Exploratory Analysis of Solar Energy Incorporation into the Oil and Gas Industry

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Math 1103 - BIG Problems, Dept. of Mathematics, University of Pittsburgh

The Problem

How can solar energy be incorporated into the oil and gas industry in a profitable manner? This is the problem we posed and attempted to answer for the company **CX Energy** with the pursuit of including more sustainable practices into the energy industry. Our goal was to **determine the feasibly of using solar energy in Pennsylvania** by analyzing solar irradiance data and profitable oil well locations.

About CX Energy

CX Energy is a real estate broker based in Pittsburgh, PA that leases land used in oil and gas sales in Pennsylvania, Ohio, and West Virginia. They are considering converting their land use sales to solar power, and we have worked on determining the feasibility, profitability, and the best time to switch from oil and gas to solar energy.

Decline Curve Analysis

Clustering
Harmonic: Not used much in the oil & gas industry

Hyperbolic: $q(t) = \frac{q_i}{(1+bD_it)^{\frac{1}{b}}}$

Exponential: $q(t) = q_i e^{-D_it}$

Reserves: $G_p = \frac{q_i^b}{D_i(1-b)}[q^{1-b} - q_i^{1-b}]$ where $b \neq 1$

Scan QR code for variable key

Problems
- No constraints
- Can't handle data bias
- Overfitting

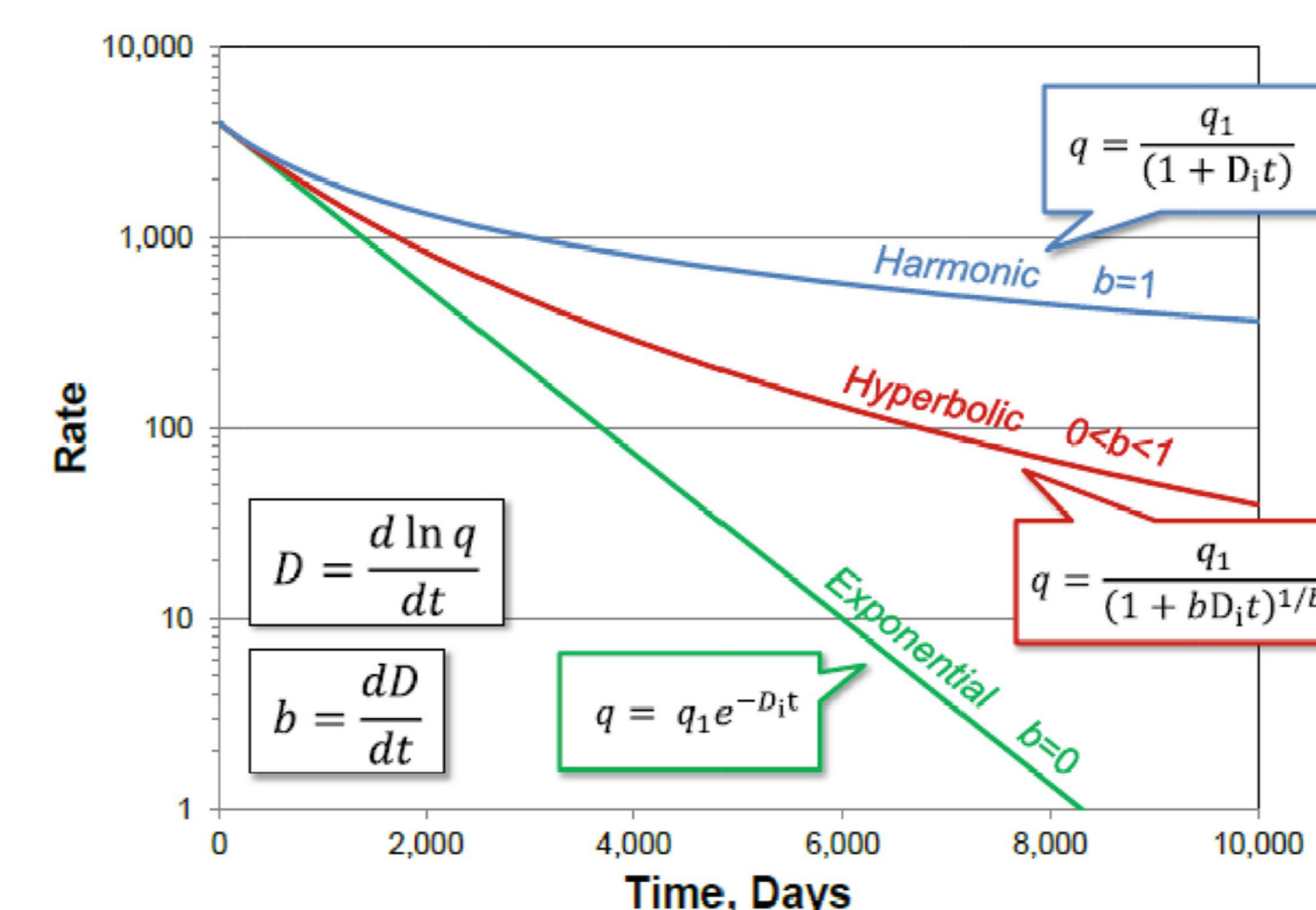Figure 1:Decline Curve Graph

Solar Viability

Objective Identify areas within CX's operating area that would be viable for solar energy production.

Data NASA's 2010 Digital Elevation Model is a publicly available dataset of earth topology, at a resolution of appx. 22,000 points/ mi^2. We use a solar irradiance model by the environmental Science Research Institute to simulate yearly sun exposure.
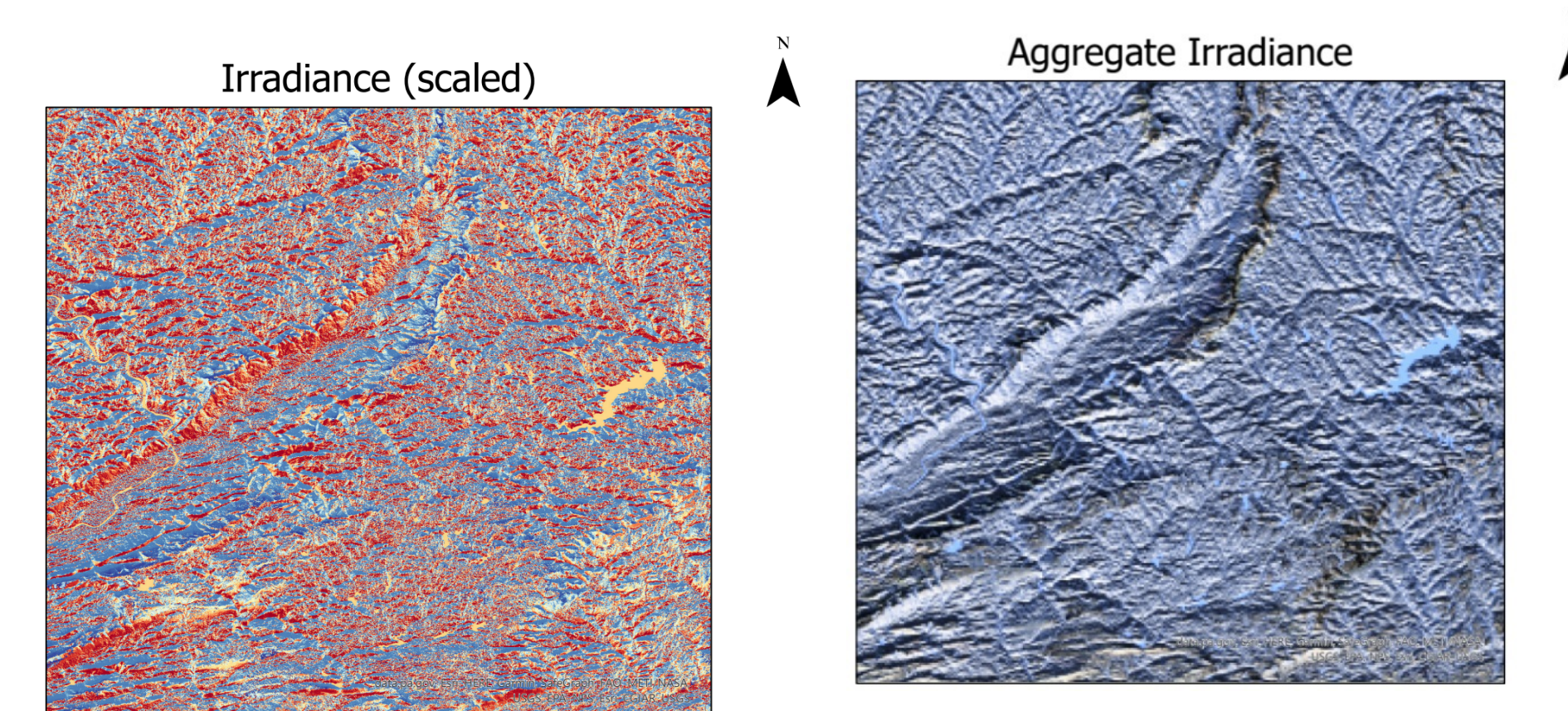

