*Task 2. Request for Proposals:* **2026**

# Power Plants: Recovering Water from Cooling Towers

**Task Sponsored by** Diamond Sponsor El Paso Electric Co. Charitable Foundation
Platinum Sponsor: Las Cruces Utilities

**Task Developed by** El Paso Electric Co., Las Cruces Utilities, and University of Texas – El Paso

## Introduction

Electricity generation requires substantial amounts of water – averaging about 11,000 gallons per MWh across the U.S. [1]. While power plants near rivers, lakes, or the sea can draw and return water with relative ease, inland facilities in arid climates face greater challenges due to limited access to natural water resources. For these facilities, minimizing water loss – especially from their largest source: cooling tower evaporation – is essential for water conservation and sustainable operations.

This design challenge focuses on developing retrofit solutions to recover and reuse water lost from power plant evaporative cooling towers. The potential for global impact is substantial since over half of the U.S. inland coal and nuclear plants rely on these systems. While evaporative cooling is energy efficient, it also results in significant water loss, with each plant potentially losing hundreds of millions of gallons annually.

Because evaporative cooling technology is so widely adopted, even modest gains in water recovery could yield substantial global benefits – conserving water, lowering electricity costs, and strengthening the sustainability of the energy infrastructure worldwide.

## Problem Statement

Design a cost-effective retrofit system to recover water vapor from a mechanical draft cooling tower at an inland power plant of your choice that faces water scarcity. Your solution should capture water vapor through evaporation and return it to the cooling tower's cold-water basin for reuse. The goal is to maximize water recovery while minimizing retrofit capital and operating expenses. The design must not compromise current cooling tower operations, performance, energy efficiency, or recirculating water quality.

The retrofit may target a single cooling-tower cell, multiple cells, or an entire tower unit. If the system is scalable, include a plan for replicating the technology across additional cells or units, as needed, to implement your design across the entire cooling tower system. Design the bench-scale demonstration to simulate your system's intended functionality.

Teams are encouraged to use innovative approaches and must consider site-specific constraints, including climate and seasonal characteristics (expected temperatures, humidity, wind velocities, etc.) throughout the year, as well as operational characteristics within the selected power plant, such as inlet/outlet temperatures, flow rates, fill structure, fans, etc., as appropriate to your solution.

Assume the cost of water to be $6.00/1000 gallons. Unless your selected cooling tower differs greatly, consider a single full-scale cooling tower cell to be 131' high x 65' wide x 65' deep (40 m H x 20 m W x 20 m D).

*Note: Terms used in this problem statement are defined below.*

## Background

Power plants – whether powered by solar-thermal, nuclear, natural gas, or even some renewable sources – often rely on boiling water to produce steam, which drives turbines to generate electricity. After the steam exits the turbines, it is cooled and condensed back into hot water. To enable a recirculating closed-loop process in wet-cooling tower systems, the hot water is routed to cooling towers, where evaporation removes the excess heat before the water is recirculated through the system and recycled for repeated use in steam generation.

Power plants – whether powered by solar-thermal, nuclear, natural gas, or even some renewable sources – often rely on boiling water to produce steam, which drives turbines to generate electricity. After the steam exits the turbines, it is cooled and condensed back into hot water. The hot water is routed to cooling towers, where evaporation removes excess heat. Most inland power plants conserve this water through a closed-loop recirculating system, cycling the same water repeatedly for steam generation.

Note that power plant cooling systems—commonly referred to as cooling towers—are not always tower-shaped, but the term is used for historical reasons. This document provides essential background to begin the task, but for a deeper dive into power plant cooling technologies, numerous overviews are available (e.g., [11 - 13]).

Definitions: For the purpose of this design challenge, we will define the following.

