Thermal Energy Storage:

More Affordable Than Ever

White Paper

How Federal Financial Incentives Could Reduce Your Investment Costs

Imagine a bank of batteries so powerful it can cool or heat your building leveraging stored energy. A building owner could:

- Store energy from clean energy sources, like solar and wind, and use it anytime
- Buy energy when rates are lower for use during expensive peak periods
- Recapture waste heat energy from your building when loads don't balance

TES is a distributed energy resource that allows building owners to store cold or heat and use it later—essentially acting as a "battery" that charges and discharges on demand. Instead of using chemicals to store electrical energy, TES uses water to store thermal energy like an HVAC battery.

This simple concept gives buildings operational flexibility—i.e., adaptable, low-carbon cooling and warming—while helping to reduce costs and increase sustainability and resilience.

That's the power of thermal energy storage (TES)

That's the power of thermal energy storage (TES). In fact, according to the Office of Energy Efficiency and Renewable Energy (EERE), an Office of the U.S. Department of Energy, ***"thermal energy storage (TES) is a critical enabler for the large-scale deployment of renewable energy and transition to a decarbonized building stock and energy system by 2050."*** [1]

1. Thermal Energy Storage | EERE

A thermal energy storage system offers a myriad of benefits for the building, the grid and the environment.

Electricity bills

TES allows building owners to store energy from the grid when it's least costly and release it during the most expensive peak periods. Peak energy use in the building is dramatically slashed by spreading out energy consumption over a 24-hour period, resulting in reducing demand charges that can account for 30% to 70% of the total charges on a monthly electric bill.[2] Benefit from additional savings through participation in grid capacity and demand limit revenue programs.

Increases reliability

With TES, a building has a secondary source of heating or cooling should the primary system fail. Thermal energy storage has been proven to work in over 4,000 installations and can last up to 40 years. It works quietly and seamlessly in combination with traditional chiller equipment, heat pump and other system equipment. Modular thermal energy storage equipment allows easy expansion of cooling or heating without adding more electricity capacity. Advances in thermal energy storage controls provide real time alerts of any issues in a convenient manner.

Reduces carbon emissions

The ability to store energy produced by solar or wind makes green technologies more viable so the grid and buildings can decarbonize. TES can increase the use of renewables by up to 50% by storing wind energy at night to cool buildings during the day.[3] Or, when the sun is not shining, relying on thermal energy storage to stay cool and comfortable indoors. When used to replace fossil fuel boilers, thermal energy storage complements all-electric heat pumps to provide a low-carbon heating source.

Increases resiliency

TES provides energy source flexibility so building managers can easily respond to utility requests for conservation when demand is high, during temporary grid outages or when renewable energy production wanes—without compromising comfort.

Makes indoor spaces comfortable

TES stores a tremendous steady source of energy for cooling or heating year-round, even if outdoor temperatures are extremely hot or cold. It's also a ready source of thermal energy for uninterrupted heating or cooling so a building's occupants stay comfortable during power outages or brown-outs.

Reduces capital expenditures

With a thermal energy storage system, buildings can operate with smaller equipment—such as chillers, heat pumps, on-site generators, etc.—based on supplementary cooling or heating provided by a TES system. This helps to lower first costs, enabling a more economical new build or HVAC retrofit. Compared to electro-chemical batteries, thermal energy storage tends to be less expensive due to lower capital expense, and operation costs, as well as slower lifecycle degradation.[4]

Eligible for tax incentives

TES comes in two options, partial and full storage. With full storage, TES handles the entire thermal HVAC load during the day. With partial storage, TES works in tandem with chillers or heat pumps. Full storage requires more storage capacity, resulting in savings on utility costs and the most emission reduction. Partial storage doesn't require as much storage capacity, so it provides a more immediate payback and can make sense where space is limited.

Incentives could help to reduce the cost of a TES project, making payback instantaneous.

2. Actual reduction varies by location. Clean Energy Group, NREL. Demand-Charge-Fact-Sheet.pdf (cleanegroup.org). Aug 2017.
3. ASHRAE RP-1607. 2018.
4. An analytical method for identifying synergies between behind-the-meter battery and thermal energy storage. NREL. June 2022.

