Supplying All US Electrical Power Needs Using Photovoltaics

The annual US electrical energy usage in 1999 was approximately 11.14×10^{15} btu = 11.14 Q = 3.3×10^{12} kWhr. [1] The average daily electrical energy used is then 0.9×10^{10}kWhr. Photovoltaic devices could, in principle, meet this need. Assume that all the pv arrays will be in southern Arizona where the yearly-average daily solar energy is about 7.0 kWhr/m^2. Furthermore, assume that the efficiency of conversion of the insolation to electrical power is 10%. Transmission losses will be ignored, though in several regions of the US the pv arrays could be close to users. The electrical energy produced per day is 7.0 kWhr/m^2 $\times$ 0.1 = 0.7 kWhr/m^2. The area needed to produce 0.9×10^{10} kWhr is then 0.9×10^{10} kWhr / 0.7 kWhr/m^2 = 1.3×10^{10}m^2.

Currently, the cost per square meter is between $500 and $1000. So, the maximum cost would be $$13\times10^{12}$, or $13 trillion. Since the cost per unit area will drop with such a great volume, the cost could drop to $1.3 trillion, the current tax reduction total for the next ten years. If the arrays lasted for 20 years, then, even using the high intial cost estimate, the cost of the electrical power would be $$13\times10^{12}/20/3.3\times10^{12}$ kWhr = $0.2 / kWhr. For comparison, before the recent increases in power costs, one kWhr cost between $0.06 and $0.2 over the country.

The required area of 1.3×10^{10}m^{2}is a square 1.14×10^5m on a side, or 0.7×10^2 miles = 70 miles on a side.

In comparison, Corvallis receives an average of 2 kWhr/m^2.

[1]US Annual Energy Outlook 2000, Energy Information Agency, Dept. of Energy.