

PROBLEM SET 2
Thanks to Adam J. Smith

ENVS 5820

Question 1

Assumes growth rate of 3.4% continues through 2006.

Total Electricity (2002)	45,600,388	MWh
Growth Rate (1993-2002)	3.4%	
Total Electricity (2006)	52,125,555	MWh
Insolation (MWh/m ² /yr)	2.0075	
PV Efficiency	10.0%	
PV Production (MWh/m ² /yr)	0.20075	MWh
Sq. Meters per Sq. Mile	2,560,000	
PV Production (MWh/mi ² /yr)	513,920	MWh
Total PV Area	101.4	mi²

Question 2

Area of Colorado	104,000	mi ²
Percentage of Colorado	0.10%	

Question 3

Total Electricity (2006)	52,125,555	MWh
Turbine Capacity	1.5	MW
Capacity Factor	22%	
Annual Turbine Production	2,890.8	MWh
Total Turbines Needed	18,032	

Question 4

Total PV Area (mi ²)	101.4	mi ²
Sq. Meters per Sq. Mile	2,560,000	
Total PV Area (m ²)	259,654,073	m ²
PV Cost	\$8	per watt
Power per Area	100	W/m ²
Cost per Area	\$800	per m ²
Total PV Cost	\$207,723,258,211	

Question 5

Total Turbines Needed	18,032
Turbine Cost	\$1,500,000
Total Wind Cost	\$27,047,299,246

Question 6

$$A = P \cdot \left[\frac{rd \cdot (1 + rd)^n}{(1 + rd)^n - 1} \right]$$

where A is the annualized payment on a loan of principal P for n years at interest rate r_d .

Loan Term (years)	20
Interest Rate	5%
PV Capital Cost	\$207,723,258,211
Annualized Capital Cost	\$16,668,251,658
Annual O&M	\$417,004,441
Total Annual PV Cost	\$17,085,256,099
Annual PV Production (kWh)	52,125,555,107
PV COE	\$0.328

Question 7

Same annualizing equation as question 6.

Loan Term (years)	20
Interest Rate	5%
Wind Capital Cost	\$27,047,299,246
Annualized Capital Cost	\$2,170,345,268
Annual O&M	\$260,627,776
Total Annual Wind Cost	\$2,430,973,044
Annual Wind Production (kWh)	52,125,555,107
Wind COE	\$0.047