1 Electric car solar panels

1.1 Approximate parameters

A typical commute might be ten miles or fifteen kilometers one way.

Lead acid batteries are about $1.25 per 12V-Ah (8.5 kJ/dollar), based on a sample of one sixty dollar, 45 Ah battery I found. However, lead acid batteries are not designed to be nearly fully discharged and can be severely damaged this way. The deeper the discharge, the more usable energy we get per battery cycle, but the fewer cycles we get. Let's say the optimal discharge is 50% of maximum storage capacity, which is where I think most car batteries are meant to operate anyway, so let's bump the battery costs up to 17 kJ/dollar.

A typical home-use, nontracking solar array might have access to a daily average of 200 W/m^2 in a building free environment and be 10% efficent. Supposing buildings block the sun for half the day, let's say home solar panels generate 10 W/m^2

Let's round the 4 km/kWh vehicle efficiency down by 10% to 1 km/MJ for convenience, and keep the four dollar per peak-watt figure. Assuming a peak-watt occurs during direct sunlight of 1 kW/m^2, one average-watt of solar power costs forty dollars and requires a tenth of a square meter of collection area.

1.2 Project costs

We need to find 30 MJ per day for the car. At 50% storage efficiency and 80% charging efficiency, the solar panels need to harvest 75 MJ per day, or about 850 watts. This will cost thirty four thousand dollars, and require 85 m^2.

We need 105 MJ total of battery storage (75 MJ for the array and 30 MJ for the car). This will cost twelve thousand dollars in lead acid batteries alone, before installation, power distribution, and eventual battery replacement.

So the whole thing will run over forty five thousand dollars to build.

2 Personal Heating

Throughout, let's approximate the human foot as equivalent to a $30 \times 8 \times 4\,\text{cm}^3$ rectangular prism of water that is ten kelvin below body temperature. It has a volume of about one liter, and the minimum energy we need to spend is 40 kJ.

2.1 Hot Water

The sink's volume is probably five liters, and is initially below room temperature when it enters the house, at maybe 285 K. Heating it to a body temperature of 310 K requires at minimum 500 kJ. We might consider adding 40 kJ to the minimum value for heat lost to the foot, which might need to be replaced if we want to keep the water at an even temperature.

Supposing the home's water heater is only only 80% efficient (maybe reasonable for a fancier modern tankless model), the cost rises to 675 kJ. Convective and evaporative heat loss to the environment might contribute something too over the several minutes we might expect this process to take, but let's assume instead we're using a carefully insulated sink and that we don't let any vapor escape, in an attempt to keep the energy estimate consistently on the low side.

So we can say this process is 6% efficient. This number is optimistic, too, because most people will prefer to heat the water to above body temperature.

2.2 Space heater

Let's say this process takes three minutes. Our 1.5 kW space heater consumes 300 kJ in this time, so the space heater is maybe 13% efficient.

2.3 Heating pad

This might take half an hour, consuming 90 kJ, making it nearly 50% efficient.

2.4 Blankets

Suppose this takes one hour. A hundred watt metabolism will consume 360 kJ, and will be a little better than 10% efficient.

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4 Planck Units

The first thing to notice is that the combination $\hbar G$ gets rid of the mass units in $\hbar$ and G, and leaves us with a combination of length and time. It's easy to see from there

$$l_p = \sqrt{\frac{\hbar G}{c^3}} = 1.6 \times 10^{-35}\,\mathrm{m}$$

The rest follow pretty easily. We would expect $c = l_p/t_p$, so

$$t_p = \frac{c}{l_p} = 5.4 \times 10^{-44}\,\mathrm{s}$$

$\hbar$ has units of action, so it would follow

$$E_p = \frac{\hbar}{t_p} = 2 \times 10^{9}\,\mathrm{J}$$

Lastly,

$$T_p = \frac{E_p}{k_B} = 1.4 \times 10^{32}\,\mathrm{K}$$