

Solar PV

Physics and Mathematics of Sustainable Energy

College of the Atlantic.

1. The average insolation in Khartoum, Sudan, is 6.32 kWh/day/m^2 . Convert this to W/m^2 .
2. The solar intensity in Hancock County, Maine is around 160 W/m^2 . Convert this to kWh/day/m^2 .
3. The median floor area of a new house in the U.S. in 2010 was approximately 2400 ft^2 . Assume that this is a two-story house, so that the “footprint” of the house is half of this. Suppose that half of the roof was covered with solar panels.
 - (a) How much electrical energy would be generated in a month? In a year?
 - (b) How much would a year’s worth of this electricity be worth in Maine?
 - (c) How does this amount of electricity compare to the electricity used in the home?
 - (d) How does this compare to the total amount energy used in the US per person per year?
 - (e) If this electricity displaced electricity that was generated with a carbon intensity of 500 g of CO_2 , how much less CO_2 would be emitted as a result? Is this a little or a lot?
4. The red roof barn at Beech Hill Farm is a 10 panel array for a total capacity of 2.3 kW . In 2016 it generated 3467 kWh .
 - (a) What is the capacity factor of this array?
 - (b) What average power did the array deliver over this year?
 - (c) What is the power density of this array in W/m^2 ?
 - (d) If this electricity is replacing the electricity generated with a carbon intensity of 500 g of CO_2 , how much less CO_2 would be emitted as a result.
5. Pemetic elementary school in Southwest Harbor, Maine, has a 1.8 kW solar array.
 - (a) What amount of energy would you expect this array to generate in one year?
 - (b) What is the dollar value of this energy?
6. Suppose we want to generate 50 kWh of electricity per day from solar for each person in the U.S.
 - (a) How much area is required per person? Assume that we have solar farms that get 10 W/m^2 .
 - (b) How much land would it take to do this for every person in the U.S.?
 - (c) How big an area is this? (What size square has this area?)