THE BASICS & THE GAPS

Future Cleantech Factsheet Series #5 / 2024

Thermal Energy Storage

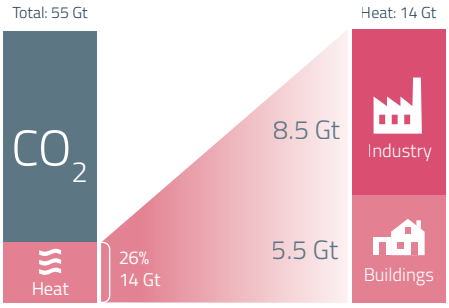
to decarbonize heat

Part 1

HEAT GENERATION AND CLIMATE CHANGE

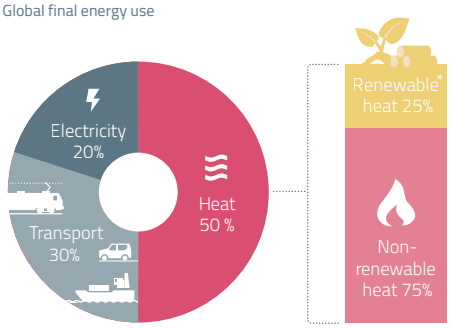
Energy use for heat generation is responsible for over 25% of global greenhouse gas emissions.

Global emissions (Gt $CO_{2,eq}$/year)



Heat accounts for 50% of global final energy use, but only 25% of this heat is derived from renewable sources.

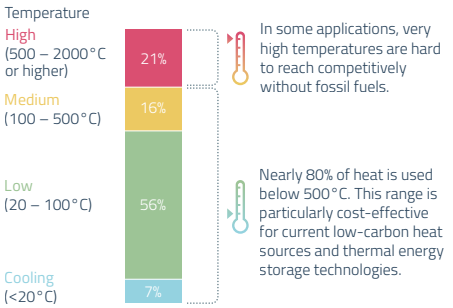
Global final energy use



*Mostly from traditional biomass usage

Heat is needed over a wide range of temperatures, but most of it is used at low and medium temperatures.

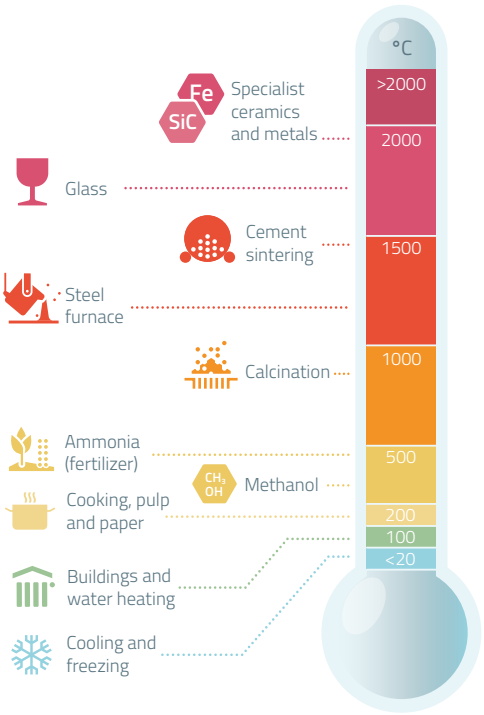
Share of total heat demand (domestic & industrial settings)



WHAT WE NEED HEAT FOR & THE CLEAN HEAT SOURCES WE CAN USE

Heat consumption spans a wide range of temperatures, processes, and services. While most heat is currently generated by burning fossil fuels, there are several alternative low-carbon heat sources at our disposal. Among them, electrification coupled with renewables is the most universal and scalable process.

What we need heat for



The low-carbon heat sources we can use

Sources that provide flexibility when coupled with Thermal Energy Storage

Green electricity turned to heat

- Induction, electric arc, and plasma
- Resistive heating
- Industrial heat pumps
- Domestic heat pumps
- Freezers

Modular and scalable everywhere. Require low-carbon electricity.

