U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

U.S. Department of Energy Geothermal Technologies Office: Reservoir Thermal Energy Storage (RTES) Portfolio

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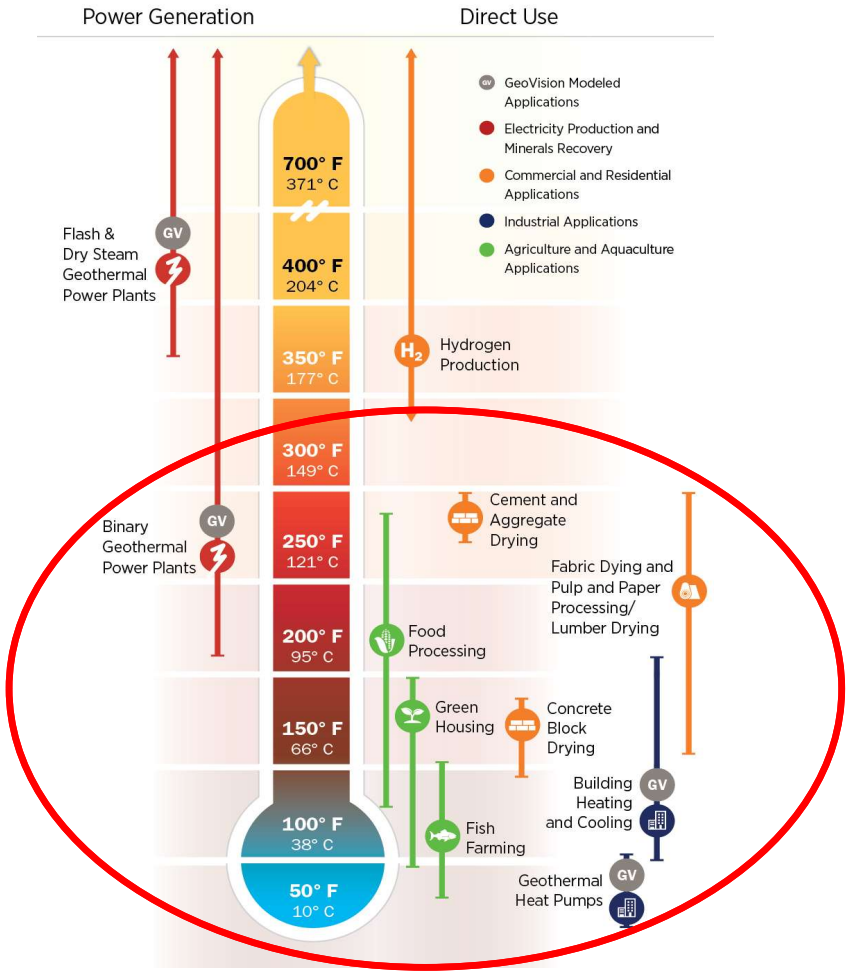
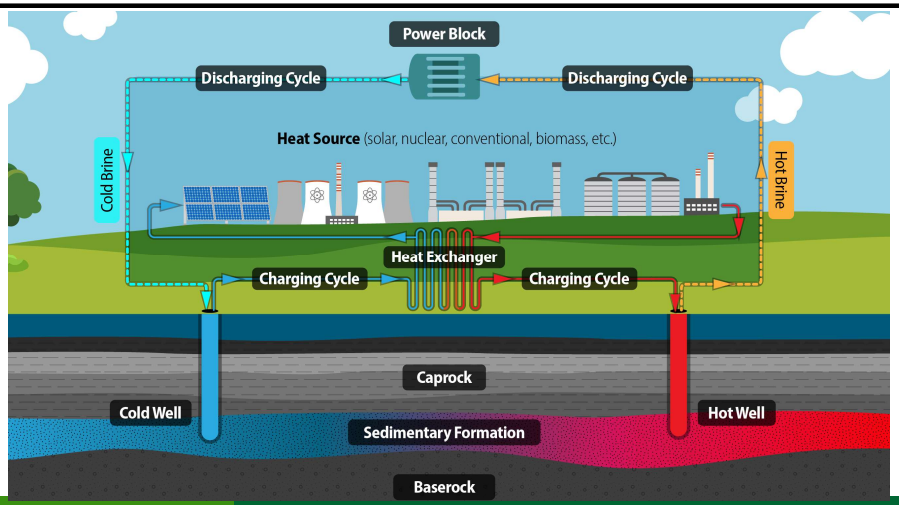
Low-Temperature Geothermal Overview

