

## IEooc\_Application4\_Exercise2: Area density of renewable energy

**Goal:** Understand the issue of area need for RE conversion, learn about typical energy densities and make own simple scenario calculation

“To date, the surface area required for RE systems is greater than that for non-RE systems, exacerbating existing environmental policy challenges, from increasing land competition, to visual impacts. A suitable metric for comparing the extent of systems is the power density of electricity production, that is, the electrical power produced per horizontal m<sup>2</sup> of surface area.” [1] **The power density of a m<sup>2</sup> of RE technology is defined as the energy generated on average throughout an entire year divided by the measurement period of one year. Figure 1 lists typical power densities of RE.**

POWER PER UNIT LAND OR WATER AREA	
Wind	2 W/m <sup>2</sup>
Offshore wind	3 W/m <sup>2</sup>
Tidal pools	3 W/m <sup>2</sup>
Tidal stream	6 W/m <sup>2</sup>
Solar PV panels	5–20 W/m <sup>2</sup>
Plants	0.5 W/m <sup>2</sup>
Rain-water (highlands)	0.24 W/m <sup>2</sup>
Hydroelectric facility	11 W/m <sup>2</sup>
Geothermal	0.017 W/m <sup>2</sup>

Table 18.10. Renewable facilities have to be country-sized because all renewables are so diffuse.

**Figure1:** Typical RE power densities, taken from “Sustainability – without the hot air” [2]

With the data given in Figure 1 and additional assumptions, the following questions are to be answered:

### Questions:

- 1) How much energy is generated on 1 km<sup>2</sup> during one year for the different technologies listed in Figure 1? Convert the result into kWh, MWh, and GWh.
- 2) How much area is needed to supply an energy demand of 250 GJ per person and year (typical of industrialized societies) for the different RE types listed in Fig. 1?
- 3) How much area would be needed to supply that level of per capita energy consumption to the total population of your home country for the different RE types listed in Fig. 1?

- 4) What is the maximum population density (inhabitants per km<sup>2</sup>) that can be sustained by local (self-sufficient) supply of the different RE types for an annual consumption of 250 GJ/person/yr?

**Important: Define parameters for all relevant quantities and provide an equation for each task!**

For additional information, see

[1] <https://doi.org/10.1016/j.enpol.2018.08.023>

[2] Sustainable energy – without the hot air. [www.withouthotair.com](http://www.withouthotair.com)

RE cities density paper: <http://science.sciencemag.org/content/352/6288/922.abstract> also provided on ILIAS