

Solar-Wind Pump for a Mongolia Village

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Korea Tech

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Location : Bayannuur, Bulgan, Mongolia (Lat : 47.83. Long : 104.44)

Population: 1000

Elevation : 850[m]

Wind Speed : 10~12[m/s]

Temperature : -42~30[°C]

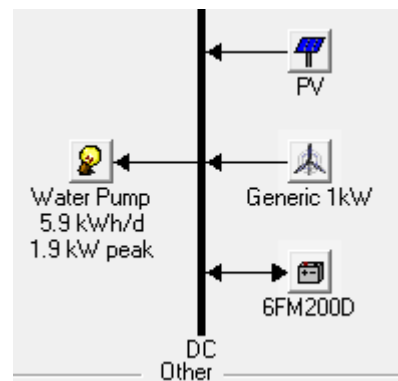


Project Goal

- ▶ Post-analysis of the solar pump installed in 2010
- ▶ Bringing up improvement and simulation of the new design

Approach

- ▶ Supplying power to a submerged pump from Solar and Wind energy sources and providing drinking water to the village folks.



Water Flow Calculation:

Water amount per capita = 1 gal/day

Water need for the village = 1000 gal/day

$$Q(\text{gpm}) = \frac{\text{Daily demand}}{\text{Insolation} \times 60} = \frac{1000}{4.04 \times 60} = 4.12 \approx 4.2(\text{gpm})$$

$$P_{\text{in}} = \frac{0.1885 \times 340(\text{ft}) \times 4.2}{0.3} = 897.6 \approx 900[\text{W}]$$

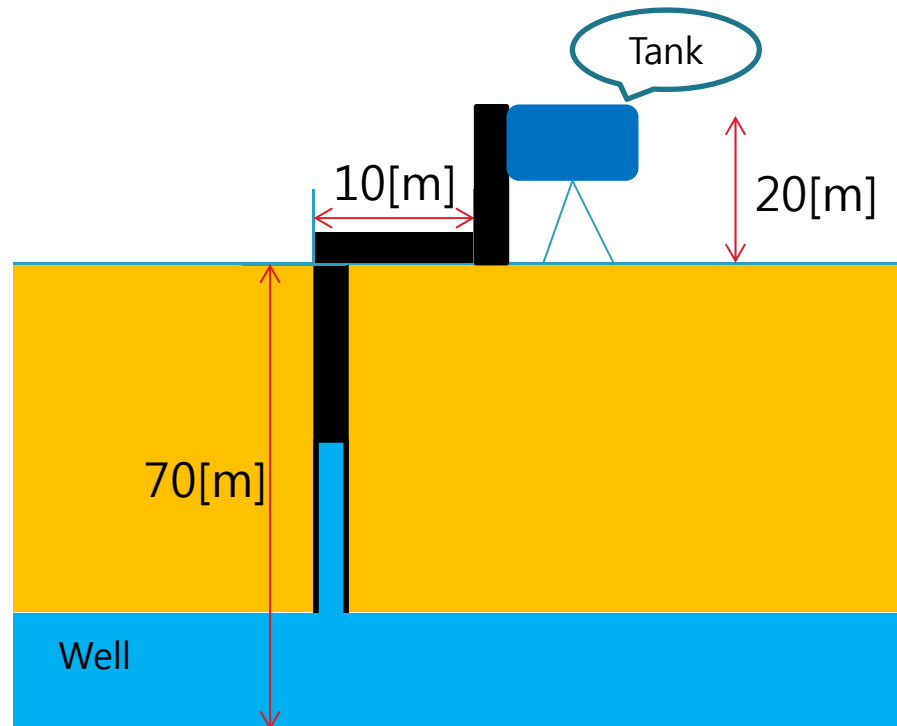
Static and Dynamic Head:

Elbow = 3[ea] \Rightarrow 6[ft]

Check Valve \Rightarrow 5[ft]

Gat Valve \Rightarrow 1[ft]

Total Head = 340[ft]



System Modeling



PV 2.4[kW]