How federal financial incentives for TES help the world decarbonize

Buildings account for nearly half of the world's energy consumption,[5] and 40% of that energy is spent on heating, ventilation and air conditioning.[6]

While buildings are slowly moving toward electrification, the sector is not on pace to meet Net Zero Emissions by 2050, a target set by the International Energy Agency. To stay on schedule, 100% of new buildings and 20% of existing buildings need to be zero-carbon-ready as soon as 2030.[7]

To step up progress in the United States, Congress has made investments in programs and incentives to accelerate the transition to a clean energy economy and drive deployment of new clean electricity resources. These investments are projected to reduce greenhouse emissions in the U.S. by about a gigaton by 2030 — a 40% reduction in climate pollution below 2005 levels.[8]

Thermal energy storage is now part of the mix

While thermal energy storage (TES) has been around for over 40 years, it has only recently qualified for certain tax incentives. Now building owners can implement a thermal storage system at a lower first cost compared to conventional chilled water plants or other heat pump systems. Utilities will also benefit from these incentives as the use of TES increases, helping to close the gap between energy produced by intermittent sustainable sources — such as wind and solar — and peak period demand. This flexibility helps utilities avoid strain on their systems and may help reduce the need to build expensive power plants to meet peak demand.

Meet the new and improved Section 48E Clean Electricity Investment Tax Credit

The Clean Electricity Investment Tax Credit (ITC) has long fueled economic growth and productivity by encouraging businesses to invest in new technology and equipment. Over time, the details of the ITC — such as eligibility and credit rates — have adapted to changes in tax policy, economic conditions and environmental priorities. Recently, it has increasingly focused on supporting decarbonization efforts by promoting investments in cleaner technologies.

The latest updates to the ITC have boosted the credit value to as much as 50% of costs. Although the base credit rate is 6%, there are substantial bonuses available for using domestic materials or for projects based in energy communities. A 5x multiplier is available if one of the following requirements are met:

1. The project has a net output of less than 1 megawatt of electrical or thermal energy; or
2. The project follows prevailing wage and apprenticeship program guidance from the Treasury Department; or
3. Construction begins before a 60-day period after Treasury Department guidance is issued—initial guidance released November 30, 2022[9]

The IRS defines thermal energy storage as a property comprising a system which:

1. Is directly connected to a heating, ventilation or air conditioning system,

5. Navigant® Research, 2016 6. EIA and based off of 2015 consumption 7. IEA (2021) Net Zero by 2050: A Roadmap for the Global Energy System 8. DOE Projects Monumental Emissions Reduction From Inflation Reduction Act | Department of Energy
6. EIA and based off of 2015 consumption
7. IEA (2021) Net Zero by 2050: A Roadmap for the Global Energy System
8. DOE Projects Monumental Emissions Reduction From Inflation Reduction Act | Department of Energy
9. https://www.irs.gov/newsroom/treasury-and-irs-announce-guidance-on-wage-and-apprenticeship-requirements-for-enhanced-credits-deductions

2. Removes heat from, or adds heat to, a storage medium for subsequent use and
3. Provides energy for the heating/cooling of the interior of a residential/commercial building

The functionally interdependent components of a thermal storage "system" will typically include the icemaking chiller(s), tank(s), glycol, glycol management system, glycol pumps, heat exchanger(s), associated piping/valves, associated controls, the labor to install each of these and the concrete pad the system rests on.[10] Combined, these components are considered the value of "energy property" for the ITC. The related materials for the thermal storage system would also then be used for determination of the domestic content bonus credit.[11]

The ITC for thermal storage is for projects completed on or after January 1, 2023. The ITC for thermal storage is for projects completed on or after January 1, 2023. The IRS recently clarified that the ***"...qualified investment with respect to the thermal energy storage property includes the total cost of the thermal energy storage property and HVAC system less the cost of an HVAC system without thermal storage capacity that would meet the same functional heating or cooling needs as the..."*** system with thermal storage.[12]

Here's how the incentives **could potentially add up**.