Solar thermal energy

- Solar tower
- Parabolic troughs
- Flat plate collectors

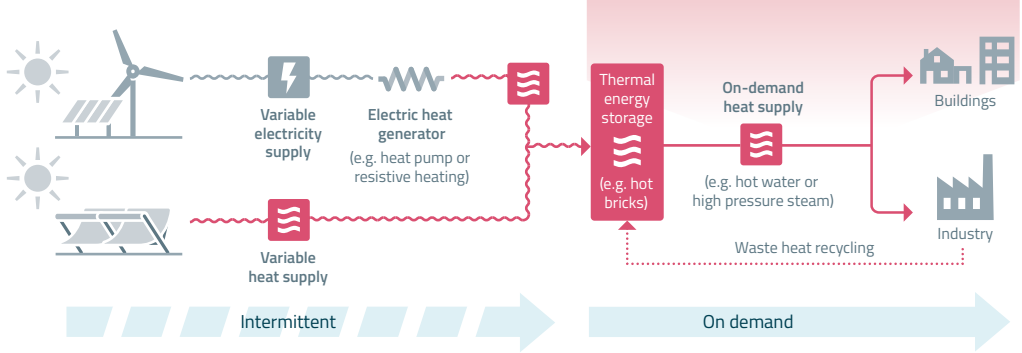
Scalable within the global solar belt. Dependent on seasons and weather.

On-demand sources

- Hydrogen & biofuels
- Solid biomass
- Nuclear energy
- Geothermal energy

Significant sources when locally available, but limited by several constraints.

HOW THERMAL ENERGY STORAGE CAN HELP US DECARBONIZE HEAT



Thermal energy storage (TES) captures different intermittent energy sources as heat up to 1500°C. The stored heat is then available on demand for various applications.

TES facilitates renewable integration, increases energy flexibility and security, and enables consumption of lower cost electricity.

It also improves energy efficiency by helping reuse waste heat from industrial processes.

Condensed sources:
Our World In Data (2023), UNEP (2022), IEA (2021), IEA (2022), CGEP (2019), LDES Council (2022), EERA (2022), IRENA (2020), EASE (2023), ESC (2023).

Methodology and sources: fcarchitects.org/tes-factsheet-sources

Want to learn more? Visit fcarchitects.org or contact us: mail@fcarchitects.org

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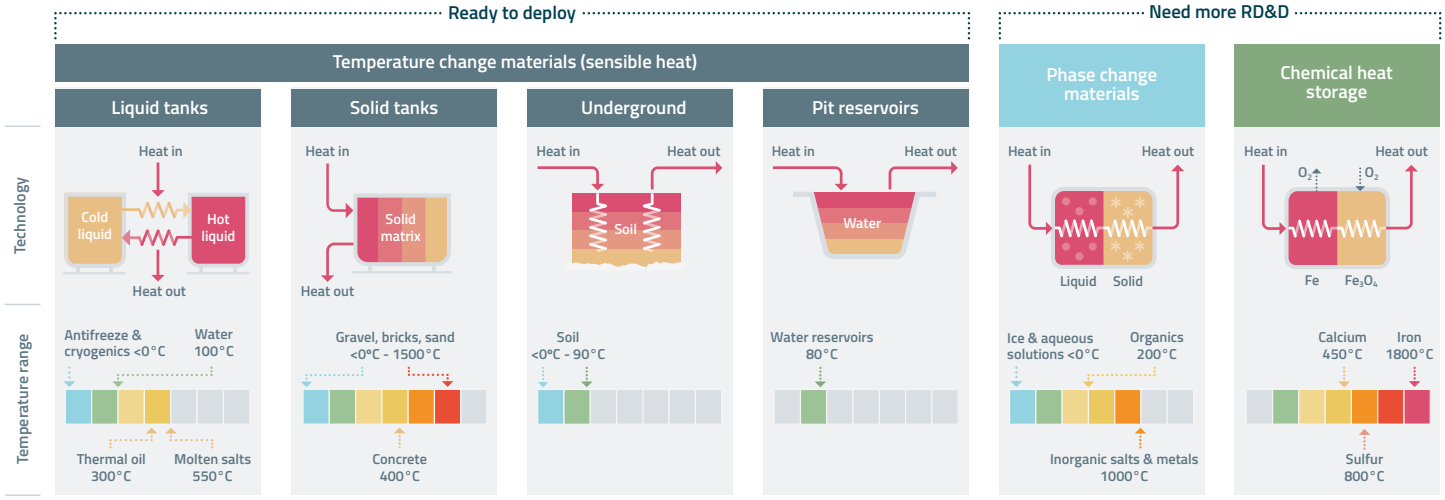
Part 2

