Modeling Hydro Solar Storage Systems

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Goals of Project

Objective: model a system to store solar energy in the form of potential energy

- Minimize energy losses in system
  - Loss due to inefficiency in turbine and pump
  - Loss due to pipe friction
  - Loss due to bends in pipes
- Minimize cost of total system
- Fill and empty in reasonable amount of time
- **Priority: Optimize Ratio of Cost to Loss**

Design Approach

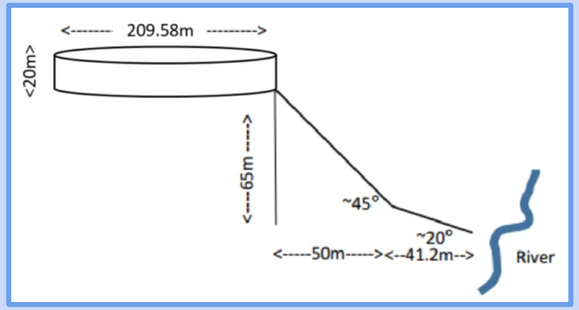
- Research equations and possible factors in design
- Choose factors that are most relevant to the performance of the design
- Create an outline of the model based on the known values
- Decide upon parts that balance low cost and high efficiency
- Finalize model with chosen parts
- Estimate cost of construction

Cost and Efficiency

- Total Cost of Model: $585,938.00
- Efficiency of Model: 70%
- Ratio of Cost to Efficiency: $8,370.54

Model

Site Illustration



Model Inputs and Outputs

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Pipe Inputs:
Pipe Diameter (m): 1.5
Pipe Friction Factor: 0.002
Pipe Length (m): 162

Fitting Inputs:
Bend Coefficient 1: 0.15
Bend Coefficient 2: 0.4
Bend Coefficient 3: 0.15

Turbine Inputs:
Turbine Volumetric Flow (m^3/s): 15
Turbine Efficiency: 0.89

Pump Inputs:
Pump Volumetric Flow (m^3/s): 25
Pump Efficiency: 0.92

Reservoir Inputs:
Elevation of the Bottom of the Reservoir (m): 65
Reservoir Depth (m): 20

Mass of water stored (kg): 6.91e+08
Required Energy Input (Mwh): 172.55
Total Efficiency: 0.70
Surface Area of Reservoir (m^2): 3.45e+04
Time to Fill Reservoir (hours): 7.67
Time to Empty Reservoir (hours): 12.79
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Factors

- Environmental: budget of sites 1 and 3
- Social: rejection of site 2
- Cost-to-loss ratio: choosing parts
- Practicality: choosing flow rates, rejection of site 1

Conclusions

- Used most cost-effective materials in the most practical site
- Efficiency is fairly high for current technology
- The ratio of cost to efficiency could be better, but that can improve as technology advances

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