

Transforming Communities with Thermal Energy Networks

Problem: A building-by-building decarbonization strategy alone will not enable California to reach our climate goals at speed and scale—and may exacerbate inequity.

Solution: Thermal energy networks (TENs), a neighborhood-scale building decarbonization strategy.

TENs transition entire communities from methane gas to a clean, affordable heating and cooling system. TENs harness low-temperature heat from local sources, including the ground, wastewater, or other buildings. A network of water-filled pipes efficiently moves this heat, using ground-source heat pumps to deliver reliable heating and cooling to each building. TENs have additional benefits for Californians: they save water, flatten peak electricity demand, reduce energy burdens on our most vulnerable residents, and protect jobs.

Water Wise

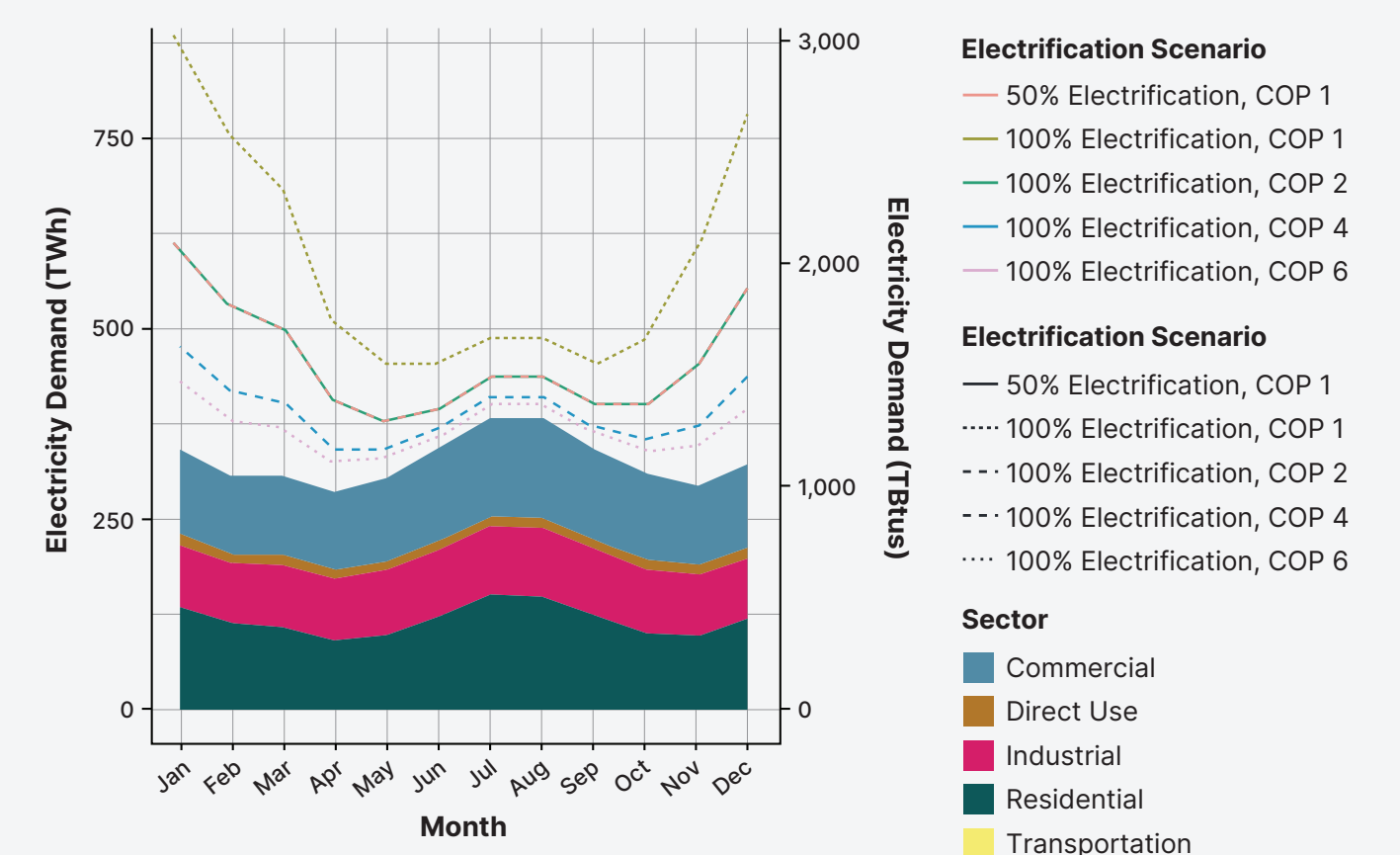
- TENs can **replace cooling towers, which use as much fresh water as 50 million U.S. residents** daily.
- Cooling towers in L.A. County waste **2.5 million gallons of water** annually.
- Stanford University's TEN **reduced water consumption by 18%**.
- Colorado Mesa University's TEN cut water use by **60% per square foot** of conditioned space.

Efficient Electrification

- TENs have a high average coefficient of performance (COP). They are roughly three times more efficient than individual air-source heat pumps, and six times more efficient than gas furnaces.
- A high COP **flattens the demand for electricity**, decreasing the potential scale and cost of expanding the electric grid (see graph).
- Ground-source heat pumps in every U.S. residence could reduce summer peak energy demand by 144 GW—equivalent to **450 million solar panels**.
- Widespread use of ground-source heat pumps could **avoid up to 24,500 miles of new transmission lines by 2050**, enough to **cross the continental U.S. eight times**.

