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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

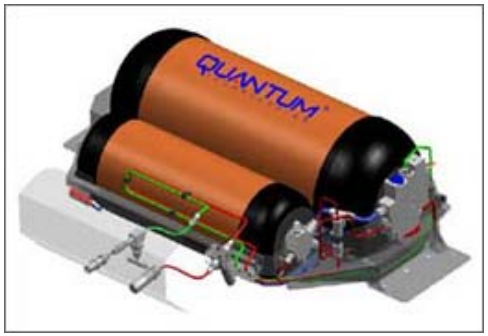
- PV Module
  - Size: 200kW: [0,100,200,300] kW
  - Derating Factor: 90%
  - Lifetime: 20 years
  - Capital Cost: $5000/kW
  - Replacement Cost: 10% of Capital Cost
  - O&M: 1% of Capital Cost

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

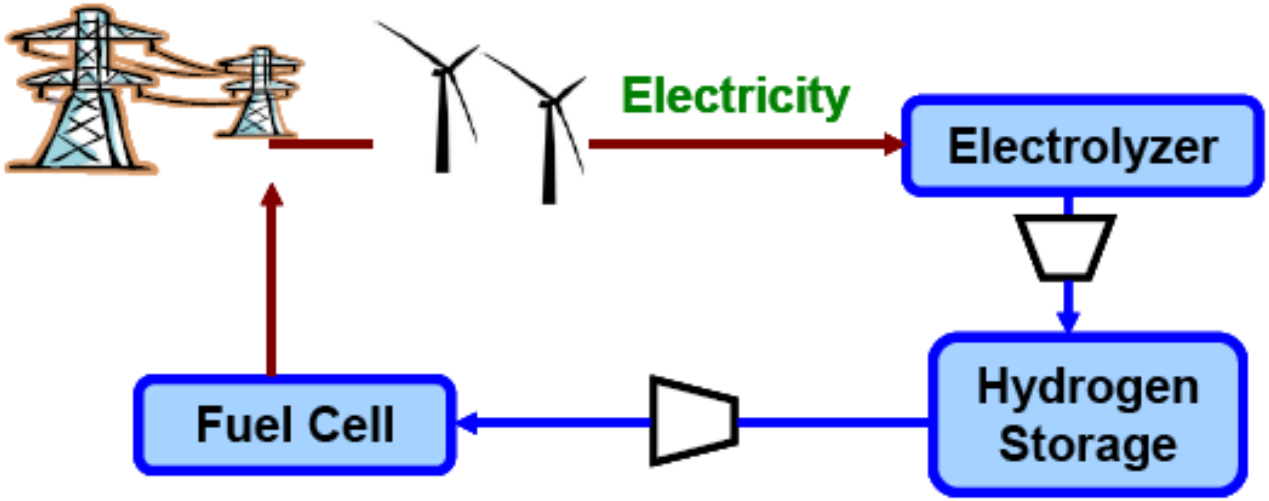
- Fuel Cell
  - Size: 200kW: [0, 100, 200, 300] kW
  - Lifetime: 30000 operating hours
  - Capital Cost: $5000/kW (or $500/kW)
  - Replacement Cost: $0
  - O&M cost: $0.1/hour