- *Evaporation:* The process by which liquid water transitions to its gaseous phase (water vapor).
- *Water vapor:* Water in its gaseous state, invisible to the eye; it can form at temperatures either below or above the boiling point. In this task, the term "water vapor" refers specifically to vapor produced through the cooler evaporation processes (not from steam).
- *Steam:* Water vapor produced at or above the boiling point. While the vapor itself is invisible, "steam" commonly refers to the visible mist of tiny water droplets that form when the hot vapor cools enough to condense.
- *Plumes:* Visible clouds of condensed water droplets formed when water vapor comes in contact with cooler air and condenses. This task refers to plumes only in the context of condensing cool water vapor.
- *Cooling:* Removing heat.
- *TDS (Total Dissolved Solids)*: A measure of substances dissolved in water, generally including inorganic salts such as calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), bicarbonates ($HCO_3$), chlorides ($Cl^-$), silica (Si), and sulfates ($SO_4^{2-}$), and small amounts of organic matter. Only some of these are typically present in recirculating cooling tower water. Note that high TDS can damage equipment.
- *Drift:* Small amounts of water from cooling towers that are carried off by wind.
- *Makeup water:* Fresh water added to a cooling system to replace water losses due to evaporation and blowdown and to help control TDS in the system.
- *Blowdown* a.k.a. *Bleed-off*: The portion of high-TDS water that is intentionally drained from the cooling system and replaced by makeup water to maintain water quality and prevent mineral buildup.
- *Scaling:* The accumulation of solid mineral deposits on pipes, filters, and equipment (commonly $Ca^{2+}$, $Mg^{2+}$, $SiO_2$, etc.). The minerals precipitate out of solution when they reach their saturation point.
- *Wet cooling systems:* Cooling technology that relies on evaporation to remove heat from water.
- *Dry cooling systems:* Cooling technology that uses blowing air to remove heat from water.
- *Water withdrawal:* Water that is withdrawn from surface waters, groundwater, etc. for use in cooling towers.
- *Water consumption a.k.a. Water use:* Water lost during industrial processes.
- *Cooling unit:* One entire cooling tower structure consisting of multiple cells (see Fig. 1).
- *Cooling cell:* A smaller self-contained section of a cooling tower unit (see Fig. 1).

By the Numbers – Sources of Water Loss in Cooling Towers

Evaporation is the primary mechanism of water loss in cooling towers; however other factors – such as drift and blowdown (bleed-off) – also contribute to overall consumption. Although the latter two are not the primary focus of this task, they are important considerations when evaluating total water usage. In some cases, reported water loss from a given cooling tower will combine the effects of evaporation, drift, and blowdown, making it important to clarify what is actually being measured.

Equations for quantifying evaporation, drift, and blowdown losses in cooling towers are well established and can be found in a variety of sources [2 - 5], among others. Representative values are summarized below.

*Quantifying Evaporation Loss:* Evaporation in wet cooling towers is quantified in a number of ways:

- The U.S. EPA reports that approximately 1.8 gallons of water will evaporate per ton-hour of cooling, a value that is independent of the system's operating efficiency [2].
- A rule of thumb provided by the New Mexico Office of the State Engineer, states that for every 10˚F in temperature reduction, approximately 1% of the recirculating water is lost to evaporation [3, 4].
- Power plants often report total water consumption in terms of *water intensity* (measured in liters per kilowatt-hour (L/kWh)). How does this translate to volumes of water lost? Based on published water intensity value ranges, WERC estimates that water losses for a high-energy-use power plant serving 1 million people may reach 4.8 - 6.9 billion gallons per year (BGY), using the following assumptions.
    - *Water Intensity:* Water consumption at power plants ranges from 1.75 - 2.5 L/kWh, according to the World Nuclear Association [6].
    - *Electricity Consumption*: A high-end estimate for U.S. electricity use is $10.376 \times 10^9$ kWh/yr per million people. WERC derived this from a data.gov electricity-usage model [7] using predictions for the 50 cities with the highest modeled electricity use.
    - *Annual Water User per 1 Million People:* The estimated water consumption for a power plant serving 1 million people is calculated as Water Intensity * Electricity Consumption:

$$\text{Estimated annual water use}/1\times10^6 \text{ people} = 1.75\text{-}2.5 \text{ L/kWh} * 10.376 \times 10^9 \text{ kWh/yr}$$

$$\mathbf{= 1.82 \times 10^{10} \text{ to } 2.59 \times 10^{10} \text{ L/year (or 4.8 to 6.9 BGY).}}$$

- One cooling tower manufacturer reports that evaporation alone accounts for 55-85% of total water loss from cooling towers, with higher values associated with continuous operation [8].
- A 2010 internal evaluation by El Paso Electric Company (EPE) indicates a 72% water loss due to combined evaporation and drift for their arid inland facility. This value is consistent with the range reported above. To illustrate how water consumption rates translate into percent water loss, we will examine this internal study of four wet cooling towers at EPE's Newman Plant [9].
    - The cooling towers received 2,348 gallons per minute (GPM) of water, with 1,693 GPM lost to evaporation and drift. Hence, 2.44 million gallons per day (MGD) or 890.6 MGY was lost to the atmosphere. Although these values include both evaporation and drift, note that drift typically accounts for no more than 0.2% of total water loss in cooling towers (see below).
    - This represents 72% of incoming water being lost during evaporative cooling. While this percentage may still be applicable today, the absolute volume of water lost in 2010 was lower than the 4.8 – 6.9 BGY estimate cited above, likely due to growth in electricity demand and the corresponding increase in water use since 2010, when the plant served approximately 400,000 customers. For comparison, in 2024, EPE's water use rate was 7.5 billion gal/yr.

