EV20001: ENVIRONMENTAL SCIENCE

Assignment #3: Renewable Energy – I

(DUE 31 MARCH 2021)

1. Switzerland intends to phase-out nuclear energy by 2035, representing approximately 25.6 TWh/year of its primary energy supply in 2010. According to a National Grid report, Switzerland has 11 TWh/year of unused PV potential.

   (i) If 60% of this potential is harnessed to replace nuclear energy and the remainder is to be met with natural gas plants, how many 500 MW gas power plants would be required if the annual average capacity factor of each plant is 85%? (*Note*: The capacity factor is defined as the ratio of a plant's actual output over a period of time to its potential output if it were to operate continuously at full capacity over the same period.) **[4]**

   (ii) What is the minimum PV panel efficiency required in order for the full PV plant potential to occupy less than 27000 hectares of land? Assume that the average daily solar radiation is 2.1 kWh/m2 and 30% of a PV plant's area is occupied by the panels. **[4]**

   (iii) What is the input solar energy required to achieve the full potential assuming the efficiency in (b)? **[2]**

   (iv) What would be the total installed PV capacity assuming a capacity factor of 9%? **[2]**

2. In a particular location in India, the solar insolation has a power density of 1000 W/m^2 for an average of 112 hours/month. The energy demand is 1500 kWh/month. This can be provided by a PV cell array with an estimated lifetime of 20 years. The cost of the solar cells is about $3 per watt.

   (i) If fabrication, maintenance and interest on the capital cost effectively double the price per watt, calculate the cost of the solar generated electricity per kWh. **[4]**

   (ii) If the present tariff of electricity is about $0.07/kWh, how much should the cost of solar generated electricity needs to be reduced in order to be competitive? **[4]**