Base Rate	**6%**
Increased Credit Amount*	**Up to 30%**
Meets Domestic Content Requirements**	**2%-10%**
Meets Energy Communities Requirements***	**2%-10%**
Total Potential Credit Value	**Up to 6% Base + Up to 50% Bonus**

*__Increase Credit Amount:__ Must meet prevailing wage and apprenticeship requirements or be less than 1 megawatt

**__Domestic Content:__ 40% of manufactured goods made in the USA

***__Energy Communities:__ A brownfield site (as defined by the EPA); a community with above-average unemployment rate and 1) $0.17 direct employment or 2) 25%+ local tax revenue from coal, oil or natural gas processes; census tracts containing mines and/or coal-fired generating units that have retired after 12/31/1999 or 12/31/2009 respectively | Source: Full text of the legislation (Link)

The Shift in Investment Tax Credits

Before 2025, thermal energy storage systems qualified for the Section 48 energy property investment tax credit.

While both Section 48 and 48E incentivize investment in renewable and clean energy technologies, Section 48E represents an evolution toward a broader, more inclusive approach to clean energy investment, aiming to cover a wider array of technologies and promote high labor standards, and is applicable to projects through at least 2032. The Trane® team can guide you through the available incentives, which are subject to change.

The Energy Efficient Commercial Buildings Tax Deduction also got a big boost

While the U.S. tax code has long included deductions for energy investments, recent updates have made them even more attractive. Section 179D now incentivizes commercial owners who retrofit or construct new facilities to be energy efficient. Increased from $1.88 to a maximum of $5.81/sq. ft., the deduction includes both private and tax-exempt entities, and the improved efficiency threshold is a more lenient 25%, with a sliding scale for a larger incentive between 25% and 50%.

It is recommended to complete projects prior to the end of 2026 due to the more stringent ASHRAE® Standard 90.1-2019 that goes into effect in 2027 to determine the baseline for the tax deduction. This change may impact the eligibility and benefits of the deduction.

Bonus and accelerated depreciation

Conventional heating and cooling systems are generally depreciated on a 39-year straight line basis, providing only 3.33% in tax savings over the first five years. But now, energy property is classified as a 5-year property and is eligible for first-year bonus depreciation. The bonus allowance is:

- 100% in 2022
- 80% in 2023
- 60% in 2024
- 40% in 2025
- 20% in 2026

MACRS depreciation offers additional tax savings equal to 20.8% of the energy property basis over the first five years.

Engineers can benefit directly from certain projects

If you're designing a building for a government or tax-exempt organization, you can claim the tax benefit for yourself on their behalf. That's like a check in your pocket for designing energy projects that meet qualifications for the Section 179D deduction.

Who else can capitalize on these incentives?

For-profit building owners who already have low taxes can transfer credits to a tax-paying entity.[13]

Owners of all but federal buildings benefit most directly, as they can take advantage of the Section 48 and 48E ITC at a typical rate of 40% of the thermal storage system construction costs.

10. Some projects will include changes to air handlers / coils, but those changes may not meet the IRS definition of a thermal storage system
11. Domestic content for manufactured products is 40% threshold in 2023, 45% in 2024
12. https://www.federalregister.gov/documents/2025/01/15/2025-00196/section-45y-clean-electricity-production-credit-and-section-48e-clean-electricity-investment-credit
13. https://crsreports.congress.gov/product/pdf/R/R45693/2

Tax-exempt organizations, including schools and government entities, can receive eligible tax credits in a direct payment from the IRS.[14]

Design-build contractors can get some tax deductions on tax-exempt projects, including federal buildings. Some utilities will pay for an engineering study for thermal energy storage.

While **traditional contractors** don't directly qualify for tax incentives, they can expect to see more thermal energy storage projects to pursue as recent tax incentives boost building projects. They may discover opportunities to branch into clean energy projects as a specialty. And with apprenticeship requirements on larger projects, they will enjoy a larger applicant pool for labor over time.

What Thermal Energy Storage means for the Grid

Over the last 40 years, TES has been a win-win for building owners and their local utilities. As buildings reduced their energy costs by shifting 40% of their load to off-peak hours, utilities were able to improve utilization of existing generation to slow peak summer electric demand growth to help keep costs lower for everyone. In the 1990s, many utilities offered rebates to promote thermal storage and reduce the need to build new, expensive central power plants.