*Drift loss:* Water loss due to drift is the smallest contributor to overall water consumption in cooling towers, typically ranging from 0.05-0.2% of the water flowing through the system. To control drift, most cooling towers are now equipped with baffles and drift eliminators that reduce this loss to less than 0.005% [3].

*Blowdown loss:* Water loss from blowdown is directly tied to evaporation and drift losses. As water evaporates, dissolved solids such as Ca, Mg, $Cl^-$, and Si become concentrated and can precipitate out of solution, causing scaling and corrosion in the system. To prevent this, a portion of the high TDS water is discharged (blowdown) and replaced with makeup water. The number of cycles that the system can operate before requiring blowdown depends on the relationship between the water's TDS levels and its electrical conductivity [2, 3].

*Makeup water quality:* Power plant operators must manage makeup water carefully. While fresh water is typically used, pure distilled water is avoided due to its corrosive nature in heat-transfer applications. Lacking essential ions, it tends to leach them from pipes and equipment, causing corrosion as it seeks to restore ionic balance. To prevent damage to pipes and equipment, distilled water is typically treated with corrosion inhibitors [10].

Wet Cooling Systems (a.k.a. Mechanical Draft Cooling Towers)

This task addresses the most widely used cooling technology for power plants: wet cooling towers that rely on evaporation to remove heat from a system. Their popularity is driven by two key advantages: evaporation is the most energy efficient way to cool water, and wet cooling towers are the most cost-effective cooling units to build.

We will focus on the subset of wet-cooling towers that transfer heat through fan-driven evaporation and forced convection. These are termed mechanical draft cooling towers (MDCTs). In MDCTs, the purpose of the fans is two-fold: to facilitate evaporation as water moves through the unit, and to release heat by venting hot air and water vapor to the atmosphere [14]. Though not addressed here, the alternative to MDCTs is Natural Convection Wet Cooling Towers that allow natural convection, rather than fans, to drive heat transfer.

For this task, the MDCT will incorporate water recycling. The basic process flow of such a system, as reported by de Souza et al. [14], is illustrated in Figure 1. In the condenser ①, flowing cold water cools and condenses the steam that has recently passed through the turbines, producing hot water that is sent to the MDCT ② where it is cooled through evaporation as it travels through "fill" ③. Fill incorporates baffles that enhance evaporation rates by increasing the surface area of the flowing water. Large fans ④ move air across the wet fill, enhancing evaporation and venting the resulting hot air and water vapor to the atmosphere ⑤. The remaining cool water returns to the cold-water basin ⑥, along with any makeup water ⑦ needed to replace losses from evaporation, drift, and blowdown. The water in the cold-water basin is then returned to the condenser ⑧, and a new cycle begins.

