

EECC325/326 Fundamentals of Energy Systems & Lab

Lab 11. Renewable Energy Micro-Power System Design

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Lab 11 Design for an Actual System

⌘ Work on your own project (or one of the examples)

⌘ Lab Objectives:

☒ Site Identification → Mission or Goal

☒ Load study → Should match with the site and the goal
→ Must be able to justify and realistic

☒ Find the Solar Radiation, and give Sensitivity values

☒ Find the Wind Speed, and give sensitivity values

☒ Include Realistic Carbon Penalty, if possible

☒ **Find the components/devices locally (or Amazon.com) available (Important)**

☒ **Correct Size – Price is very important**

☒ **Physical Size must considered against the project site**

☒ Calculate and Check the Optimization results

☒ Check the Sensitivity Results

Suggested Component Data – Wind and PV

⌘ Wind Turbine

☒ Furhlander 30

- ☒ Size: 30 kW
- ☒ Lifetime: 20 years
- ☒ Quantity: 10: [0, 5, 10]
- ☒ Capital Cost: \$7,800 [for 1 unit]
- ☒ Replacement Cost: 10% of the Capital Cost
- ☒ O&M Cost/Year: 5% of the Capital cost



⌘ PV Module

- ☒ Size: 200kW: [0,100,200,300] kW
- ☒ Derating Factor: 90%
- ☒ Lifetime: 20 years
- ☒ Capital Cost: \$5000/kW
- ☒ Replacement Cost: 10% of Capital Cost
- ☒ O&M: 1% of Capital Cost



Suggested Component Data – Hydrogen

⌘ Electrolyzer

- ⊞ Size: 100kW: [0, 50, 100] kW
- ⊞ Lifetime: 20 years
- ⊞ Capital Cost: \$3000/kW
- ⊞ Replacement cost: 50% of Capital Cost
- ⊞ O&M Cost/Year: 5% of Capital cost



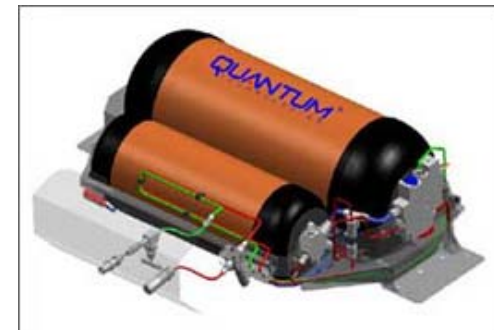
⌘ Fuel Cell

- ⊞ Size: 200kW: [0, 100, 200, 300] kW
- ⊞ Lifetime: 30000 operating hours
- ⊞ Capital Cost: \$5000/kW (or \$500/kW)
- ⊞ Replacement Cost: \$0
- ⊞ O&M cost: \$0.1/hour



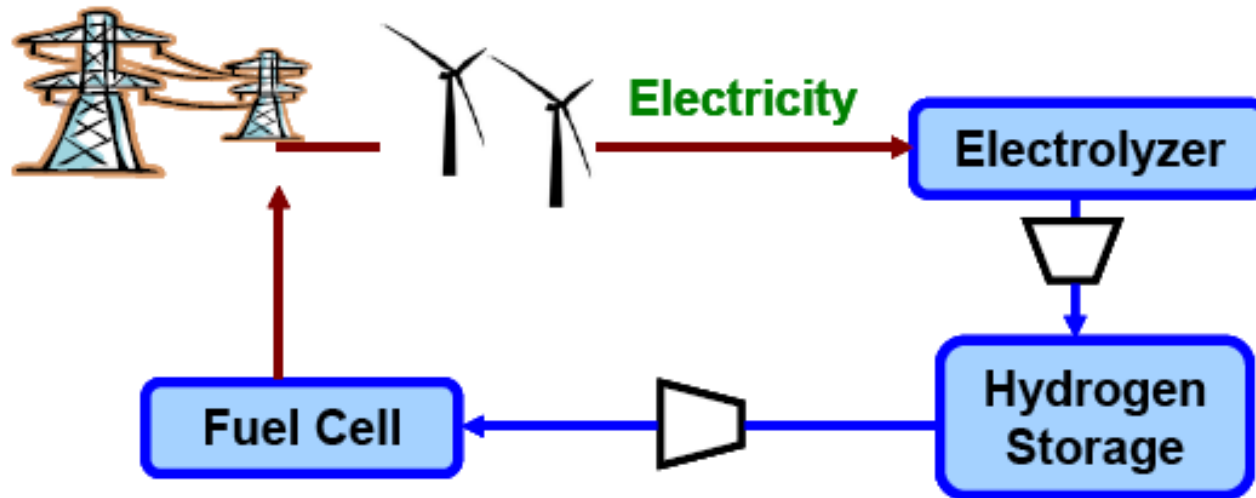
⌘ Hydrogen Tank

- ⊞ Size: 2000 kg: [0, 1000, 2000, 3000]kg
- ⊞ Lifetime: 25 years
- ⊞ Capital Cost: \$500/kg
- ⊞ Replacement Cost: 10% of Capital Cost
- ⊞ O&M Cost/year: 0.5% of the Capital Cost



