EV20001 Assignment-3

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Ans 1:-

(i) Required primary energy supply

= nuclear energy supply in 2010 = 25.6 TWh/year

Unused PV potential = 11 TWh/year

Energy supply met by harnessing 60% of PV potential

$= \frac{60}{100} \times 11 = 6.6$ TWh/year

Remaining primary energy supply need

$= 25.6 - 6.6 = 19$ TWh/year

Annual supply of a 500 MW gas power plant

$= 500 \text{ MW} \times 24 h \times 365 \times 0.85$ / year

$= 3.723 \times 10^6$ MWh/year

$= 3.723$ TWh/year

∴ required number of gas power plants

$= \frac{19 \text{ TWh/year}}{3.723 \text{ TWh/year}} = 5.1 \approx 6$ gas power plants would be required

(ii) let the minimum PV panal efficiency $= \eta$

maximum area of PV panels = 27000 hectares × 0.3

= 8100 hectares

$= 81 \times 10^6 \text{ m}^2$

Solar radiation utilized by panels daily
$= 2.1\ KW/m^2 \times \eta \quad = 2100\,\eta\ W/m^2$

PV potential to be utilized $= 11\ TWh/year \times 0.6$
$= 6.6\ TWh/year$
$= 6.6 \times 10^{12}\ Wh/year$

Solar radiation utilized by panels annually
$= 2100\,\eta \times 365\ Wh/m^2\ year$

Area required for panels $= \dfrac{6.6 \times 10^{12}\ Wh/year}{2100\,\eta \times 365\ Wh/m^2\ year}$

$\leq 81 \times 10^6\ m^2$

$\Rightarrow \eta \geq 0.1063$

$\therefore$ minimum efficiency $= 10.63\%$.

(iii) ~~let input solar energy required~~ =
Input Solar energy required $= \dfrac{\text{full potential}}{\text{efficiency}}$

$= \dfrac{6.6\ TWh/year}{0.1063}$

$= 62.09\ TWh/year$

(iv) total installed PV capacity $= \dfrac{\text{full potential}}{\text{Capacity} \times \text{No. of hours}}$

$$= \frac{6.6 \text{ TWh/year}}{0.09 \times 365 \times 24h}$$

$$= 0.008371 \text{ TW}$$

$$= 8371.39 \text{ MW}$$

Ans 2:-

(i) Effective cost of solar cells $= 2 \times \$3 \text{/Watt}$

$= \$6\text{/ Watt}$

Electricity produced by solar cells per month to meet the demand $= 1500 \text{ KWh/month}$

Solar insolation available for 112 h/month

Solar power produced by Solar cells

$$= \frac{1500 \text{ KWh/month}}{112 \text{ h/month}}$$

$$= 13.39 \text{ KW}$$

Cost for producing 13.39 KW $= 13.39 \times 10^3 \times 6$

$= \$80.35 \times 10^3$

Total solar energy produced for 20 years

$= 1500 \times 12 \times 20$

$= 36 \times 10^4 \text{ KWh}$

Cost of Solar generated electricity per kWh

$$= \frac{\$ 80.35 \times 10^3}{36 \times 10^4 \text{ kWh}}$$

$$= 0.223 \ \$/\text{kWh}$$

(ii) Required ~~number~~ reduction in cost of solar generated electricity $= \$0.223/\text{kWh} - \$0.07/\text{kWh}$

$$= \$ 0.153 \ /\text{kWh}.$$

Let new cost be $c \ \$/W$

So, total cost calculated with power produced in 20 years

$$= \$ 13.39 \times 10^3 \times c$$

$\therefore \$0.07 =$ cost per kWh of Solar electricity

$$= \frac{\$13.39 \times 10^3 \times c}{1500 \times 12 \times 20}$$

$$\therefore c = 1.882 \ \$/W$$

$\therefore$ The cost that needs to be reduced

$$= 6 - c \quad \$/W$$

$$= 6 - 1.882$$

$$= 4.118 \ \$/W.$$