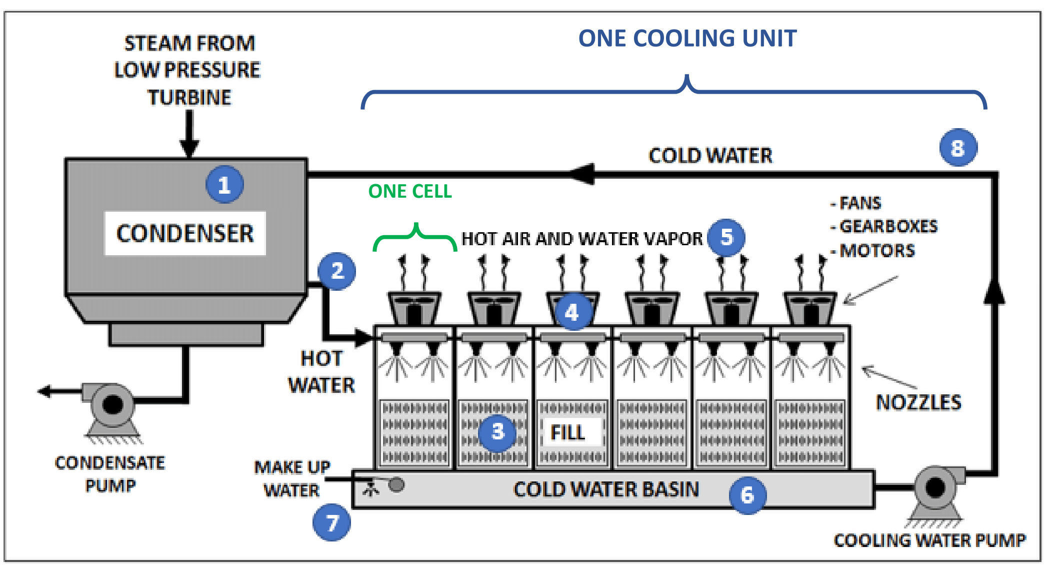


Fig. 1. Schematic of a Mechanical Draft Cooling Tower (MDCT) [*from de Souza, et. al., 14*]. Processes 1-8, are described in the text above. The representative cooling unit shown has six cells, with the green bracket highlighting a single cell.

In a wet cooling tower, a *cell* is the smallest independently functioning unit, capable of handling its own air and water flow. Each cell is a self-contained section of the larger tower. It is defined by exterior walls or internal partitions and equipped with its own fans and water distribution system. A key advantage of this configuration is that a single cell can be isolated and shut off for maintenance while the others continue operating. Fig.1 illustrates a tower with six cells, and Fig. 2 shows one with 18.

For this design challenge, your team may choose to design either:

- a system for a single cell that can be replicated across multiple cells, or
- an over-arching system that simultaneously integrates and manages water recovery from multiple cells or the entire tower.

In either case, each team's solution will be evaluated primarily by the total volume of water recovered, the feasibility of implementation, and the cost-effectiveness of achieving it.

<u>Comparing Wet vs Dry Cooling Systems</u>

MDCTs' main advantage – energy-efficient heat removal – also creates their primary drawback: significant water loss due to evaporation. To address this, power plants are beginning to replace some of their wet cooling towers with costlier and less energy-efficient dry cooling units. For example, EPE recently replaced three 60+ year-old wet cooling towers with the Newman 6 natural gas unit that uses dry cooling technology. The 228 MW unit is expected to save 600 million gallons of water per year [15].

Dry cooling uses air to cool and condense the turbine steam. In most systems, hot water from the condenser flows through a closed-circuit heat exchanger, such as closed tubing, while cooler air passes across it. Because the water is sealed inside the system, dry cooling can reduce water consumption by up to 90%, but there are significant drawbacks compared with wet cooling systems: 1) higher capital costs due to need for higher cooling surface areas, and hence, more infrastructure and land area; 2) higher energy costs because the air-to-water heat transfer rate is lower and usually requires auxiliary cooling fans, and steam exiting the turbine tends to be at higher temperatures, placing greater demands on the cooling system, further reducing energy efficiency [16].

Many power plants cannot justify fully transitioning to dry cooling systems because of the high costs involved that would be passed on to the customer. They are already heavily invested in MDCTs with 10-20+ years of remaining service and are reluctant, both financially and environmentally, to discard functioning systems in favor of those that inherently have higher capital and operating costs. In contrast, an affordable retrofit could save water, extend the life of existing infrastructure, and help keep electricity rates lower for customers.

<u>Controlling Plumes While Recovering Water</u>

When the temperature of the water vapor leaving a cooling tower falls below the dew point, some of the water vapor will condense, developing plumes of water vapor (Fig. 2). As expected, this phenomenon is more common during cooler seasons.

Fig. 2. Plumes rising from an 18-cell mechanical draft cooling tower. The cells are arranged in two rows of nine cells [*photo from Marley, 17*].

Visible plumes are often regulated by local governments, because: 1) The public may mistake the harmless vapor for pollution or smoke from a fire; 2) The droplets can reduce visibility near roads and airport runways; 3) In winter, drifting plumes that freeze on walkways or roads could cause safety hazards; and 4) Elevated humidity near the towers can accelerate corrosion of nearby equipment.

Thus, developing a means of capturing the water vapor for reuse in MDCTs would also benefit power plant operations by reducing regulatory oversight, extending equipment life, and enhancing public relations.

## Task-Specific Parameters

The previous sections provided a general overview of cooling towers. Below you will find contest-specific parameters to consider.