Side Bar- Hydrogen Systems

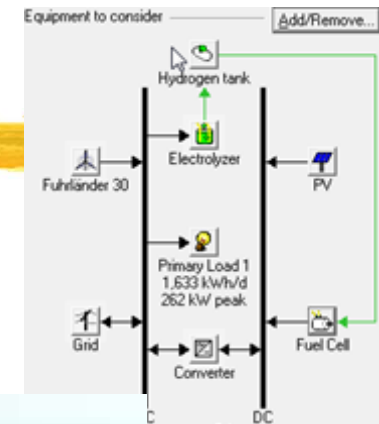
- ⌘ Electrolyzer system converts electricity into hydrogen by electrolyzing water
- ⌘ Hydrogen is stored in steel tanks or geological cavern
- ⌘ Reconverted to Electricity using 2 methods:
 - ⊞ Polymer Electrolyte Membrane (PEM) fuel cell
 - ⊞ Hydrogen Expansion Combustion Turbine



Fuel Cell Modeling

⌘ Fuel Cell In HOMER modeling:

- ☑ Pick a generator
- ☑ Type: DC
- ☑ Fuel: Stored Hydrogen



Generator Inputs

File Edit Help

Choose a fuel, and enter at least one size, capital cost and operation and maintenance (O&M) value in the Costs table. Note that the capital cost includes installation costs, and that the O&M cost is expressed in dollars per operating hour. Enter a nonzero heat recovery ratio if heat will be recovered from this generator to serve thermal load. As it searches for the optimal system, HOMER will consider each generator size in the Sizes to Consider table.

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

Cost | Fuel | Schedule | Emissions

Costs

Size (kW)	Capital (\$)	Replacement (\$)	O&M (\$/hr)
200.000	1000000	0	0.100
(.)	(.)	(.)	(.)

Properties

Description: Fuel Cell Type: AC DC

Abbreviation: Label

Derating factor (%): 70

Cost | Fuel | Schedule | Emissions

Fuel curve

Fuel: Stored hydrogen Details... New...

Intercept coeff. (kg/hr/kW rated): 0.08 (.)

Slope (kg/hr/kW output): 0.25 (.)

Advanced

Heat recovery ratio (%): 0 (.)

Configure with biomass

Help Cancel OK

Suggested Component Data – Converter

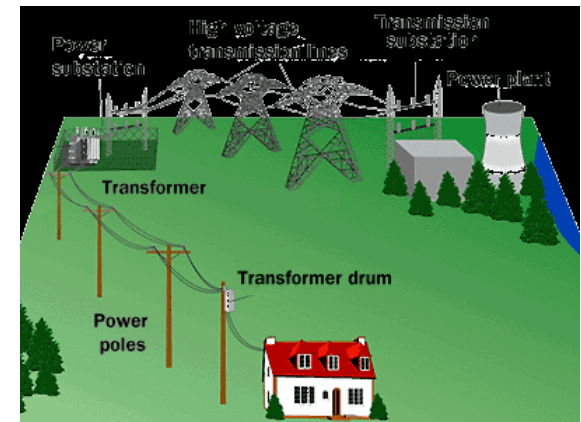
⌘ Converter

- ⊞ Size: 200kW: [0, 100, 200, 300]kW
- ⊞ Lifetime: 20 years
- ⊞ Efficiency: 90%
- ⊞ Capital Cost: \$1000/kW
- ⊞ Replacement Cost: 30% of Capital Cost
- ⊞ O&M Cost/Year: 10% of Capital Cost



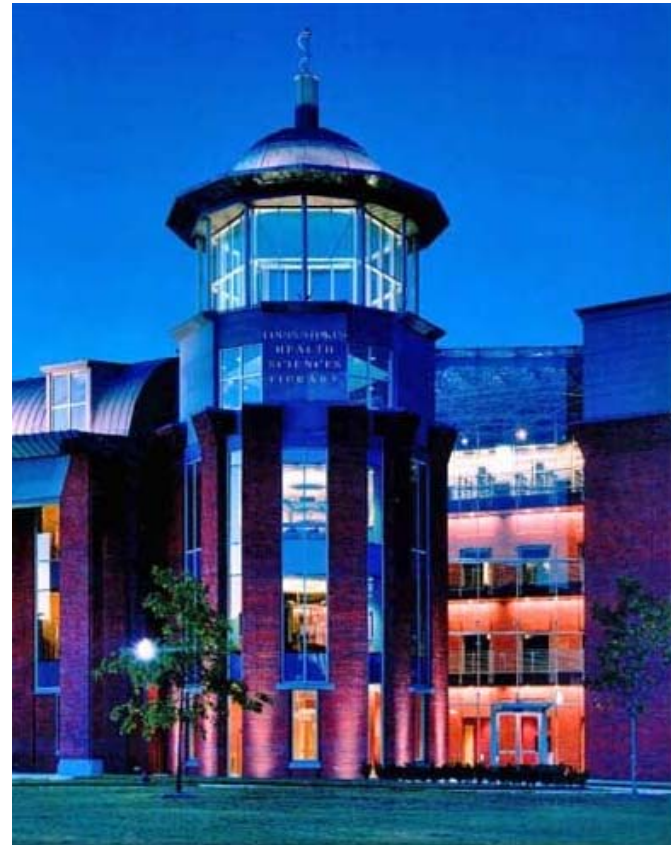
⌘ Grid (If needed)