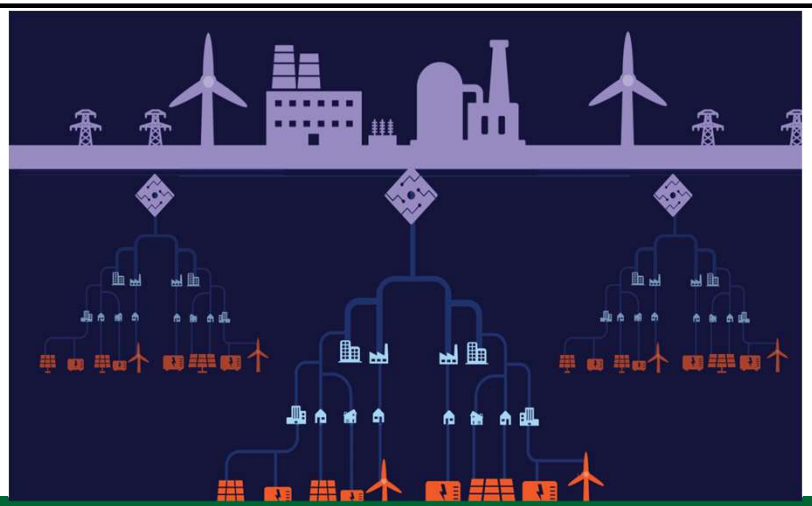
Geothermal Heat Pumps	•Entering Water Temp (40–80°F) •Shallow trenches to wells hundreds of feet deep •Residential, light commercial
Direct Use and Thermal Energy Storage	•Entering Water Temp (80–300°F) •Wells hundreds to thousands of feet deep and Saline or Brackish Aquifers •Large buildings, agriculture
Electric Power	•Entering Water Temp (>150°F) •New Organic Rankine Cycle Modular •Distributed off-grid power



Recent Work: Reservoir Thermal Energy Storage (RTES)

Research Projects Finishing Up or Concluded	Lead Organization(s)
Resource assessment of saline brackish basins for aquifer thermal energy storage and feasibility study for use on a campus	U.S. Geological Survey Portland State University
Advanced insulating lightweight thermal shock-resistant cement suitable to withstand frequent thermal cycling	Brookhaven National Laboratory Sandia National Laboratories
Dynamic reservoir storage: Terawatt-year, grid-scale energy storage using Earth as a thermal battery	Idaho National Laboratory Lawrence Berkeley National Laboratory
Developing sustainable communities through reservoir thermal energy storage	Lawrence Berkeley National Laboratory
Developing metrics to evaluate success and progress for RTES projects	Idaho National Laboratory
Dual-Purpose underground thermal battery that integrates building heat pump system with energy storage	Oak Ridge National Laboratory





Current Work: Geothermica Projects w/Thermal Energy Storage

Project Name	VESTA	FLXenabler	DEMO FTES	THE CHANGE
Lead U.S. Laboratory	Lawrence Berkeley National Lab (LBNL)	National Renewable Energy Lab (NREL)	Pacific Northwest National Lab (PNNL)	Oak Ridge National Lab (ORNL)
Project Goals	Conduct detailed scientific and technical examination of underground geologic reservoirs for seasonal energy storage systems with goal of making such thermal energy storage systems commercially and technically viable Use demonstration projects underway in Europe as a testbed to evaluate technical and non-technical barriers and improve process understanding	Develop an implementable framework for flexible, fossil-free heating and cooling supply Demonstrate the impact of sector coupling and integration of heat pumps, geothermal resources, and thermal energy storage Address flexibility utilization in decarbonized heating and cooling systems at national, district and community level	Validate fracture thermal energy storage (FTES), a method of seasonal, underground thermal energy storage where an efficient heat exchanger connecting multiple wells is created using hydraulic fractures Measure the thermal efficiency and capacity of FTES at the laboratory scale and in a 10 m scale multi-month field test	Demonstrate 5th-generation geothermal district heating and cooling (Geo5GDHC) systems that can decarbonize heating and cooling in urban areas by optimizing building systems, re-using waste heat within buildings, and coupling with underground thermal energy storage Develop new models, design algorithms, and design tools to facilitate rapid design of resource-efficient and sustainable distribution systems that take advantage of sector-coupling and incorporate thermal energy storage

Current Work: Hybrids Research

Three projects recently selected to investigate research, analysis, and modeling of hybridized geothermal systems that include thermal energy storage:

- National Renewable Energy Laboratory—*Techno-economic analysis and market potential of reservoir thermal energy storage charged with solar thermal and heat pumps*
- Brookhaven National Laboratory—*Cements and a modeling tool to calculate viability under various exploitation conditions of high-temperature reservoir thermal energy storage systems*
- Lawrence Berkeley National Laboratory—*Application of using unwanted thermal energy produced by data centers to be used directly in a district heating system or stored in a reservoir thermal energy storage system for later use.*

Aerial view of the Stillwater triple hybrid project (photo courtesy of ENEL Green Power North America, taken from "Better Together: New Synergies and Opportunities From Hybrid Geothermal Projects" by Ann Robertson-Tait and Douglas Hollett via geothermal.org/our-impact/blog/geothermal-hybrid-renewable-systems).