### The Cost of Water

The cost of water is a key factor when evaluating the economics of installing and maintaining water-conservation retrofits. Hence, it will be an important component of your team's techno-economic analysis. Industrial water rates vary widely across the U.S. [18]. In the arid Southwest, they range from under $3.00 to over $9.00 per 1000 gallons, depending on local water supplies and political influences [19].

WERC will reference the Environmental Protection Agency's *WaterSense* program as a basis for establishing an industrial water rate to be used by all teams. In 2023, *WaterSense* reported the U.S. average commercial cost of water in the U.S. as $5.64/1000 gal ($/kgal), noting that costs are expected to rise as water scarcity increases [18]. Based on this value, teams will assume the cost of water to be $6.00/kgal.

### Climatic Conditions

Your team should explore technologies that support year-round water recovery. Consider, on a month-by-month basis, how climate affects evaporation rates, condensation rates, and cooling performance, taking into account temperature, relative humidity, and air movement, etc. [for guidance, see 20].

A key opportunity for innovation is enhancing water recovery during hot summer months, when it is more challenging to condense vapor. Teams are encouraged to explore strategies for these conditions, but even if your team achieves the most efficiency gains during cooler months, the total annual water savings can still be substantial. Consider all seasonal conditions, aiming to maximize annual water recovery while minimizing costs.

Your design must also prioritize structural and material durability that addresses extreme conditions at your chosen site. These may include high winds, heavy rainfall or snowfall, intense sunlight, and other harsh climatic conditions. For example, El Paso frequently experiences strong solar radiation and powerful winds. Although annual rainfall is low, most heavy rains are during the late July – August monsoon season, when short-lived, intense thunder storms can happen daily. Therefore, your design should be engineered to withstand these harsh environmental conditions.

### Case Study: El Paso Electric Co, El Paso, TX.

Your team may explore retrofit solutions for <u>any</u> inland power plant that is challenged by water scarcity. You are welcome to use EPE's infrastructure and service area as a model, or select another inland facility with similar water constraints. The chosen site should provide a relevant context for developing and demonstrating innovative water-conservation strategies.

For illustration, EPE operates in an inland water-stressed region. It serves approximately 465,000 customers within a 10,000 square-mile area across West Texas and Southern New Mexico. With an average annual rainfall of only 9 inches, natural recharge of both ground and surface water is minimal, highlighting the critical need for water conservation. In their 2024 annual sustainability report, EPE reported a water consumption rate of 2.48 L/kWh, placing it at the higher end of the World Nuclear Association reported range reported earlier in this document (see p. 3).

Highlighting the lack of surface-water recharge in El Paso, Fig. 3 shows the Rio Grande[1] in April, 2022. Once a consistently flowing river, it now runs only seasonally, typically from June through August, due to controlled releases from Elephant Butte Reservoir, 83 miles north. These releases are managed by the Bureau of Reclamation under the Rio Grande Project to allocate water for irrigation and municipal use.

Persistent drought has reduced supplies, and El Paso has not received its full allocation of water in the past decade. (For an interesting weekend diversion, watch the river return in the NMSU-student-run news report, *"Water Comes Back to the Rio Grande":* https://www.youtube.com/watch?v=KHh994-Ilzk).


Fig. 3. Tire tracks on the dry riverbed of the Rio Grande – a typical site in El Paso, TX from October-May each year. The blue arrow indicates where the river normally flows. The gold P locates a moist portion of the riverbed that sustained plant life during the dry season. The river will fill again later in the summer when water is released from the Elephant Butte Reservoir. [*From Danielle Prokop, El Paso Matters, April 2022, 21*].

EPE is the largest water user in El Paso County, Texas, with a consumption rate of 2,048 L/Net MWh in 2024. This translates to a total water use of approximately 28 trillion L/yr (or 7.5 billion gal/yr) [15]. For reference, the total water usage from all sources in El Paso is about 40 billion gallons per year [22]. Thus, generation of electricity accounts for almost 19% of El Paso's total water consumption.

While continuing to provide reliable power to the community, EPE has reduced water consumption by 300 L/Net MWh over the past two years. Recent water-conservation strategies include recycling water in cooling towers and replacing three wet-cooling towers with a new dry cooling unit [15].

However, most of EPE's cooling units (including the Rio Grande and Montana power stations, and all but one unit at the Newman Station) are MDCTs with an expected remaining life of 10 to 20 years. These existing units are prime candidates for retrofits that can maintain the plant's current energy efficiency and further reduce water use without needlessly and prematurely replacing the units. A well-designed retrofit could both extend unit performance life and reduce water costs, resulting in substantial operational savings that could benefit customers.