Inverter, Solar Controller

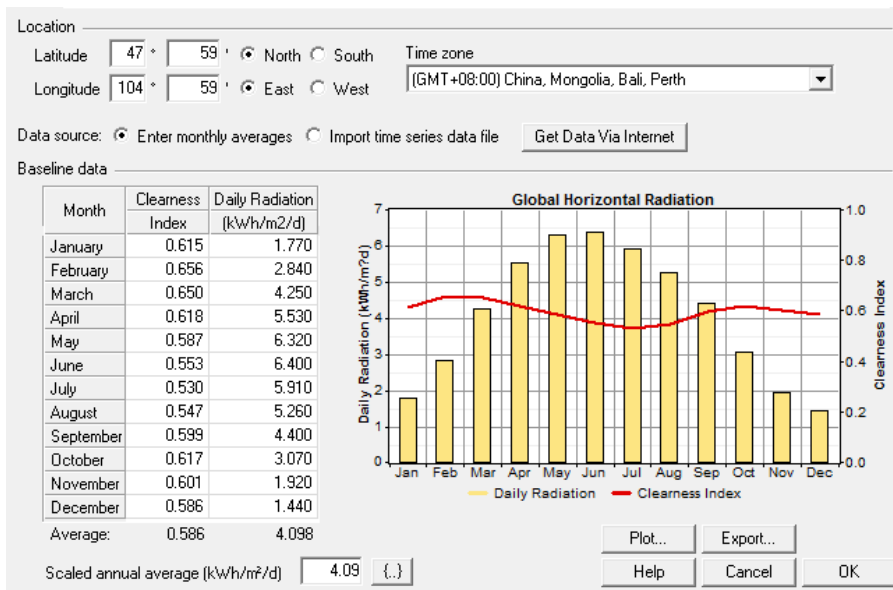


1[kW] Water Pump

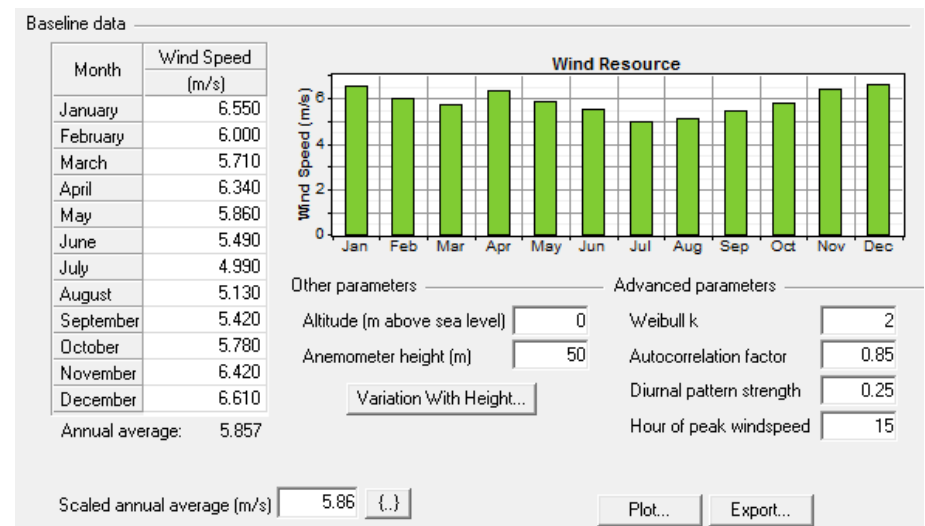


Battery 12[V] 1000[AH]