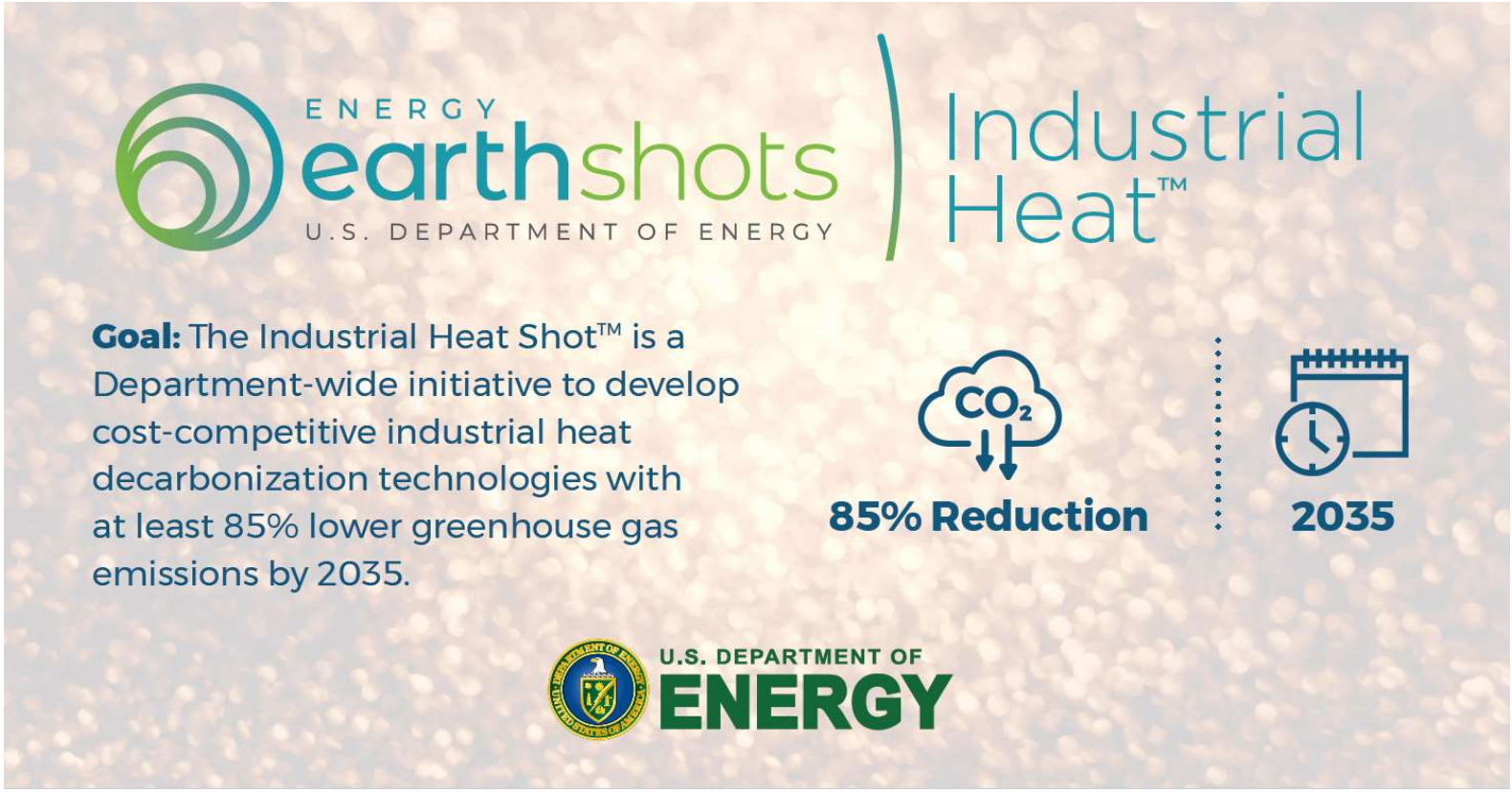
Future Work: RTES Pilots / Demonstrations

FY2023 DOE Congressional Budget Request, Vol. 4:

energy.gov/sites/default/files/2022-04/doe-fy2023-budget-volume-4-eere-v2.pdf

Reservoir Thermal Energy Storage (RTES): In this initiative aimed at unlocking the terawatt-scale thermal energy storage of using the Earth as our battery, GTO will conduct new pilots and demonstrations that build on prior years of early stage research to demonstrate technical feasibility, grid integration, and long-term storage opportunities for renewable energy systems. These projects will consider where geothermal energy storage can be used in combination with other renewable energy generation and energy efficient technologies to create industrial and community energy systems that are fully decarbonized.

