Responding to power demand growth with inlet air cooling retrofits

August 4, 2025 Curated By Clarion Energy Content Directors

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By Chris Sanchez, Burns & McDonnell

and tighter energy markets. Inlet air cooling (IAC) offers a practical, proven solution for enhancing turbine efficiency and gaining valuable megawatts from equipment already in the field.

Why inlet air cooling matters now

Combustion turbine output is directly affected by ambient air temperature. When temperatures rise, air density decreases, reducing the amount of oxygen available for combustion and degrading turbine efficiency. For every 4-degree Fahrenheit drop in inlet temperature, output can increase by roughly 1%. When summer temperatures climb above 90 degrees, utilities can see a 10% performance loss without mitigation.

IAC counteracts these effects by chilling the incoming air before it enters the turbine. Many turbines are designed to operate most efficiently when inlet air temperatures are maintained between 50 and 60 degrees. Reaching that target range can unlock 10% or more in additional capacity — without the need for added generation. For operators dealing with long interconnection queues, lengthy lead times for new turbines and tariffs on imported equipment, IAC offers a quick and straightforward solution to get more megawatts on the grid.

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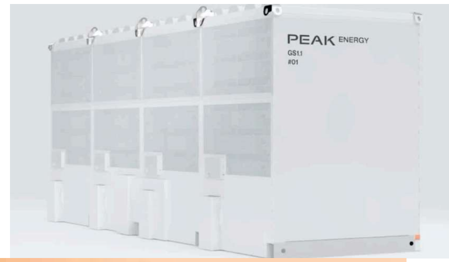

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Electricity use in the U.S. rose by 2% in 2024, signaling an upward shift after nearly 20 years of relatively steady demand. The U.S. Energy Information Administration projects similar growth rates in 2025 and 2026, which would mark the first period of three consecutive years of demand growth since 2005 to 2007. Industrial users are expected to drive much of this increase, with new semiconductor and battery manufacturing facilities adding significant load. In the commercial sector, the expansion of data centers continues to push electricity demand even higher.

Start with a feasibility study

Every power plant has unique characteristics that influence the feasibility and design of an IAC retrofit. A Class 4 or 5 feasibility study is essential for reliable, cost-effective project planning. Key areas of evaluation include:

- Turbine type, age and thermal performance.
- Site layout, existing ductwork and space constraints.
- Local permitting, environmental impact or water use restrictions.
- Electrical capacity for supporting chilling systems and thermal energy

Space is often the greatest constraint. Utilities must evaluate whether there is sufficient space for chillers, piping and TES tanks. Some sites may benefit from modular systems that offer faster installation and a smaller footprint, while others may opt for stick-built central utility plants that provide greater long-term flexibility and customization.

Comparing with inlet fogging systems

Inlet fogging systems are another method for reducing inlet air temperature, offering a lower capital alternative to chiller-based IAC systems. Inlet fogging systems use evaporative cooling to reduce air temperature by spraying ultrapure water mist into the airstream. While inlet fogging systems can be effective in dry climates, their performance is heavily dependent on ambient conditions. Unlike chiller-based systems that provide consistent cooling, fogging systems introduce greater variability, making them less predictable in humid environments. Fogging systems generally require less electricity but can demand more physical space and may generate greater environmental air impacts via larger plumes. Additionally, care should be taken when designing the nozzle placement to facilitate complete evaporation of water in the air before entering the turbine, as this could lead to damage. For sites with limited budgets and suitable environmental conditions, inlet fogging may provide certain benefits. However, for utilities focused on maximizing output consistently, chiller-based solutions, like IAC, typically deliver greater reliability and performance.

Choosing the right cooling solution

The appropriate IAC design depends on the plant's operating profile, local temperature trends and thermal characteristics of its turbines. Commonly used centrifugal chillers can be tailored for turbine applications using series configurations or hybrid setups. TES systems can reduce operational costs by shifting load and minimizing chiller runtime during periods of peak electrical demand.

Key considerations include:

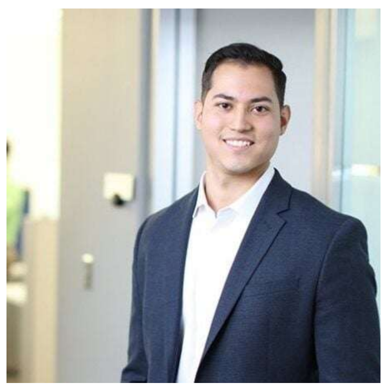
- Required temperature drop based on turbine specifications and seasonal temperature extremes.
- Available capacity and limitations on equipment with a long lead time.
- Cooling water availability or environmental restrictions on evaporative systems.

Utilities with strict power delivery commitments may require built-in redundancy, while other plants with more operational flexibility may tolerate temporary deviations. TES systems help bridge gaps and reduce maintenance downtime by storing chilled water for dispatch as needed.

What to expect from a retrofit

With the appropriate IAC system, plants can realize output gains of 10 percent or more during extreme temperatures. While every site is different, this improvement is typically achieved through careful integration of chillers, coils, duct modifications and electrical upgrades to work with the existing generation equipment.

About the Author: Chris Sanchez is a project manager in the OnSite Energy & Power Group. He leads the design and design-build delivery of centralized utility systems for campuses, airports and industrial facilities. His experience includes central utility plant design, energy distribution, hydraulic modeling and pipe stress analysis, with a strong focus on sustainability and energy efficiency.



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