters for power generation within 10 years	R&D: Utilize waste heat to treat water (U of Fl work)
Improved thermal efficiency/water efficiency approaches	PC: 40-45% eff IGCC: 43+% eff Coal: 300-500 g/kWh Nuc: 400-700 g/kWh NG: 100-200 g/kWh	R&D: Evaluate the potential for using in ground cooling to reduce capital costs and evaporative loss.(DOE) R&D: IGCC ability to handle high ash content coals.(DOE) R&D: Steam turbine improvements <ul style="list-style-type: none"> Improved modeling of steam turbines (reduce heat load). Steam turbine materials R&D: Heat recovery from condenser water discharge.(DOE) R&D: Computational modeling of power plant design/efficiencies, reduce heat load to environment and surface water	T&E: Demonstrate the technology	I: Develop design and economic criteria and move to implementation GOALS: PC: 60% IGCC: 60% Coal: 200-330 g/kWh Nuc: 340-600 g/kWh NG: 50-100 g/kWh

		T&E: Cooling tower condensate capture/ Reducing consumptive loss across a cooling tower(DOE)		
Enhanced scrubbing	Extensive research has been conducted- but questions about acid rain and mercury still occur No widescale testing of water conservation techniques at existing WFGDs. Water conservation may be limited by existing WQ of on-site water	NOTED AS LOW PRIORITY: R&D to reduce water loss in scrubbers R&D: Assess issues of advanced scrubbing to reduce CO2 and impacts on air quality and climate variability changes. R&D: Need to identify WQ parameters that could be detrimental to scrubber chemistry via on-site reuse of scrubber waters.	R&D: Need to identify polishing systems to combat WQ problems associated with scrubber water reuse; demonstrate same.	
More ecologically benign fresh and seawater intakes	Old data still being used for regulations on intakes, new emphasis on seawater intakes	R&D: Improved intake designs that reduce fish and aquatic species mortality. (DOE)	T&E: Pilot of advanced designs for seawater and fresh water	

Topic 1. Dry/Hybrid Cooling

GOAL: Reduce hot day impacts to generation capability

- Develop estimates of impacts of use of dry or hybrid cooling on capital costs, energy unit costs, extra capacity needs, carbon emissions, and air quality to identify system requirements for future applications of dry or hybrid cooling and overall system impacts
- Examine past work/research on extended surface tubes/fins. Demo fabrication solutions.
- STUDY: Examine application to nuclear plants—preliminary design studies, figure out questions to investigate.
- Wind/fan impacts. Computational fluid dynamics modeling/detailed data gathering; field-demonstrate solutions.
- Engineering research to improve performance of dry/hybrid systems
- Demonstrate hybrid wet surface cooling
- Mid-Term activity: Pilot test improved dry cooling concepts to collect performance data

Topic 2. Use of non-traditional cooling water in thermoelectric plants

GOAL: 25% use of impaired waters for power generation within 10 years

- Examine compatibility of materials in cooling systems with non-traditional waters
 - Impacts of using desal concentrate as cooling medium.
 - What water quality components are most detrimental when used in hybrid cooling systems, and the mechanisms of adverse impact.
 - Research on cooling tube, etc. materials that can handle produced water chemistries without degradation
- Conduct health risk assessments of sewage water/effluent use in cooling towers.(WERF/DOE)
 - Demonstrate better drift eliminators to reduce health risks.
- Reduce aerosol of reuse water in power plant cooling to reduce health impacts
- Mid-Term activity: Couple water quality polishing systems with hybrid cooling systems at demo sites.
- Mid-Term activity: Zero discharge processes.
- Long-Term activity: Utilization of waste heat to treat water (U of Fl work)

Topic 3. Improving thermal efficiencies/water efficiencies

GOALS: Thermal efficiency--PC: 60%, IGCC: 60%

GOALS: Water consumption—Coal: 200-330 g/kWh, Nuc: 340-600 g/kWh, NG: 50-100 g/kWh

- Evaluate the potential for using in ground cooling to reduce capital costs and evaporative loss.
- IGCC ability to handle high ash content coals.
- Steam turbine improvements
 - Improved modeling of steam turbines (reduce heat load).
 - Steam turbine materials
- Heat recovery from condenser water discharge.(DOE)
- Computational modeling of power plant design/efficiencies, reduce heat load to environment and surface water
- Cooling tower condensate capture/ Reducing consumptive loss across a cooling tower

- Mid-Term activity: Demonstrate the technology
- Long-Term activity: Develop design and economic criteria and move to implementation

Topic 4. Enhanced scrubbing

- R&D to reduce water loss in scrubbers
- Assess issues of advanced scrubbing to reduce CO₂ and impacts on air quality and climate variability changes.
- STUDY: Identify WQ parameters that could be detrimental to scrubber chemistry via on-site reuse of scrubber waters.

Topic 5. Intake research

- Improve intake designs that reduce fish and aquatic species mortality.
- Mid-Term activity: Pilot of advanced designs for seawater and fresh water