- 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



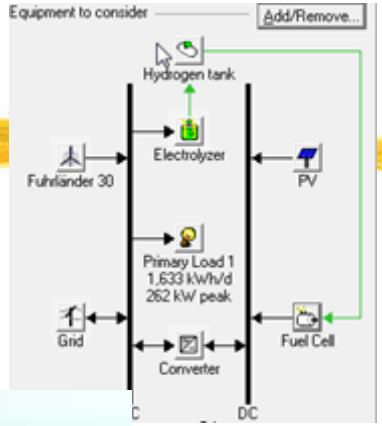
Side Bar- Hydrogen Systems

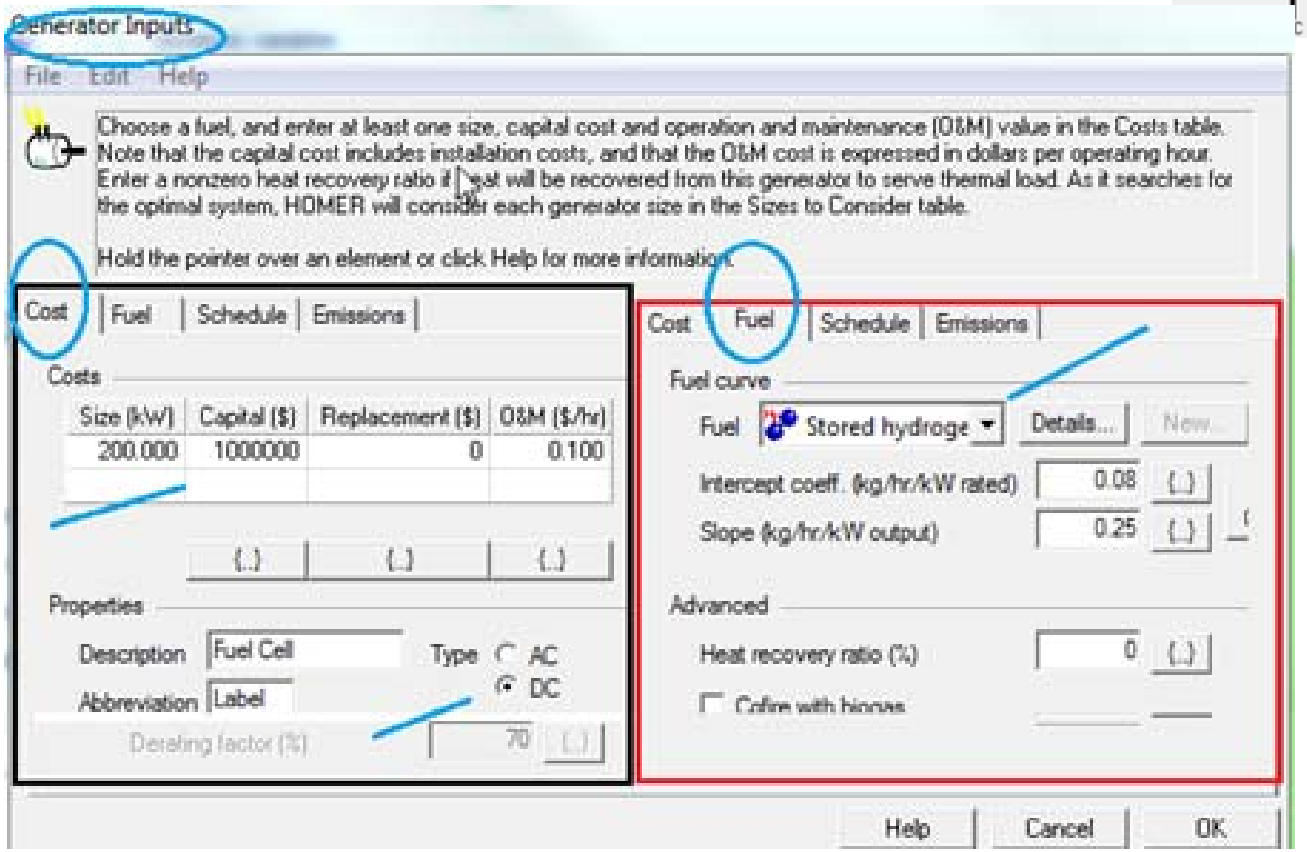
- Electrolyzer system converts electricity into hydrogen by electrolyzing water
- Hydrogen is stored in steel tanks or geological cavern
- Reconverted to Electricity using 2 methods:
  - **Polymer Electrolyte Membrane (PEM) fuel cell**
  - Hydrogen Expansion Combustion Turbine



Fuel Cell Modeling

- Fuel Cell In HOMER modeling:
  - Pick a generator
  - Type: DC
  - Fuel: Stored Hydrogen