Buonocore, J.J., Salimifard, P., Magavi, Z. et al. Inefficient Building Electrification Will Require Massive Buildout of Renewable Energy and Seasonal Energy Storage. Sci Rep 12, 11931 (2022).

Current monthly total electricity demand by sector from March 2010 to February 2020, and projected changes to total building energy demand under different building electrification scenarios using technology with varying COPs.



Saving Energy, Saving Costs

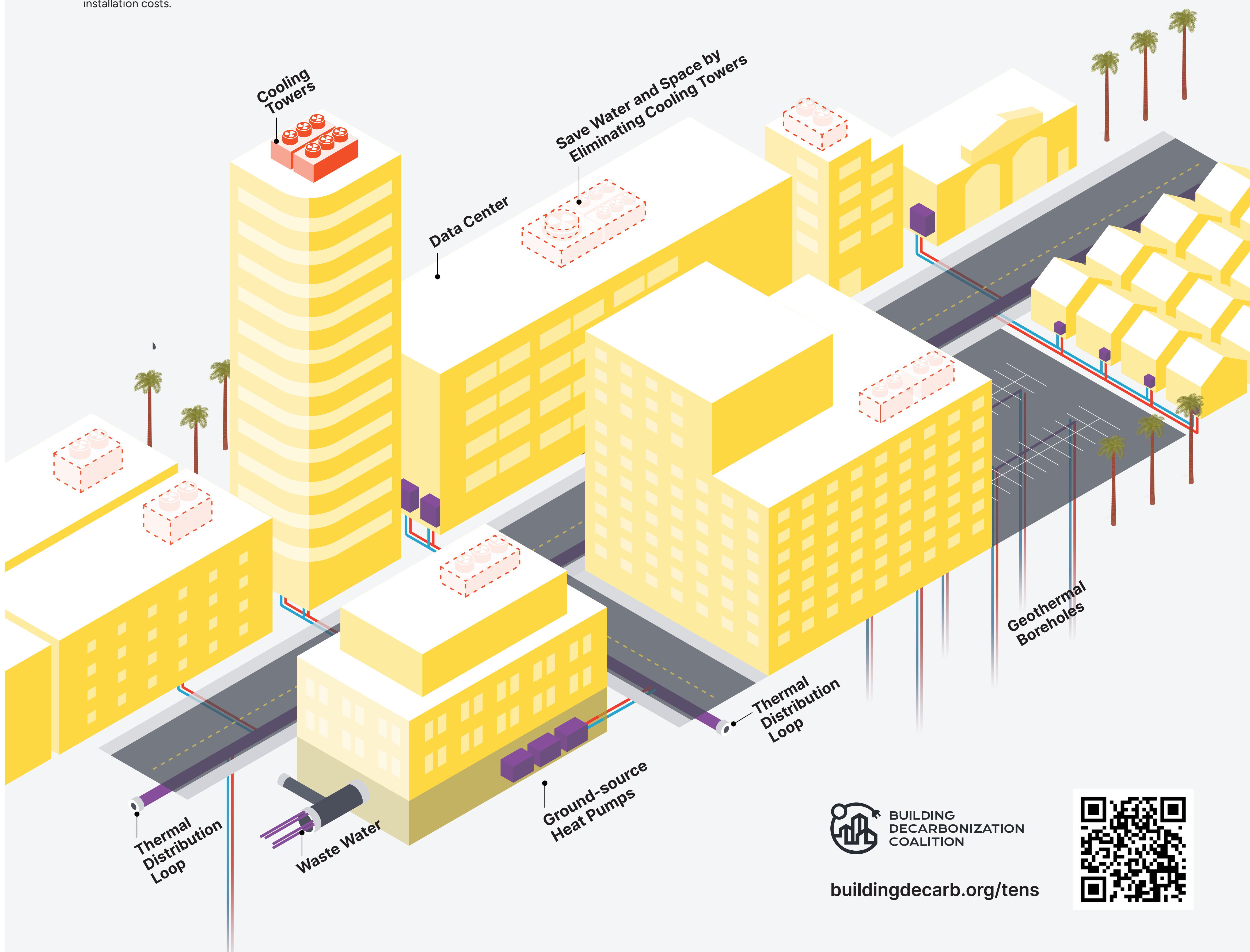
- TENs remove **volatile gas or oil prices** from customer utility bills.
- TEN-enabled homes in Whisper Valley, TX, achieved a **40-70% reduction in energy consumption** compared to traditional HVAC units.
- Captured waste heat efficiently **supplies 80% of heating needs** at Stanford University.
- A TEN in CO is projected to **save \$195 million over 30 years** compared to installing air-source heat pumps.
- Widespread deployment of ground-source heat pumps could save **\$1 trillion** in cumulative electricity costs to ratepayers.
- Federal tax credits can cover up to 50%** of commercial installation costs.

Dynamic Economies & Communities

- Community and municipal TENs can support **local equity, resiliency, and energy democracy**.
- TEN pilots in MA, NY, and MN are proving a **new business model for utilities**.
- TENs provide **job opportunities** for gas utility workers in a clean-energy transition.
- TENs encourage **collaboration** among municipalities, industries, utilities, and developers.

Reliable & Resilient

- TENs use **underground infrastructure**, protecting them from climate and weather-related hazards.
- California experienced **142 power outages in 2022**, but Santa Rosa Junior College proved that TENs paired with microgrids or solar batteries can operate during outages.
- A TEN in Whisper Valley, TX, **was resilient** during the state's 2021 and 2023 ice storms, unlike neighborhoods that went without power for up to 10 days.



buildingdecarb.org/tens

