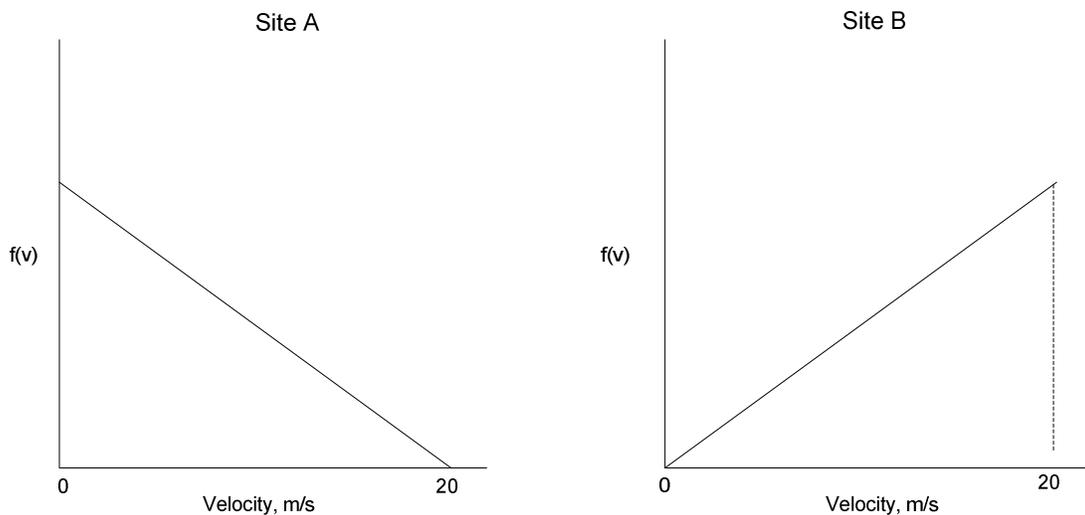


# Sustainable Energy Take-Home Exam 1

This is a take-home quiz, due Friday 10/29 at 5pm. You may use any class notes, texts, or other reliable sources that you wish, but be sure to cite any sources you use. State all assumptions made.

## Question 1 (50 Points):

A 3 MWe wind turbine can be placed at either Site A or B, which have respective probability density functions for the wind velocity at the site (assume that the power output of the turbine varies as the cube of the velocity) as shown in Fig 1.



The land for Site A costs \$1.0 million and that at Site B costs \$2.0 million. The turbine capital cost is \$2 million. O&M costs for a turbine is \$100,000/yr. Electricity from a wind turbine can be sold to the grid for \$60/MWhre. The turbine lifetime is 20 years. The discount rate is 0.04 annually. Inflation and taxes may be ignored. Which site offers the expectation of a better investment?

**Extra Credit (up to 5 Points):** Once the more attractive site is identified what additional factors should a potential investor take into account prior to deciding whether to fund the wind turbine?

**Question 2 (50 Points):**

An ocean thermal gradient electric generating system is proposed for siting in Hawaii. This system would operate a heat engine driven by heat flow from warm ocean water (cooled from 27 °C to 25 °C in the heating heat exchanger of the system), and cooled by heat flow to cold ocean water (which is heated from 3 °C to 5 °C in the cooling heat exchanger of the system). The ocean water used in the different parts of the heat engine is obtained from different depths of the surrounding sea. Using this heat engine electricity can be produced at 90% of the corresponding Carnot efficiency of the heat engine.

- a. (10 points) What is the value of the Carnot efficiency of the heat engine? Explain the basis for selecting the parameter values used in calculating this value.
- b. (15 points) Should the cold ocean water flow through the engine at a rate of 100 million kg/min what is the electric power output of the engine?
- c. (15 points) What is the corresponding flow rate of warm ocean water?
- d. (10 points) Friction losses arising in pumping seawater through the engine account for 0.33 of the engine's irreversibilities. Over time we can expect such friction losses to double, due to fouling in the flow circuits. What would be the resulting value of the heat engine's efficiency?

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