- ⊞ Single rate
- ⊞ Price (\$/kWh): \$0.15 :
Sellback (\$/kWh): \$0.15
- ⊞ Demand: \$0
- ⊞ **Purchase Capacity: Penetration(fraction) condition**
- ⊞ Sellback Capacity: 100kW



Example 1 – Green Campus

- ⌘ Green Campus Feasibility Study for Howard University
- ⌘ Entire Campus or a building (Engineering or Blackburn etc) or an area (such as Quadrangle's lighting)



Example 2 - Solar/Wind Pump

⌘ Site Information

- ⊞ 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]

⌘ 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.



Example 2 (continued) - Water Flow

- ⌘ Water Need per day: 1000 Gal
- ⌘ Insolation: Full Sun Hour = 4.04
- ⌘ $Q(\text{GPM})=4.2$

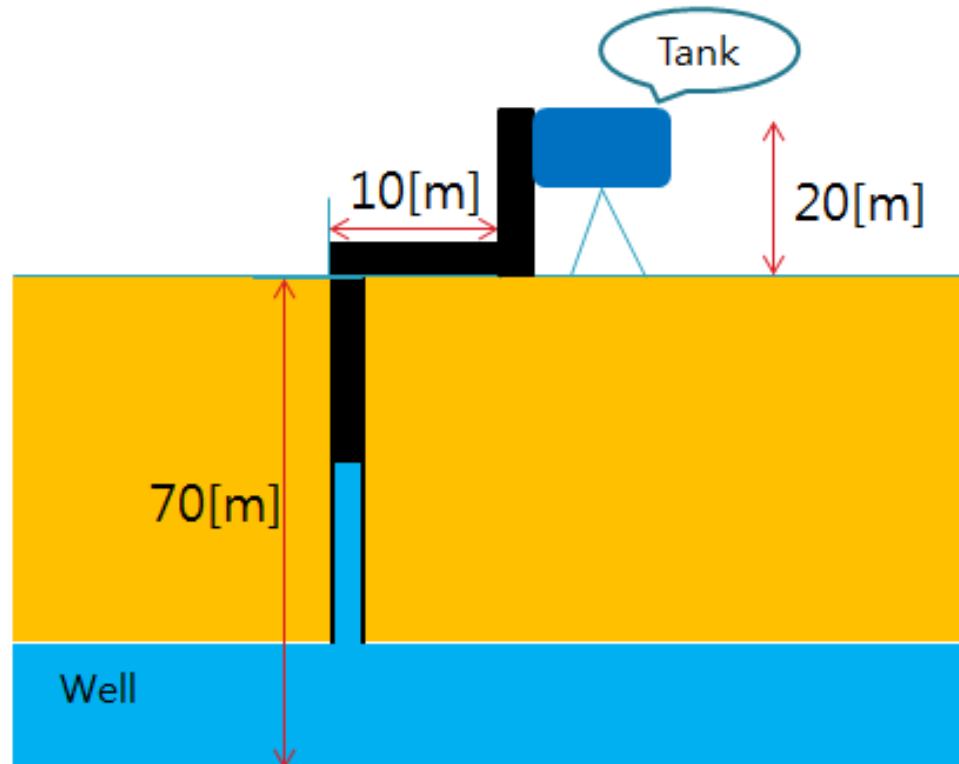
Static and Dynamic Head:

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

Check Valve \Rightarrow 5[ft]

Gat Valve \Rightarrow 1[ft]

Total Head = 340[ft]



Example 3 – Lighting 14th Bridge by Renewable Energy

- ⌘ 100% Renewable Sourced Night Flood Lighting System for the 14th Street Bridge



Report and Homer Code Submission

⌘ 1. Report File (MS Word File)

⊞ Explanation of

- ⊞ Mission, System Site, Location,
- ⊞ Load,
- ⊞ Economics, carbon limit, emission penalties
- ⊞ Optimum result → Comment and Opinion
- ⊞ Appendix: Homer produced report

⊞ Put all into 1 MS Word file

⊞ File name: **Lab11_Lastname.docx**

⌘ 2. Homer Code File

⊞ Filename: **Lab11_lastname.hmr**