



Thermal Energy Storage:

More Affordable Than Ever

WHITE PAPER



How financial incentives available through the Inflation Reduction Act of 2022 can dramatically reduce your investment costs

Imagine a bank of batteries so powerful it can cool or heat your entire building with stored energy. You 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

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

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.

1. [Thermal Energy Storage | EERE](#)

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



Avoids high 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 Add the ability to participate in grid capacity and demand limit revenue programs for even more savings.



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 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 50% by storing wind energy at night to cool buildings during 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 you 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 cold (below 0° F) or it's a hot summer day. It's also a ready source of thermal energy for uninterrupted heating or cooling so your 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, slower lifecycle degradation and potentially lower operation costs.⁴



Eligible for new tax incentives

TES comes in two flavors, 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 maximum 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.

Due to the Inflation Reduction Act of 2023, funds are now available that could help to reduce the cost of a TES project.

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 new 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 enacted the Inflation Reduction Act (IRA) of 2022, the most significant climate legislation in U.S. history. The legislation offers funding, programs and incentives to accelerate the transition to a clean energy economy and drive significant deployment of new clean electricity resources.

New initiatives made possible through IRA funding 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

The commercial market will benefit from \$369 billion in incentives and investments⁹ earmarked for green energy projects. Included in the legislation are:

- ~\$216 billion in corporate tax incentives designed to catalyze private investment in clean energy, transport and manufacturing¹⁰
- \$30+ billion to boost U.S. clean energy production¹¹
- \$30 billion to transition states and electric utilities to clean energy¹²
- \$3.4 billion to decarbonize federal buildings¹³
- \$1+ billion in grants for local governments to modernize commercial and residential buildings to meet energy codes¹⁴
- \$50+ million to reduce air pollutants in schools¹⁵

Thermal energy storage is now part of the mix

Historically, the Internal Revenue Service (IRS) has limited “energy properties” to solar, wind, fuel cells, microturbines, geothermal heat pumps and combined heat and power. And, while thermal energy storage (TES) has been around for over 40 years, it has not qualified for tax incentives—until now.

The Inflation Reduction Act expanded eligible technologies to include TES, enabling building owners to 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 reduces the need to build expensive power plants to meet peak demand.



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](#)

9. [U.S. Department of Energy. The Inflation Reduction Act Drives Significant Emissions Reductions and Positions America to Reach Our Climate Goals](#)

10. [McKinsey & Company](#)

11. [U.S. Senate. Summary of the Energy Security and Climate Change Investments in the Inflation Reduction Act of 2022](#)

12. [U.S. Senate. Summary of the Energy Security and Climate Change Investments in the Inflation Reduction Act of 2022](#)

13. [U.S. General Services Administration. Inflation Reduction Act.](#)

14. <https://www.energy.gov/scep/technical-assistance-adoption-building-energy-codes>

15. <https://www.nea.org/resource-library/addressing-indoor-air-quality-schools>

The IRA's new financial incentives

Even more credit through the Investment Tax Credit (ITC)

Through revisions to the energy Investment Tax Credit (IRS Section 48), the credit value has been increased to up to 50% of the costs.¹⁶ While the base rate of the credit is 6%, there are significant bonuses for using domestic content or for projects located in energy communities. Above the 6% base rate credit, significant bonuses may be applied for using domestic content or for projects located 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, 2022¹⁷

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,
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

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.¹⁸ Combined, these components may qualify as “energy property” under the Investment Tax Credit. The related materials for the thermal storage system would also then be used for determination of the domestic content bonus credit.¹⁹



The ITC for thermal storage is for projects completed on or after January 1, 2023. The current section 48 ITC for thermal storage is for projects that begin construction before January 1, 2025 (5% of construction costs). A similar tax incentive, known as section 48E, goes into place for qualified energy storage projects that start in 2025.²⁰

As you can see, the IRA has greatly expanded incentives in the form of tax credits for qualifying projects. Here's how they 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
<p>*Increase Credit Amount: Must meet prevailing wage and apprenticeship requirements or be less than 1 megawatt</p> <p>**Domestic Content: 40% of manufactured goods made in the USA</p> <p>***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)</p>	

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A new and improved Energy Efficient Commercial Buildings Deduction

While the U.S. tax code has long included deductions for energy investments, the IRA has made them even more attractive. Section 179D now incentivizes commercial owners who retrofit or construct new facilities to be energy efficient. Increased to a maximum of \$5/sq. ft., the deduction includes both private and tax-exempt entities, and the improved efficiency threshold is a more lenient 25%.