However, as the utility industry deregulated, the transmission and distribution businesses no longer wanted to subsidize the generation business, and some thermal storage rebates were lowered or withdrawn. Deregulation also removed the requirements for capacity reserves, and utilities could now accept bids from independent power producers who were not prohibited from using natural gas for power generation. This ultimately led to a proliferation of combustion turbine plants and a decline in coal-fired steam plants—further eroding rebates and promotional support for thermal storage.

Times have changed. Driven by a global goal of Net Zero Emissions by 2050 or sooner, demand is growing for clean energy provided by solar and wind. However, both energy sources are intermittent. TES enables utilities to store excess renewable energy while sun and wind is available to make up for periods when they're not. As the industry anticipates greater surpluses from renewables, it is increasingly focused on energy storage and dispatch-on-demand as an essential tool to maintain the grid.

Is thermal energy storage right for your building?

Most U.S. thermal energy storage businesses now qualify for a 40% investment tax credit. This is expected to encourage commercial building owners to add thermal storage to their chilled water plants or heat pump systems to provide redundancy and resiliency. It will also enable them to participate in demand response programs and generate revenue.

A TES system can be installed in new construction or retrofitted with a chiller plant replacement. It's ideal for buildings with high energy costs, particularly large buildings such as a big church or a university district plant with multiple buildings. Essentially, thermal energy storage tanks can enhance any building that has an air- or water-cooled chiller plant, air-to-water heat pump or water-to-water heat pump. Tanks can be placed in a basement, garage, on the roof or an outdoor pad or partially or fully buried.

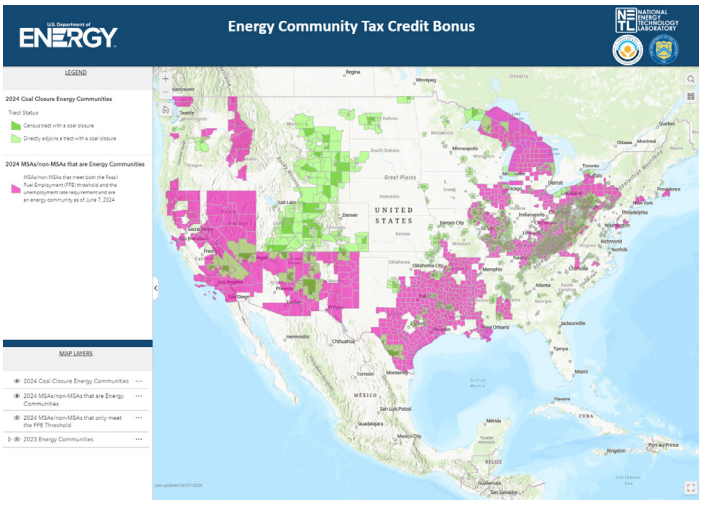
Federal Financial Incentive Snapshot

	Eligible Technologies	Credit Amount †	Eligibility	Carryover
Investment Tax Credit (Section 48E)	Any clean electricity generation facility or qualified energy storage	Typically, 30%-40% of the energy property costs	Projects beginning in 2025-2032 Residential and commercial entities	Unused credits may be carried back one year or forward up to 20 years
	Qualifying Improvements	**Deduction Amount**	**Eligibility**	
Energy Efficient Commercial Buildings Deduction (Section 179D)	Improvements in new construction or retrofits that result in a 25% or more reduction in energy and power costs (partial deductions may be available)	Up to $5.65 per square foot of building's floor area	Commercial entities; Designers of government-owned or nonprofit-owned buildings	

†Percentage may vary depending on technology, the year the project is placed in service and compliance with labor and domestic content requirements

***Read the full tax code here: Section 48E:**
https://www.law.cornell.edu/uscode/text/26/48E

Section 179D:
https://www.irs.gov/credits-deductions/energy-efficient-commercial-buildings-deduction



As of January 2025, IRA Energy Community Tax Credit Bonus

14. https://www.jdsupra.com/legalnews/inflation-reduction-act-levels-2695137/

Cooling and heating with a Trane® thermal energy storage system

The Trane Thermal Battery System enhances thermal energy storage technology for cooling and heating buildings on the modern grid. The system includes Trane ice-making chiller(s) with controls, Ice Bank storage tanks, chiller plant controls, pumps, piping specialties, control valves and factory-mounted plant controls.

