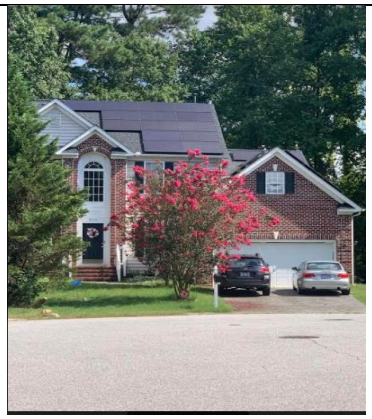
Solar Panel Energy Prediction Study

SAMPLE OF TASKS

Introduction

Solar energy and panels have now become a more popular alternative to traditional electricity to power residences. The main question is whether utilizing solar panels are a more cost efficient alternative when all costs are factored in. This research study will benefit both the interested consumer and the solar panel manufacturers. Using data science, data analytics, and machine learning to predict (Forecast) Residential, Commercial Building, and Farm Solar Energy and make decisions. More techniques will be used, not limited, to modeling, optimizing, simulation, and visualization analytics in three-dimensions to solar energy.


Problem Statement

The rise in the cost of electricity from a traditional source makes solar installation seem like the best choice for a homeowner or for commercial buildings, or for farms. They are a few key factors that will determine the true cost of solar panels and whether they are cost effective. According to the Center for Sustainable Energy, on average, the installation and the system together can cost anywhere between $15,000 and $25,000. One of the major problems is that there is not a standard method of giving a cost estimate. The key factors that have to be taken into consideration will determine whether solar panels are a good choice for a customer on an individual basis. One of the most important key factors customers have to identify is the amount of sunlight exposure at their residence. The more sun equates to more energy produced and offers a greater potential to save with solar. Using ML and AI will generate better understanding with predictions models to provide investment return analysis and to compare.

Objectives and Tasks "Brainstorming":

Task 1: Conduct a Literature Review for cost of solar energy (installation, panels cost, system, cost of solar energy back to grid, etc.) for three types:

1- Residential,
2- Commercial Building, and
3- Farm Solar

A. Conduct a Literature review about how to use investment return analysis.

Task 2: Identify data maturity required. Based on what you find on US for example NC or other Sunny States or China.

- **Data Collection**
- Weather and rain data!
- Cost of solar panel kits
- Average solar cost data

Task 3: Build a data environment, such as data preparation, cleansing, meta data, and ETL (Extract Transform Load):

Data Dictionary

Create Solar Energy Data Dictionary definitions and standards to store in data warehouse on the Cloud (AWS or Azure or Google)

Prepare Data/ETL

- Column/Row transform
- Calculated field
- Casting/Formatting
- Extraction
- Parsing
- Partition

Task 4: Develop common tools such as AI and ML models and code repositories that can be shared. For example, analyzing data to predict citizen/business man/farmer preferences and behavior, leveraging AI to automatically classify complex big data.

Data Analytics 4 Types

Explore and visualize

Build Model

Build Decisions

Model Comparison

Performance

Misclassification Rate

Computer Vision for solar panels

Task 5: Develop findings, comparisons, and recommendations how to improve cost operations using Data

Some thoughts for findings:

1- How much money can a solar roof save you in North Carolina?
2- Predict (Forecast) Residential, Commercial Building, and Farm Solar Energy and make decisions.
3- What is the Predict Cost of Solar Energy? Installation
4- Solar Array Investment Prediction? Find savings by month.
5- Predict Daylight, rain precipitation, energy daily consumptions KWh and rates
6- Predict Profit, if you got surplus power and you want to sell it back onto the power grid?

7- What are the challenges! Geographic areas, Environmental weather, Seasons, snow, rain, and clouds and sun hide, etc.?
8- Use different prediction model and compare the results.
9- Create decision tree interactive
10- Optimize energy use and comfort: Optimization and Simulation
11- Visualize analytics in three-dimension

Task 6: The desired outcomes and final products may include:

(a) a report outlining research methods and findings;

(b) an approach to build a roadmap for an AI and ML program for solar energy, including key foundational elements that must be considered;

(c) AI and ML case studies that were developed during research; and

(e) code repositories/tools that will be shared with others.

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- Template Solar Energy Development Ordinance for North Carolina NC Clean Energy Technology Center –
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- Cost of Solar Energy: Article with comments from John Morrison, chief operating officer of Strata Solar in Chapel Hill, https://www.carolinajournal.com/news-article/n-c-state-prof-casts-shadows-on-solar-meeting/

  Read more at: https://craven.ces.ncsu.edu/considerations-for-transferring-agricultural-land-to-solar-panel-energy-production/

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Machine vision to detect solar panel defects:

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- https://omdena.com/blog/machine-learning-rooftops/

- https://www.scnsoft.com/blog/machine-vision-to-detect-solar-panel-defects

Schedule

Zoom meeting at least once a week to monitor progress to give advice, answer questions, and troubleshoot any problems. Always email me at mnalgha@ncsu.edu

Tentative Timeline:

See you schedule by GEAR

Literature Review

There are many advantages and disadvantages of solar power. One advantage of solar energy is that solar energy is a renewable energy source. As long as there is sun, solar energy will be accessible. Solar energy is available every day in all areas in the world. Another advantage is that solar energy systems require low to no maintenance. The panels only need to be cleaned a few times per year in order to maintain their effectiveness. One widely views advantage is the reduction of electricity cost. Using solar energy can offer customers a drop in their current electricity bill. The amount of the drop will be dependent upon the size of the system and how much electricity is used.