System Modeling – Renewable Resources

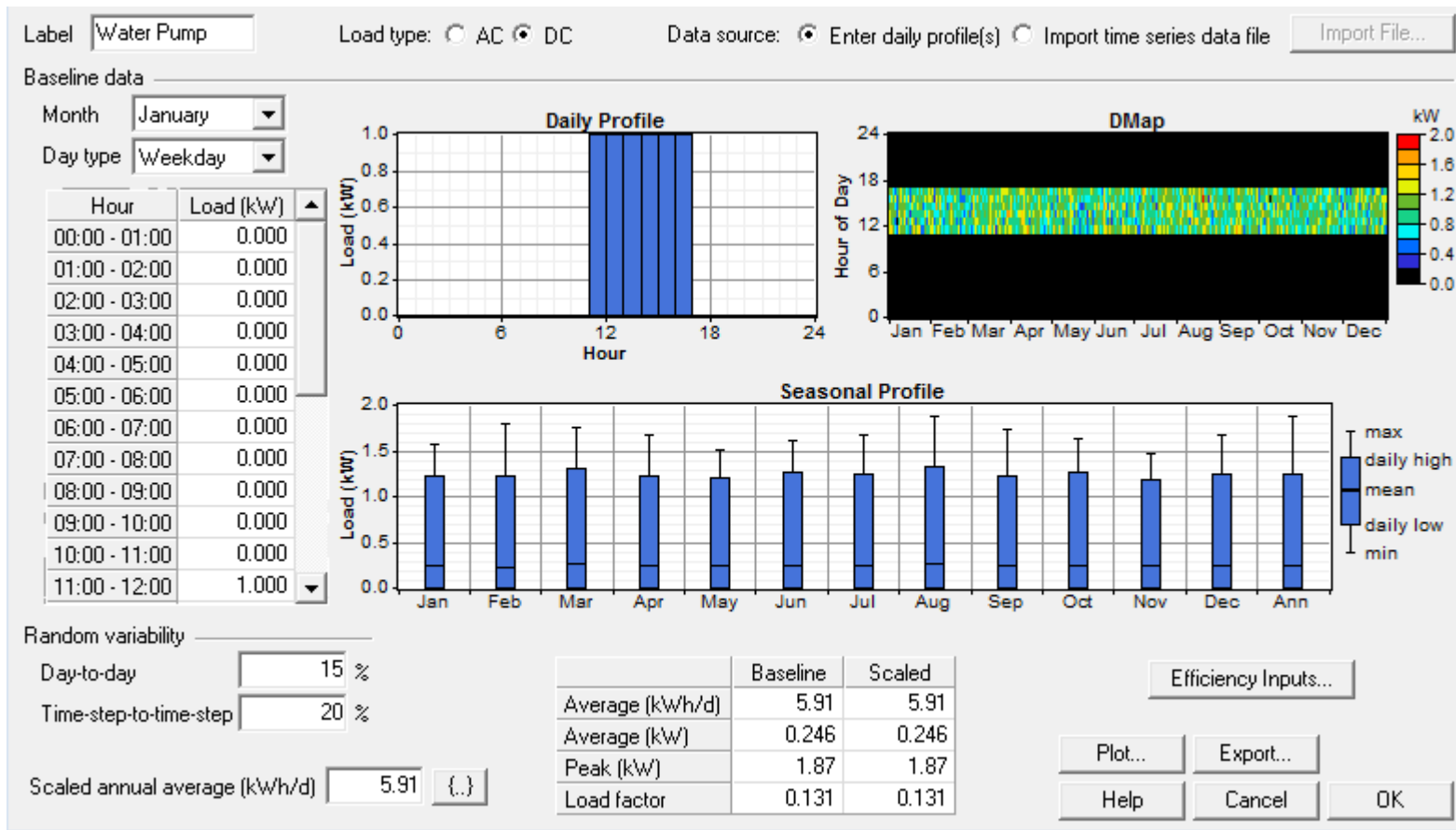


Solar resource



Wind resource

System Modeling – Load Profile



Under the assumption of running the water pump for 6 hours a day following the peak-sun hour of the location in the design (worst) month.

System Modeling – PV and WT



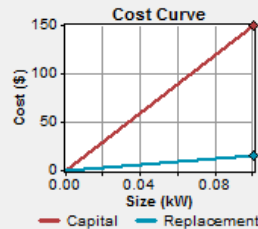
Enter at least one size and capital cost value in the Costs table. Include all costs associated with the PV (photovoltaic) system, including modules, mounting hardware, and installation. As it searches for the optimal system, HOMER considers each PV array capacity in the Sizes to Consider table.

