If you had a really good battery, it wouldn't matter that the sun goes down at night and the wind stops blowing sometimes. But at the moment, battery technology is nowhere near good enough to use at utility scale.

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Energy in Everyday Life

Order of Magnitude Estimate

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How much does it cost to heat the water for a typical American household for one year?

Our guidelines for making an order-of-magnitude estimate:

- *Guess*
- *Talk to your gut*
- *Divide and conquer*
- *Lie skillfully*
- *Punt*
- *Use guerrilla warfare*
- *Lower your standards*
- *Cross-check*

My monthly electric bill is ~ $150. I'll guess ~$50/month is used to heat water. Assuming we're an average American, the cost is $50/mo x 12 mo/yr = $600.

In order to estimate this, we need to estimate the hot water consumed, the temperature increase of the water, the energy used to heat the water, and the cost of that energy.

The total water used in my house (3 people) includes

showers ~30 minutes per day at 3 gal/min,
dish washing ~15 minutes per day at 3 gal/min,
clothes washing ~100 gal/week
drinking ~3 gal/day

Adding,
90 gal/day (showers) + 45 gal/day (dishes)
+ 15 gal/day (clothes) + 3 gal/day (drinks)
~ 150 gal/day ~ 600 liters/day.

I'll estimate about half of this hot water, so 300 liters/day.

Water has a density of ~ 1kg/liter, so the mass of this hot water is 300 kg/day.

The water is heated from ~60 °F (winter) or ~80 °F (summer) to 140 F. The temperature change is then ~ 70 °F, or ~40 °C, or ~40 K.

The specific heat of water is ~ 4 J/g-K ~ 4 kJ/kg-K.

So the energy needed is
E = specific heat x mass x temperature change
~ 4 kJ/kg-K x 300 kg/day x 40 K x 400 days/year
~ 2 x 10^7 kJ
~ 2 x 10^{10} J

Assume I pay ~ $0.1 per kW-hour.
Since 1 kW-hour = 1000 x 60 x 60 = 36 x 10^5 J,
I pay $0.1/kW-hour = $0.1 / 36 x 10^5 ~ 3 x 10^{-8} $/J.

My estimate for annual cost, assuming I'm an average American is ~ (2×10^{10}) J x (3×10^{-8}) \$/J ~ \$600.

This is the same as my original guess.
Fortuitous, but comforting.