[1] *"Rio" means "river", therefore calling it the "Rio Grande river" is technically redundant.*
*"Grande" means "large". The Rio Grande was once a large river, until affected by drought and upstream damming.*

Outage Seasons: Full-scale Prototype Testing Timeline

As teams plan for full-scale implementation of their designs, it is important to understand prototype testing and timelines at a power plant. The best time to install and test a retrofit system is during a power plant's *outage season*, when a unit is taken offline for maintenance and repairs. Power plants typically schedule outages during the "shoulder months" of spring and fall, when electricity demand is lower, to minimize impact on customers.

For example, at EPE, a single unit may be taken offline for four consecutive months, such as October through February, while the other units continue operating. This leaves only four months to fully install, test, and troubleshoot a retrofit system before the unit must be returned to service. The outage schedule is strict, and a unit cannot remain offline beyond the designated outage period.

Your team's design should allow for complete installation and testing to comfortably fit within this four-month timeline, allowing a factor of safety for delays and troubleshooting.

Current Technologies and Opportunity for Innovation

By retro-fitting already energy-efficient MDCTs, your team can enhance water recovery without compromising cooling performance or constructing costly new infrastructure. Given the widespread use of MDCTs, a successful design could save millions of gallons of water annually, reduce operational costs, and support more sustainable energy operations.

Note that some companies are already tackling issues that overlap with this task. For example, retrofits designed to reduce cooling tower plumes [23, 24], inherently address water-vapor capture. A few of these companies have expanded these systems to actively recover water [25].

Your team's challenge is to look beyond existing technologies and develop innovative, cost-effective solutions. In particular, strategies that improve water recovery during hot summer months (even if less efficient than in colder months) could represent a major breakthrough in sustainable cooling tower operation.

## Design Requirements

Your proposed design should answer the Problem Statement given on page 1 and provide specific details and outcomes as follows:

- Select an inland power plant that uses MDCT wet-cooling technology and is challenged by water scarcity. Design your retrofit based on the plant's cooling tower parameters, climate conditions, and other relevant factors. Unless your selected power plant differs significantly, consider the cooling tower to be 131' H and 65' square in cross-section (40 m H x 20 m W x 20 m D).
- Research the potential to capture condensate from escaping vapor in your selected cooling tower system and return the recovered water to the cold-water basin. Disregard other water losses, such as drift and blowdown, in your water-recovery system.
- Ensure that your design will not hinder day-to-day operations at the plant or the performance of the cooling tower. Your 30% Project Review will serve as the starting point for addressing this concern.
- Design your system to endure extreme environmental conditions, including high winds, heavy rainfall or snowfall, intense sunlight, and other climate-specific stresses relevant to your chosen power plant.
- Include a Process Flow Diagram (PFD) that outlines the primary processes involved in your water-recovery system. Include all inputs (such as water, other influents, chemicals, etc., energy required) and outputs (such as water recovered and delivered to the cold-water basin, water lost to the atmosphere or retrofit equipment), and any waste generated.
- Evaluate and report the potential percent water recovery of the system on a month-by-month basis and under a variety of climatic conditions (temperature, humidity, wind, barometric pressure, etc.). In the

technical report, recommend strategies for full-scale seasonal implementation to minimize capital, operating, and maintenance costs throughout one year.

- Plan for full-scale implementation at the power plant of your choice by developing a detailed timeline for installation, testing, and troubleshooting that can be comfortably completed within a four-month outage period. Document this timeline based on real-world construction and commissioning estimates. Account for site-specific factors such as permitting, equipment delivery, labor availability, and integration with existing infrastructure.
- Limit your bench-scale designs to operate under atmospheric pressure (for safety at the contest), unless otherwise approved in the ESP.
- Evaluate the expected quality of the recovered water as it is returned to the cold-water basin. If needed, propose strategies to ensure that the retrofit will not adversely affect water quality within the circulating water. Such proposed strategies shall be included in the technical report and perhaps the poster and oral presentations, but they are not necessary for the bench-scale demonstration.
- Develop a community engagement plan (see Team Manual). Focus on energy efficiency, aesthetic appeal, water-wise programs, etc., as appropriate to your project that inform and/or engage the community.
- Outline a plan for proper disposal of waste products generated by your system, if needed.
- Present a Techno-Economic Analysis (TEA) to recover water from cooling towers on an annual basis. The outcome of the TEA should be to evaluate the cost of building, installing, and maintaining a water recovery retrofit system. Assess how water savings could offset those costs. The ultimate metric for evaluation should be the <u>cost/gallon of water recovered per year</u>.