Note that by default, HOMER sets the slope value equal to the latitude from the Solar Resource Inputs window.

Hold the pointer over an element or click Help for more information.

Size (kW)	Capital (\$)	Replacement (\$)	O&M (\$/yr)
0.100	150	15	0

Size (kW)
0.000
0.100



Properties

Output current AC DC

Lifetime (years) (.)

Derating factor (%) (.)

Slope (degrees) (.)

Azimuth (degrees W of S) (.)

Ground reflectance (%) (.)

Advanced

Tracking system (.)

Consider effect of temperature

Temperature coeff. of power (%/°C) (.)

Nominal operating cell temp. (°C) (.)

Efficiency at std. test conditions (%) (.)



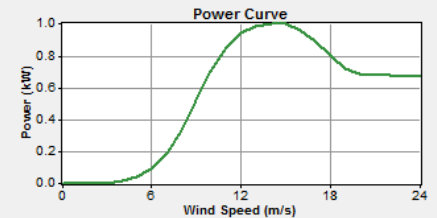
Choose a wind turbine type and enter at least one quantity and capital cost value in the Costs table. Include the cost of the tower, controller, wiring, installation, and labor. As it searches for the optimal system, HOMER considers each quantity in the Sizes to Consider table.

Hold the pointer over an element or click Help for more information.

Turbine type Details... New... Delete

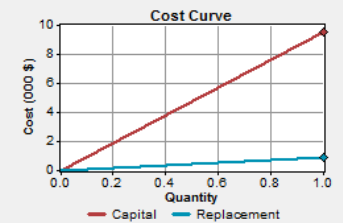
Turbine properties

Abbreviation: G1 (used for column headings)
 Rated power: 1 kW DC
 Manufacturer:
 Website:



Quantity	Capital (\$)	Replacement (\$)	O&M (\$/yr)
1	9500	950	0

Quantity
0
1




Other

Lifetime (yrs) (.)

Hub height (m) (.)

System Modeling - Battery

 Choose a battery type and enter at least one quantity and capital cost value in the Costs table. Include all costs associated with the battery bank, such as mounting hardware, installation, and labor. As it searches for the optimal system, HOMER considers each quantity in the Sizes to Consider table.

Hold the pointer over an element or click Help for more information.

Battery type:

Battery properties

Manufacturer: Vision Battery
Website: www.vision-batt.com

Nominal voltage: 12 V
Nominal capacity: 200 Ah (2.4 kWh)
Lifetime throughput: 917 kWh

Costs

Quantity	Capital (\$)	Replacement (\$)	O&M (\$/yr)
1	484	48	0.00
	<input type="text" value="{}"/>	<input type="text" value="{}"/>	<input type="text" value="{}"/>

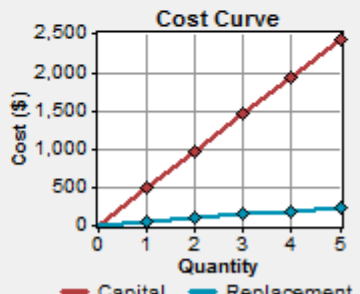
Sizes to consider

Batteries
0
1
2
3
4
5

Advanced

Batteries per string: (12 V bus)
 Minimum battery life (yr):

Cost Curve















Quantity	Capital Cost (\$)	Replacement Cost (\$)
0	0	0
1	484	48
2	968	96
3	1452	144
4	1936	192
5	2420	240

Result – Optimization by NPC

Sensitivity variables

Global Solar (kWh/m²d) Wind Speed (m/s)

