CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY

Name(s)
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Project Number
22529

Project Title
Energy Enigma

Abstract

Objectives/Goals
My objective was to determine an optimal location for a gas-powered electrical power plant to help meet the energy shortfall in southern CA by building a mathematical model using linear programming. I hypothesized that the optimal location would be centrally located to the major cities of southern CA, those with the greatest power consumption, because the distribution from this location would have minimal line loss.

Methods/Materials
To determine the best location to construct a power plant, I developed a set of functions in an Excel spreadsheet. I placed a coordinate plane over a map of southern CA and established nodes within the state boundaries. I determined whether a given node was within the natural gas pipeline corridor by calculating linear inequalities to represent the boundaries of the corridor. To find the distance from a given node to the major cities, I used the distance formula and weighted the distances by the city populations. I used the weighted distances to calculate the power loss from a potential plant to consumers. I used the power loss to calculate a hypothetical sales price, decreasing this sales price with increasing power loss. I expressed environmental and property costs by assigning higher costs to nodes within 50 miles of a major city. I devised an optimizing objective equation that combined the sales price and production costs (constraints) and then used this equation to find the locations (feasible solutions) that balanced a low production cost with a high sales price.

Results
The mathematical model shows that the best location to construct a power plant is about 50 miles east of Lancaster. Second and third best locations are east of Riverside and Bakersfield, respectively. I changed the constraints to approximate hot summer conditions and found that in addition to the regions above, two locations closer to LA were also feasible solutions during periods of high demand.

Conclusions/Discussion
The optimal location for a power plant is not centrally located to the major cities included in my experiment, as I hypothesized. The model showed that the best locations are outside the Clean Air Zones and areas of high property costs and within the gas corridor, but still close to the population centers. The environmental, property, and production costs associated with running a power plant in the LA basin shifted the optimal locations further from the major cities than I had anticipated.

Summary Statement
My project is a mathematical model using linear programming and multiple constraints to determine an optimal location for a gas-powered electrical power plant to help meet the energy shortfall in southern California.

Help Received
Tejbir Bling, Bob Collins, and Peter Wiley provided me with math books and advice. My uncle, Greg Ford and Greg Ford (no relation) of the California ISO provided information about energy production in California. My parents helped me with the spreadsheet and the display.