  Include your estimate of capital costs (CAPEX) and operational costs (OPEX) and include appropriate graphical representation of your cost data:
  - Capital expenses typically include, but are not limited to, equipment, pipes, pumps, wiring, etc., needed to set up your retrofit water-recovery system. Do not include costs of buildings needed to construct or store your system until it can be installed.
  - Operating expenses (OPEX) should include the cost of materials needed, including consumables (chemicals, sacrificial components, etc.). In addition to other operating costs your team identifies, include:
    - staff labor rate of $70/hour;
    - solids disposal costs ($50/ton);
    - energy requirements (research an industrial natural gas rate and state in $/MM BTU; use an electricity rate of $0.09/kWh).
  - Visualization tools: Use tools such as sensitivity analyses, graphs, and other visuals to illustrate how key parameters impact system performance and economics.
- Reflect on alternative designs and situations in which those designs might be more viable than your chosen design, recalling that an optimal solution depends on outside factors–the "best" design may be dependent on region and may change over time.
- To be eligible for consideration for the P2 Award (Pollution Prevention Award), if applicable, set up a "Pollution Prevention" section of the report that documents success in energy efficiency, pollution prevention, and/or waste minimization.
- Address any intangible benefits of the selected treatment process.
- Address safety aspects of your design for both the full-scale design and the bench-scale demonstration in both the written report and the Experimental Safety Plan (ESP).

## Bench Scale Demonstration

The Bench-scale demonstration will serve to illustrate the design considerations listed above. Your team will demonstrate the functionality and effectiveness of your cooling tower water-recovery system during the bench-scale demonstrations on Tuesday, April 14, 2026.

Build a functioning prototype that will demonstrate your MDCT retrofit technology, whether for a single cell, multiple cells, or an entire cooling-tower unit. If your design applies to a single cell and can be replicated across cells, only one single-cell prototype is necessary. If your design integrates multiple cells, the prototype should demonstrate the full system, showing how multiple cells or an entire unit function together.

Any recommended post-recovery water treatments should be addressed in the technical report, oral presentation, and poster presentation, but are not required for the bench-scale demonstration.

***Before the contest:***

- Your team will submit the 30% Project Review and build and test the bench-scale prototype.
- For the safety of all competitors, your bench-scale system must operate no higher than 1 atm of pressure, unless otherwise approved in your 30% Project Review and ESP. The full-scale system may theoretically operate at higher pressures. If that is optimal, plans for elevated pressures should be addressed in the technical report.
- Build your bench-scale apparatus on a 1:60 scale. If this is impractical for your design and WERC's bench-scale booth area (see Team Manual), include a request in your 30% Project Review to use an alternative scale.

***At the contest your team will provide:*** A working bench-scale prototype, built on a 1:60 scale (or as approved by WERC), that demonstrates your team's full-scale cooling tower unit functionality. Teams will provide all materials and supplies needed to generate and recover water vapor. For the purposes of demonstration, teams may use steam in lieu of water vapor to simulate evaporation.

***At the contest WERC will provide:*** Basic booth setup, as described in the Team Manual, water, and any other items requested by your team. For example, if there are materials or chemicals that would be difficult/unsafe to transport to the contest, your team may request that WERC provide these. (See 30% Project Review, below.)

***Bench-scale testing****:* Due to contest constraints, all teams at the contest have a maximum of 30 hours to demonstrate their solution. Your team will be demonstrating your solution outdoors, unless otherwise requested.

## 30% Project Review

Your 30% Project Review. Is an important part of preparing your bench-scale demonstration. Due in late January (or as arranged with WERC), it outlines the design and functionality of your cooling-tower model and water-recovery system; it also outlines the details for demonstrating and testing your system during the contest in Las Cruces.

The 2026 Team Manual gives general guidelines for the 30% review.

- Submit a <u>complete</u> Process Flow Diagram (PFD). The PFD serves as a robust outline of all processes in your treatment system, showing balanced inputs and outputs.

In addition, and specific to this project:

- Request the volume of water needed to run your bench-scale demonstration.
- Submit scaled plans of your retrofit design. Ensure that all items are labeled.

