ABT 182: Final Project Proposal

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Objective:

The California TIMES, an energy systems model, projects the energy demands, and the different kinds of renewable energy investments that needs to be made to reach the 80% reduction of 1990 greenhouse gas emissions levels by 2050 (according to Assembly Bill 32). The goal of this exercise is to extend the results from the energy systems model to a spatial dimension. This project will focus on the electricity generation sector, it takes the projected data from the model, and spatially optimizes the locations of renewable energy power plants, specifically, (a) Wind power, (b) Solar power, (c) Biomass, and (d) Geothermal. Several geographical factors play into each of the renewable energy power plants. This project will find optimal locations to meet the energy demand considering the respective factors. Finally, once the locations are determined, the investment costs for each energy source is determined. ArcGIS package will be used for this project with arcpy module for Python scripting. The usage of numpy module will be considered for the mathematical calculations in the model.

Output: The output will be a customized ArcToolBox tool that will take the input file from the model and generate new power plant locations geographically and write the new power plant investment cost output to a text file.

Methodology:

I. Input Data:

The input data is obtained from the Energy Systems Model results, CA-TIMES in a CSV format. It details the electricity generation for each renewable source (in Petajoules). The numbers pertaining to wind, solar, biomass and geothermal are read from the input file.

The total energy generated (for each renewable source) is divided by the energy production power of a single power plant, and the total number of locations needed to meet future demand is determined. The next step is to locate the optimal locations.

II. Spatial Optimization:

This step finds the optimal locations for each renewable energy source based on their desired factors. Figure 1 shows the major preliminary deciding factors for each renewable energy source considered in the project.

A. Wind Energy:

The wind velocity data, and elevation data for California are obtained from National Renewable Energy Laboratory (NREL). The wind velocity data is classified into grids ranging from Class 7 (high winds, most favorable) to Class 1 (poor winds, least favorable). Using arcpy and python, the Class 7 is chosen first and is made to iterate through to fit the 'appropriate elevation' guidelines according to NREL literature. If the locations satisfy other common criteria listed in Figure 1, and any conflict with existing locations. Then, it is checked in order of preference to see if the demand in 2050 is met by these locations. If not, the process is repeated for Class 6, and so on.

B. Solar Energy:

The same process (as the wind energy explained above) is repeated for solar, except that, the criteria for choosing the preliminary locations are high solar radiation and low rainfall (Source: NREL). Solar radiation data are measured in terms of annual solar radiation levels.

C. Geothermal and Biomass energy:

The geo-processing exercise is repeated for high geothermal levels and biomass levels in California, and filtered through the common criteria listed in Figure 1 and Table 1.

Figure 1. Flowchart of the Electricity Generation Spatial Optimization Project

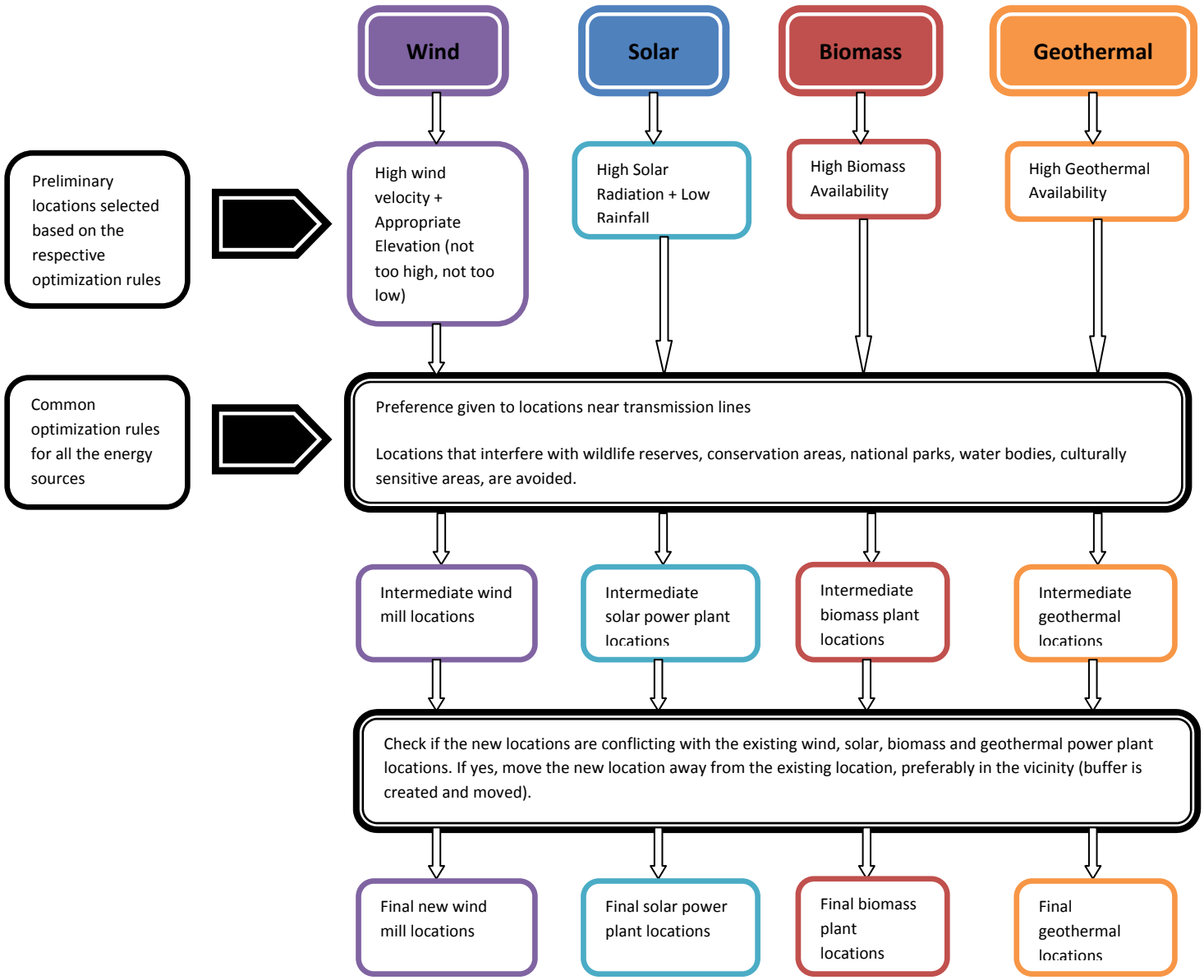

Table 1. Spatial Optimization Project (Data needed & Source)

Renewable Energy	Data needed (all shapefiles)	Source
Wind Power	Wind Velocity	NREL, categorized into 7 classes (Class 7 being high winds, class 1 being poor winds)
	Elevation	California Elevation data from California GIS Depot
Solar Power	Solar Radiation	NREL, measured in terms of annual solar radiation
	Rainfall	California GIS Depot, measured in terms of annual rainfall
Biomass	Biomass	NREL, Total annual biomass mass availability
Geothermal	Geothermal	NREL, categorized into 5 classes (Class 5 being most favorable, class 1 being lease favorable)
All	Transmission Lines, wildlife reserves, conservation areas, national parks, water bodies, culturally sensitive areas	California Energy Commission
All	Existing wind, solar, biomass and geothermal projects	California Energy Commission

III. Conflict detection and final cost calculation:

Once, the locations are finalized, any conflicts 'between' the different renewable energy power plants are detected. If there are any, the locations are revised and moved, preferably in the vicinity of the same location (using arcpy.Buffer_analysis).

The final locations are then used for investment cost calculation and it is printed out in an output text file.