Department of Energy Industrial Heat Shot



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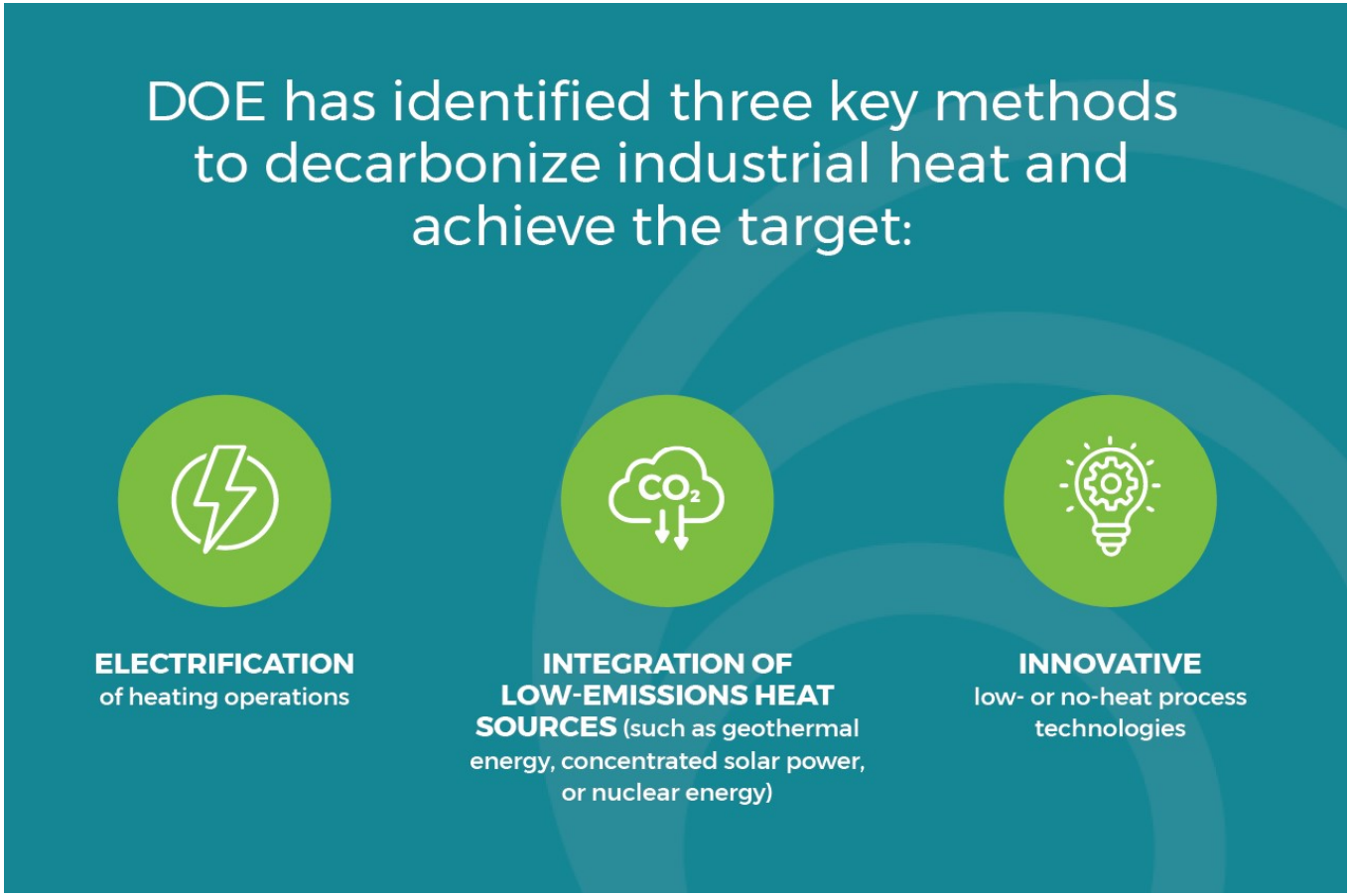
Department of Energy Industrial Heat Shot



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the drill down

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