Engineers often choose to enhance this system with pre-packaged pumps, energy dashboards and service contracts for continuous and remote monitoring.

At the heart of the Trane Thermal Battery System are Ice Bank storage tanks. They contain water which is frozen and melted depending on if cooling or heating is needed. One thermal energy storage tank has the equivalent amount of energy to cool four 2,000-square-foot houses for an entire day.

Heating with Ice

Ice heating is an innovative all-electric method that utilizes heat pumps and thermal energy storage to regulate temperatures in commercial buildings. It offers a sustainable solution to leverage electricity from renewable energy sources.

Trane's Thermal Battery Storage-Source Heat Pump System captures and stores excess energy from today to provide heating for tomorrow, ensuring reliability even in colder climates. Additionally, it enables the reduction of rooftop equipment size, making it suitable for densely populated urban areas.

Types of Trane thermal energy storage systems

Air-Cooled Chiller Plant
The Trane Thermal Battery ice-enhanced air-cooled chiller plant is a thermal energy storage system that simplifies installation and makes it more consistent, saving design time and construction costs. Air-Cooled chillers be easily reused as part of a new system. Trane offers pretested, standard system configurations for air-cooled chillers, ice tanks, and pre-packaged pump skids, all integrated with customizable, pre-programmed system controls.

Storage-Source Heat Pump System
As part of Trane's Comprehensive Chiller-Heater System family, the all-electric Trane Thermal Battery Storage Source Heat Pump System stores today's waste energy for tomorrow's heating. It captures waste energy to reduce traditional heating equipment such as boilers that rely on fossil fuels. The system leverages thermal energy storage, an ice-making chiller-heater, air-to-water heat pumps and controls to provide cooling and heating.

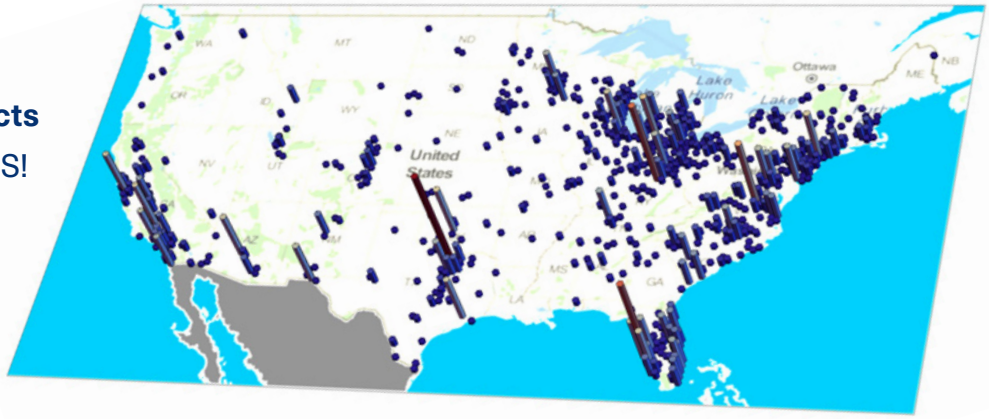
Customized Solutions
Trane's experts leverage over 30 years of engineering experience and the successful installation of more than 1 gigawatt of thermal storage to help you design enhanced solutions for your clients. By integrating Trane's industry-leading chillers, heat pumps, and controls with best-in-class Ice Bank energy storage tanks, your clients' buildings can achieve exceptional energy efficiency and performance

Technical Support and Resources

- Trane Design Assist
- Thermal Energy Storage Systems
- Engineers Newsletters
- Locate a Sales Office
- Prevailing Wage and the Inflation Reduction Act

Histogram sampling of Trane Thermal Energy Storage Projects

Over 2000 projects across the US!



For more information, join us at trane.com

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