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. Through revisions specified by the IRA, energy property is now 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.

16. Whitehouse. Building a Clean Energy Economy. January 2023.

17. <https://www.irs.gov/newsroom/treasury-and-irs-announce-guidance-on-wage-and-apprenticeship-requirements-for-enhanced-credits-deductions>

18. Some projects will include changes to air handlers / coils, but those changes may not meet the IRA definition of a thermal storage system

19. Domestic content for manufactured products is 40% threshold in 2023, 45% in 2024: <https://crsreports.congress.gov/product/pdf/IN/IN11983>

20. Section 48E on pages 20-21: <https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf>

Who will benefit from these incentives?

The IRA's financial incentives will have a ripple effect across various industries and professions.

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

Tax-exempt organizations can receive eligible tax credits in a direct payment from the IRS.²¹ Or, they can transfer credits to a tax-paying entity, such as a company that is part of the design team or a tax equity investor.²²

Engineers can benefit as designated tax credit recipients for projects involving tax-exempt organizations and federal buildings.

Design-build contractors can get some tax deductions on tax-exempt projects, including federal buildings.

While **traditional contractors** don't directly qualify for tax incentives, they can expect to see more thermal energy storage projects to pursue as IRA 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.



Ultimately, large-scale electric batteries will enable utilities to store and dispatch clean energy when it's available. For now, though, these batteries are still in development. They are expensive, use scarce materials, degrade over time and no end-of-life recycling options are available yet. Over the near term, we will have to rely on thermal energy storage to take part of the needed peak reduction.

However, a combination of thermal and electric batteries may turn out to be the optimal long-term solution. A new study by the National Renewable Energy Laboratory (NREL) and the Colorado School of Mines has shown that combining thermal and electric batteries results in lower storage costs, lower peak demand, reduced electric battery full charge cycles (increasing their lifespan) and lower building operating costs compared to a single storage technology.²³

21. <https://www.jdsupra.com/legalnews/inflation-reduction-act-levels-2695137/>

22. <https://crsreports.congress.gov/product/pdf/R/R45693/2>

23. Science Direct. June 2022. An Analytical Method for Identifying Synergies between Behind-the-Meter Battery and Thermal Energy Storage



Is thermal energy storage right for your building?

Most U.S. thermal energy storage businesses now qualify for a 40% investment tax credit through the IRA. 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.

Cooling and heating with a Trane thermal energy storage system

The Trane® Thermal Battery™ system optimizes 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.

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

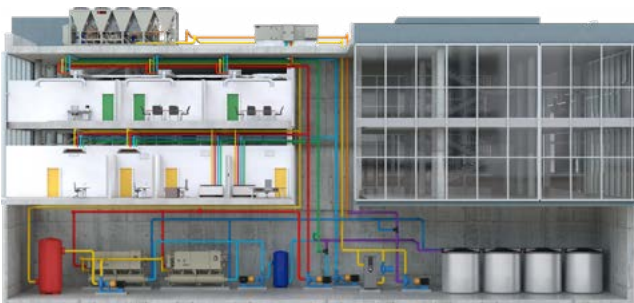
At the heart of the Trane Thermal Battery™ system are Ice Bank® storage tanks. They contain water which is frozen and melted depending on if cooling or heating is needed. One thermal energy storage tank has the equivalent amount of energy to cool four 2,000-square-foot houses for an entire day.

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, which can make installation simpler and more repeatable, saving design time and construction costs. Trane offers pretested, standard system configurations for air-cooled chillers, ice tanks and pre-packed pump skids integrated with customizable, preprogrammed system controls.



Storage Source Heat Pumps

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 eliminate 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

Our experts draw on 30+ years of engineering experience installing more than 1 gigawatt of thermal storage to help you design the best solution for your needs. Combine the benefits of Trane's industry-leading chillers, heat pumps and controls with best-in-class Ice Bank® energy storage tanks.

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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