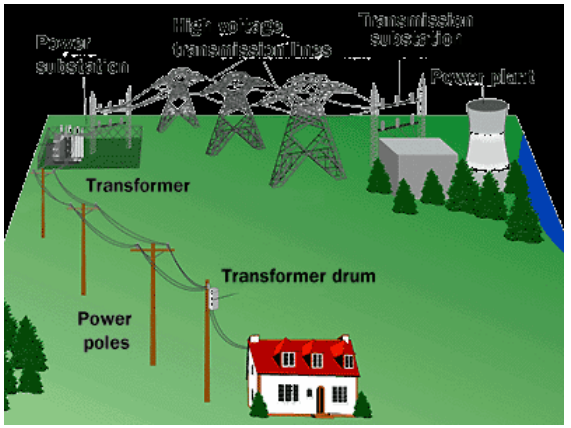




Suggested Component Data – Converter

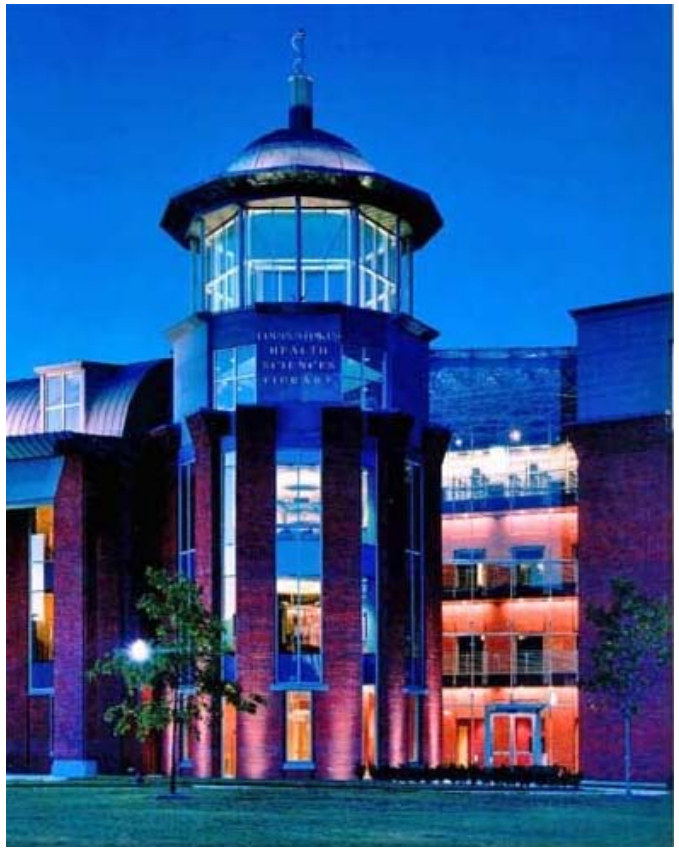
- Converter
  - Size: 200kW: [0, 100, 200, 300]kW
  - Lifetime: 20 years
  - Efficiency: 90%
  - Capital Cost: $1000/kW
  - Replacement Cost: 30% of Capital Cost
  - O&M Cost/Year: 10% of Capital Cost

- 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

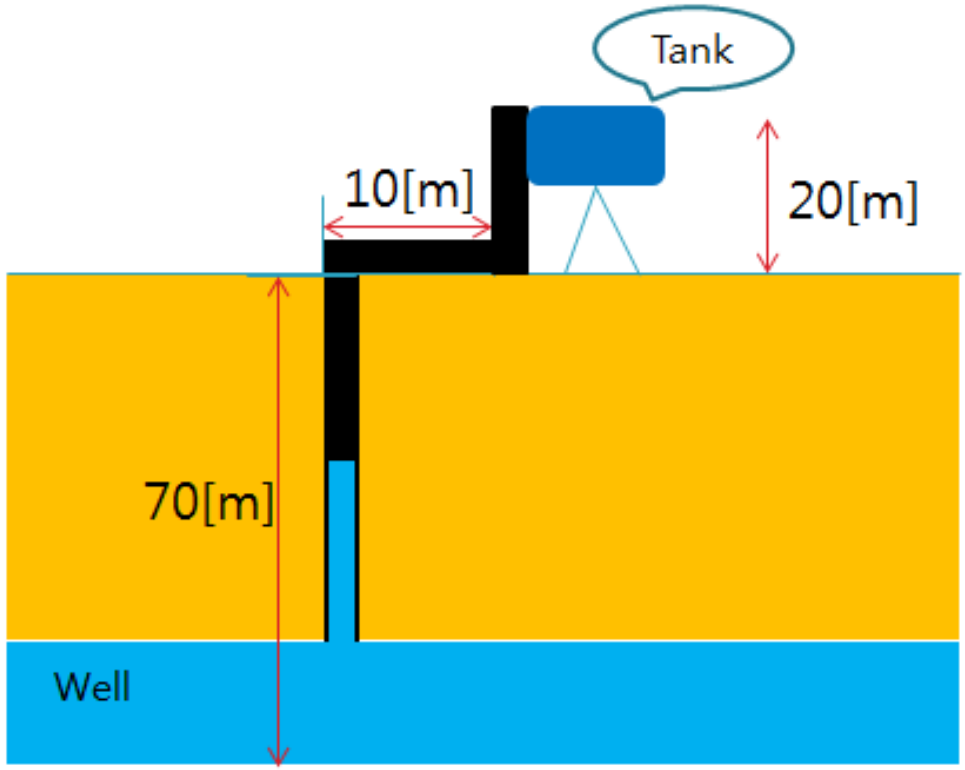
- Site Information
  - Location : Bayannuur, Bulgan, Mongolia (Lat : 47.83. Long : 104.44)
  - Population: 1000
  - Elevation : 850[m]
  - Wind Speed : 10~12[m/s]
  - Temperature : -42~30[℃]
- Post-analysis of the solar pump installed in 2010
- Bringing up improvement and simulation of the new design
- 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(GPM)=4.2

Static and Dynamic Head:
Elbow = 3[ea] ⇒ 6[ft]
Check Valve ⇒ 5[ft]
Gat Valve ⇒ 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