As with all things, there are also disadvantages to utilizing a solar energy system. One of the most notable disadvantages is the initial cost of the system. As examined in this study, the cost of a solar energy system can outweigh the desired benefit. Once the cost of the system, installation, and loan amounts are calculated, the system may turn out to not be in the best interest of the customer. Another major factor that is in direct correlation is the fact that solar energy systems are weather dependent. The efficiency of these systems is dependent on sunlight. Though some energy can be collected on rainy and cloudy days, there will be a noticeable drop in production. Solar energy cannot be collected at nighttime so those days that rain or clouds are present will present much of an issue for customers with these systems.

The solar energy is the cleanest and most rich renewable energy source available, according to the Solar Energy Industries Association (SEIA). Data collected through Quarter 4 of 2019 show that North Carolina ranked 6th nationally for solar installation in 2019. It also shows that North Carolina installed enough solar to power over 722,000 homes. North Carolina's solar industry grew obviously since of the state's Renewable Energy Efficiency Portfolio Standard. A law passed in 2017 authorized solar leasing and gave

residential consumers more options to control their use of energy. The chart below from the SEIA shows the annual amount of solar installations in North Carolina over the last 9 years.

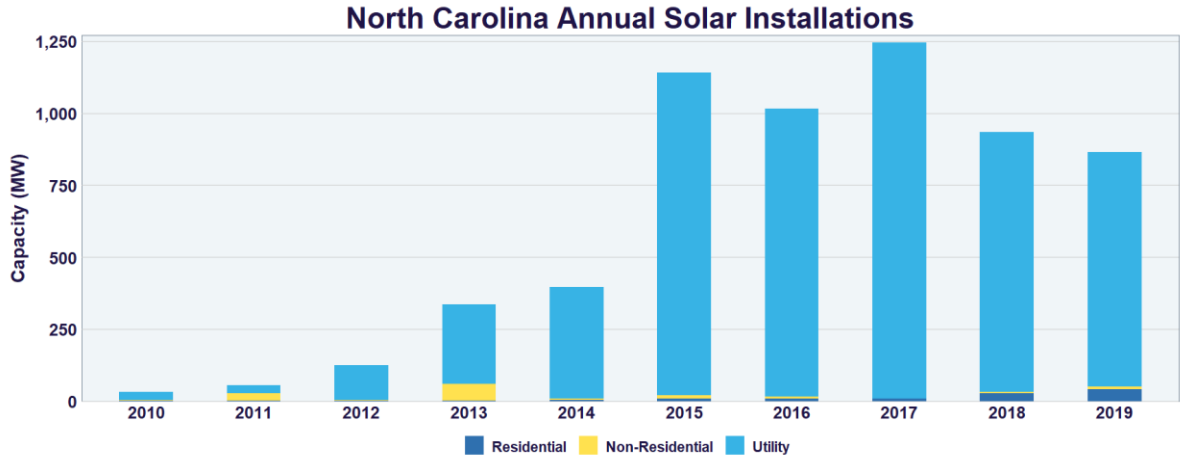

Chart 1: North Carolina Solar Installations

According to Matasci (2020), "Changes in solar panel cost over time can be explained by Swanson's Law, which states that the price of solar PV modules decreases by about 20 percent for every doubling in global solar capacity." The average cost of solar panel installation over the last 10 years have significantly dropped and it is predicted that this trend will continue in the years to come. The chart below from EnergySage shows the drop in the gross cost per watt over a 4-year period. Even with the drop in the cost of solar panels, utility lawyer Brian Potts (2015) believes that the rooftop solar "craze" is hindering the growth of more cost-effective renewable power sources. Though a study conducted by North Carolina State, backed by the Department of Energy, shows that installing a fully financed, average-size rooftop solar system would reduce energy costs for 93% of the single-family households in the 50 largest American cities today.

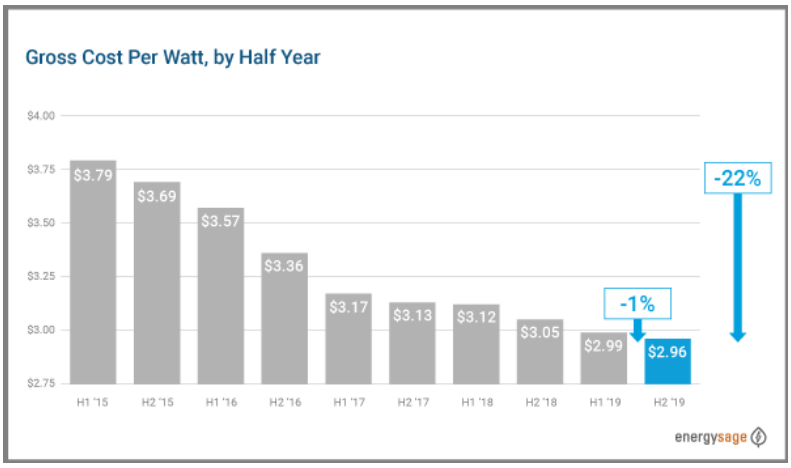

Chart 2: Shows drop in gross cost per watt