THE THERMAL ENERGY STORAGE TECHNOLOGIES THAT WE HAVE

There are multiple thermal energy storage (TES) technologies and materials, covering a wide range of temperatures, storage durations, and applications. While some TES technologies require further support for RD&D, many others are mature and ready to deploy, making TES an efficient and cost-effective tool ready to support the growth in renewables.



HOW LONG THEY LAST & WHAT WE CAN USE THEM FOR

	Liquid tanks	Solid tanks	Underground	Pit reservoirs	Phase change	Chemical storage
Storage duration	Hours – Days	Hours – Days	Weeks – Months	Weeks – Months	Hours – Days	Weeks – Months
Example application	Steam generation	High-temperature industrial heat	Domestic heating	Seasonal district heating	High-temperature industrial heat	Seasonal high-temp heat storage

OUR RECOMMENDATIONS

Context

Raise awareness

The sheer size of the heat sector and its emissions are often overlooked, and so is the crucial role that thermal energy storage can play in decarbonizing heat in both domestic and industrial settings. This can result in a loss of critical funding and investment.

Tackle low temperature heat

Nearly 80% of heat is used below 500°C, 60% is used below 100°C. At these temperatures, low-carbon heat sources (such as heat pumps, solar thermal, and geothermal) are particularly abundant and cost-effective, as are currently commercial TES technologies.

Reward clean flexibility

Low-carbon flexibility providers, such as energy storage and demand response, often struggle to build a compelling business case due to long-term uncertainties and competition with existing polluting flexibility assets such as natural gas.

Facilitate planning and investment

To decarbonize the heat sector (in both domestic and industrial settings), it is imperative to include energy efficiency, storage, and flexibility as integral elements of energy transition plans at the EU, national, and regional levels, and to increase RD&D support for TES technologies.

Recommendations

- Recognize the magnitude of the heat sector and prioritize its decarbonization within policy frameworks.
- Raise awareness among all relevant stakeholders (from industry to the public sector) on the crucial role that TES can play in providing energy flexibility and security for the heat and power sectors.
- Increase public awareness on the current availability of TES technologies, showcasing their vast range of applications, both in domestic and industrial settings.

- Expand deployment of heat pumps, solar thermal energy, and geothermal energy to decarbonize low-temperature heat applications in domestic and industrial settings.
- Use building codes as a regulatory tool to phase out fossil fuels from heating systems in buildings.
- Where possible, build district heating networks supported by seasonal storage to boost energy flexibility and independence, particularly in densely populated areas.

- Implement targeted flexibility support schemes (such as Contracts for Difference) to offer investment security for energy storage projects, which often face high capital costs.
- Ensure that flexibility support schemes are exclusively accessible to non-fossil providers.
- Boost the competitiveness of low-carbon heating by phasing out fossil-fuel subsidies, establishing a suitable price on carbon, and avoiding extra taxes on electricity.

- Develop long-term deployment targets to support sustained investments in thermal energy storage.
- Support the demonstration and scale-up of TES technologies at early commercialization stages to derisk investments, advance readiness levels, and create robust supply chains.
- Target R&D efforts on early-stage TES technologies with significant scalability potential, especially those suitable for high-temperature applications and seasonal storage.

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