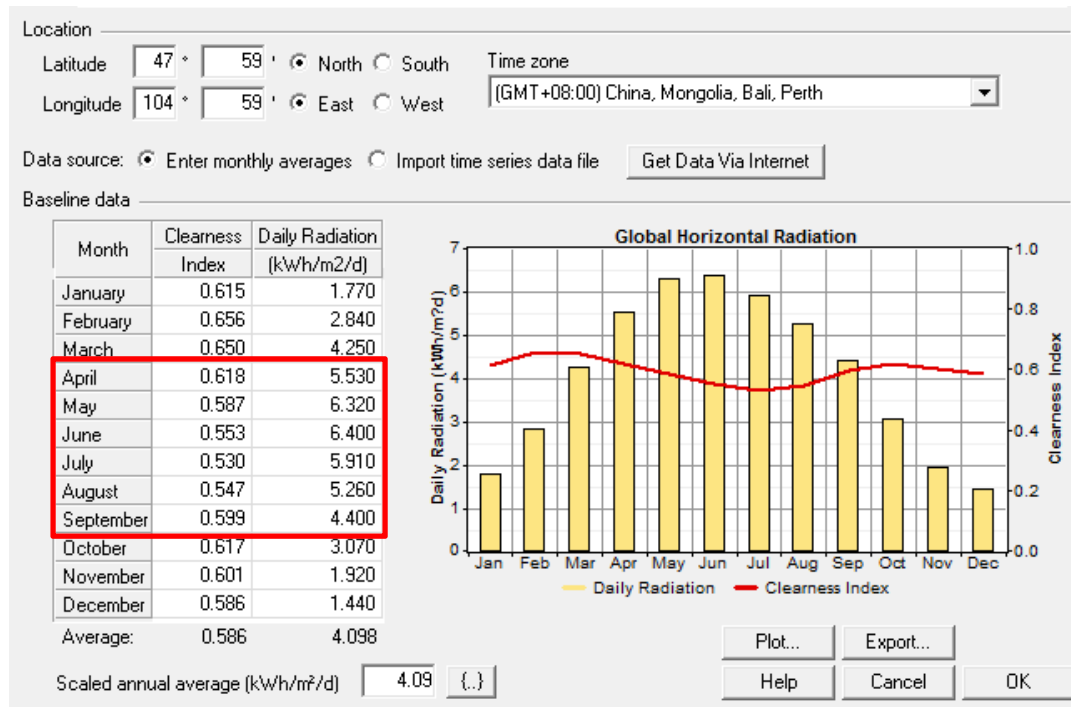
Double click on a system below for

			PV (kW)	GT	BFM200D	Initial Capital	Operating Cost (\$/yr)	Total NPC	COE (\$/kWh)	Ren. Frac.
			2.2	1	5	\$ 15,220	43	\$ 15,769	0,572	1,00
			2.4	1	5	\$ 15,520	43	\$ 16,073	0,583	1,00
			2.8	1	4	\$ 15,636	41	\$ 16,161	0,586	1,00

Best Combination:

2.2[kW] PV + 1[kW] Wind Turbine

Result – Sensitivity Analysis



In consideration of the months
Between April and September,
⇒ 3[kW] PV is most economical

Sensitivity variables

Global Solar (kWh/m²/d) 5 Wind Speed (m/s) 5.86

Double click on a system below for




	PV (kW)	G1	6FM200D	Initial Capital	Operating Cost (\$/yr)	Total NPC	COE (\$/kWh)	Ren. Frac.
	3.0		5	\$ 6,920	19	\$ 7,163	0,260	1,00
	1.6	1	5	\$ 14,320	42	\$ 14,856	0,539	1,00
	1.8	1	5	\$ 14,620	42	\$ 15,161	0,550	1,00

Result – Sensitivity Analysis

Sensitivity variables

Global Solar (kWh/m²d) Wind Speed (m/s)

Double click on a system below for

	PV (kW)	GT	BFM2000	Initial Capital	Operating Cost (\$/yr)	Total NPC	COE (\$/kWh)	Ren. Frac.
  	2.4	2	5	\$ 25,020	68	\$ 25,895	0.940	1.00

In winter months, the combination of 2.4[kW]PV and 2[kW]Wind Turbine is required, due to the extreme dropping of PV Generation during the harsh weather condition.

Conclusion

- Goal of the project: Solar-Wind Water Pump Feasibility Study
- Broad Impact: Small step toward stopping global warming and preventing the desertization of Mongol
- Findings:
 - Solar energy alone [the 2010 configuration] cannot be used during the winter months between October and March.
 - The PV+ WT configuration is more suitable for annual operation of the pump