- Submit a draft for your bench-scale demonstration setup. The draft should be a 3-D view, drawn to-scale, with dimensions labeled.
    - Consider that the contest is held at a banquet facility, without typical lab resources (e.g., no fume hoods, ovens, etc.). WERC typically provides your team with an 8’ folding table with access to 120V power. See the Team Manual for more booth parameters.
    - Drawings that WERC cannot easily interpret will be returned to the team for revisions – help us understand your plans so we can support you!
- Outline bench-scale testing parameters by describing how you will:
    - Generate the water vapor: describe the source and method, target temperature, airflow, etc.
    - Measure*:
        - 1) *Pre-capture vapor production:* the amount of water converted to vapor prior to capture;
        - 2) *Captured water*: how much water vapor is recovered by your system.
        - 3) *Losses:* how much water bypasses your system and is lost, either to the atmosphere or within your system.
        - 4) *Other parameters, as needed:* Ambient temperatures, relative humidity, pressures, pressure drops, energy use, basin temperature, water quality, etc.

        *Because measuring water loss and recovery can be challenging, WERC recommends using multiple methods to provide cross-checks. Note that water recovery and loss may be also be assessed indirectly through water-quality measurements.

## Experimental Safety Plan (ESP) and Required Short Course

See team manual for details. Due date is listed below.

### Technical Report Requirements

The written report must address in detail the items highlighted in the Problem Statement, Design Requirements, Evaluation Criteria, and the 2026 Team Manual. The written report should demonstrate your team’s insight into the full scope of the issue and include all aspects of the problem and your proposed solution. The report will be evaluated for quality of writing, logic, organization, clarity, reason, and coherence. Standards for publications in technical journals apply.

The report must include 3 independent audits that should be obtained 2-3 weeks prior to the report submission due date (see Team Manual).

## Evaluation Criteria

Each year, the WERC Environmental Design Contest and its sponsors award more than $30,000 in cash prizes. There are task-specific prizes and overall contest awards. See the Team Manual for more information.

Each team is advised to read the 2026 Team Manual for a comprehensive understanding of the contest evaluation criteria. For a copy of the Team Manual, Public Involvement Plan, and other important resources, visit the WERC website: https://werc.nmsu.edu/team-info/guidelines.html

Your team’s response to this task includes five components (see Rubrics in the Team Manual):

- Written report,
- Formal oral presentation,
- Bench-scale Prototype Demonstration,
- Poster concisely conveying the essence of your work through text and graphics,
- Flash Pitch: a separately judged 3-minute investor pitch for your project

Judges' evaluation of your entry will include consideration of the following points specific to this task:

- Potential for real-life implementation, including effectiveness, expected reliability, and maintainability.
- Operational impact, ensuring the retrofit does not hinder cooling efficiency, water quality, or day-to-day operations of existing cooling towers and associated equipment.
- Overall adjusted costs and the cost/benefit of your solution against those for other teams, measured in terms of cost/gallon of water recovered per year.
- Thoroughness and quality of the economic analysis.
- Originality and innovation represented by the proposed technology.
- Quality of the Community Engagement Plan.
- Other specific evaluation criteria that may be provided at a later date (watch the FAQs).

**Dates, Deadlines, FAQs** (*dates subject to change—watch website FAQs*)

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|---|---|
| This Fall | Email us to reserve a spot for your team and get on the email list for this task. Registration is limited. |
| Weekly | Check FAQs for updates:<br>• Task-specific FAQs: 2026 Tasks/Task FAQs<br>• General FAQs: 2026 General FAQs |
| November 1, 2025 - December 31, 2025 | Early Bird Registration (discount applies) |
| December 1, 2025 – January 30, 2026 | 30% Project Review Due (or as arranged with WERC). |
| December 1, 2025 – February 16,2026 | Mandatory On-demand Course:<br>Preparing the Experimental Safety Plan. See Team Manual. |
| February 17, 2026 | Final date to register a team w/o permission. |
| March 9 -13, 2026 | Experimental Safety Plan (ESP) due to Juanita Miller.<br>Include requests for chemicals, materials, etc. |
| April 2, 2026 | Technical Report due |
| April 12 – 15, 2026 | Contest in Las Cruces |

**Contacts:**

ESP and Safety Officer: Juanita Miller, miljgh@nmsu.edu
All other questions and concerns: Ginger Scarbrough, werc@nmsu.edu

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