Figure 2:Raw irradiance data from ESRI solar model and NASA DEM

Figure 3:Irradiance map compiled to one value, where lighter areas indicates higher average irradiance

Constraints
- Data is not normalized
- Quality degrades at edges
- Find PA areas with most sunshine to provide more solar energy

Cost-Benefit Analysis

Objective Function Calculate the cost and benefit of functioning CX Energy oil and gas wells and the potential cost and benefit of installing solar panels in Pennsylvania.

Data We calculated the total revenue earned by CX energy for every well in terms of dollar per KiloWatt hour ($/kWh). We converted the gas quantity of one thousand cubic feet (MCF) to KiloWatt-hour to provide a better means of measuring oil revenue versus solar revenue. We multiplied the kWh by $0.1438 which was the average selling point of electricity in the fall of 2021.

Constraints
- No data provided for cost of maintenance of oil wells
- Cost of solar installation
- Cost of purchasing land

Further Research

With more well production data, information on CX's cost to maintain wells, and the cost of purchasing land, we can better predict the lifetime and economic viability of each well.

Landslide Data Especially in Pennsylvania, landslide susceptibility is a crucial data aspect regarding location choice for solar farms. We plan compare slope gradient data in PA with solar irradiance data to find the best locations to start leasing land for solar panels.

Production Data Using CX's data, we took an overall production per day average and plotted the top 500 oil and gas Wells to start help determining potential locations that have an overlap of high well production and solar hot spots in PA
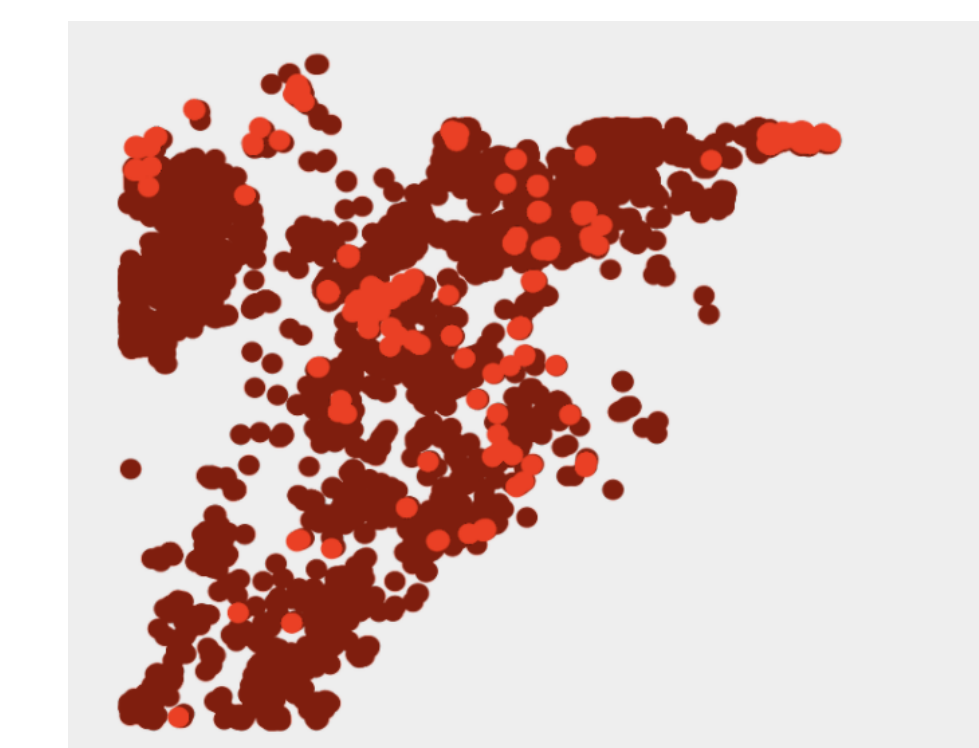
Results

Figure 4:Top 500 Oil Wells
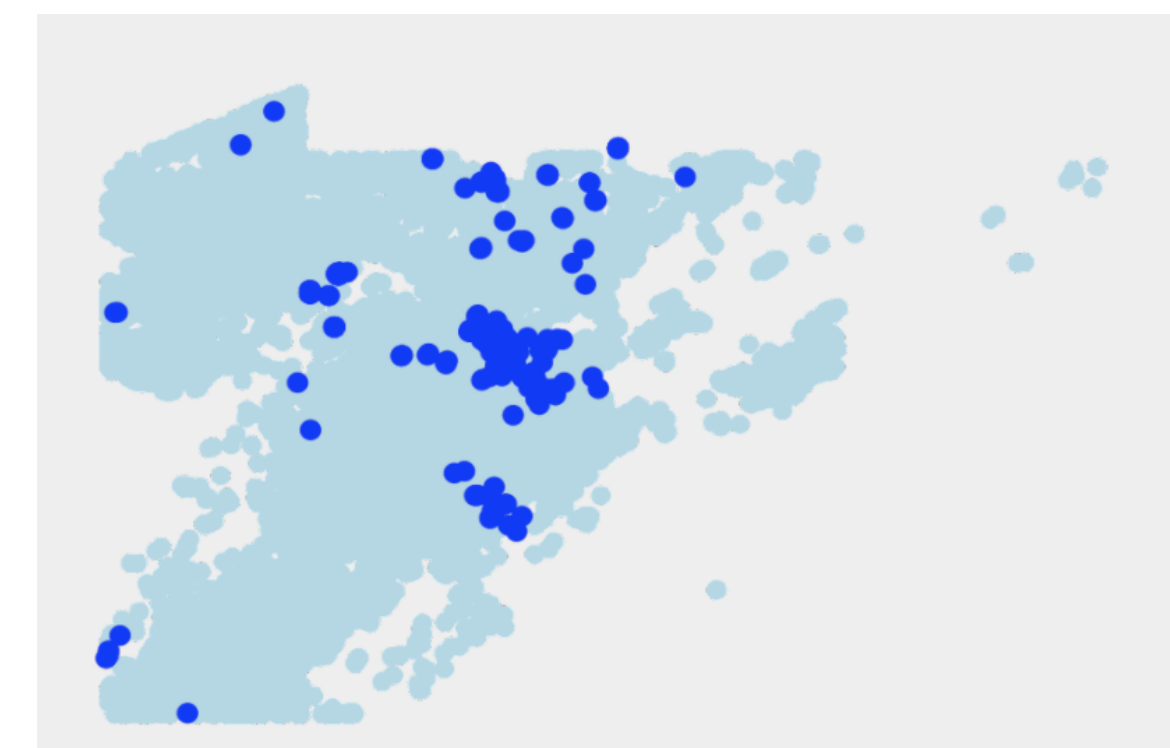
Dark Red: All Wells

Bright Red: Top 500 Wells

Figure 5:Top 500 Gas Wells

Light Blue: All Wells

Royal Blue: Top 500 Wells

Deliverable

In the future, we will use the solar hot spot analysis and cost-benefit analysis to identify active wells, and future locations most ideal for solar energy. We hope to further optimize well and solar locations. Combining the data we've collected and created, we can give CX energy an online dashboard to help identify valuable land to purchase.

Technology Used/Skills Learned

Decline Curve Analysis • Excel • GIS • Data Cleaning • Optimization • R • Cost-Benefit Analysis

Acknowledgements