SOLAR PANEL STUDY

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INTRODUCTION

- My house is located in Austin, Texas
- Texas has a lot of sunlight available during the year
- Installed solar panels on roof during Thanksgiving of 2019 to help the environment
- The panel control unit is equipped with data collection capability
  - Energy production data from solar panels
  - Energy consumption data from daily household electronics and appliances
- Weather data was scraped from internet to correlate with energy production data
- Exploratory Data Analysis performed on energy production and consumption
- Model built to see the correlation between various weather parameters and energy production and consumption
- Made predictions based on previous years average weather data

SOLAR PANELS LAYOUT

- 330 W x 32 panels total 10.5 kW
  - 12 facing south
  - 14 facing west
  - 6 facing east

- Microinverters used to optimize individual solar panel power generation

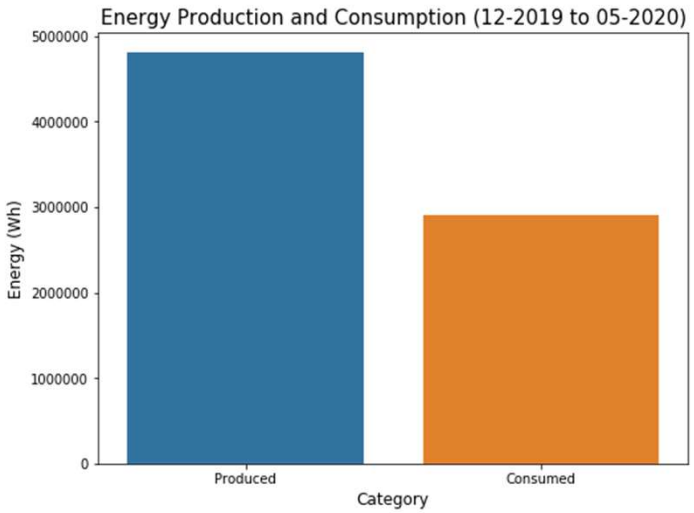
SOLAR DATA FEATURES

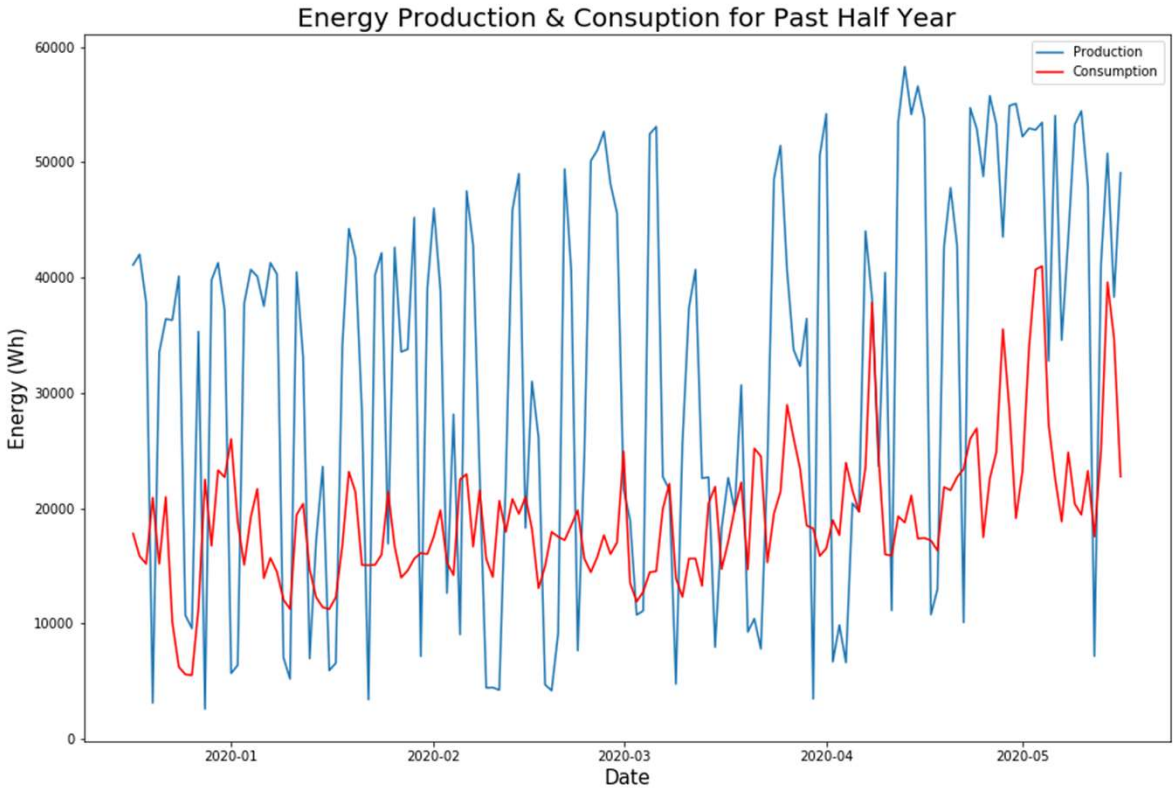
- Solar energy production from solar panels collected from December 2019 to May 2020
- Household energy consumption collected during the same time period
  - Gas consumption during winter was not accounted for
- Weather data scraped from https://openweathermap.org using API key
- Sun location (elevation & azimuth) data scraped from https://sunearthtools.com
  - Elevation: height of sun in degrees
  - azimuth: direction of sun in degrees
- Key weather data
  - Temperature, temperature index, cloud coverage, humidity, precipitation, pressure, wind

EXPLORATORY DATA ANALYSIS

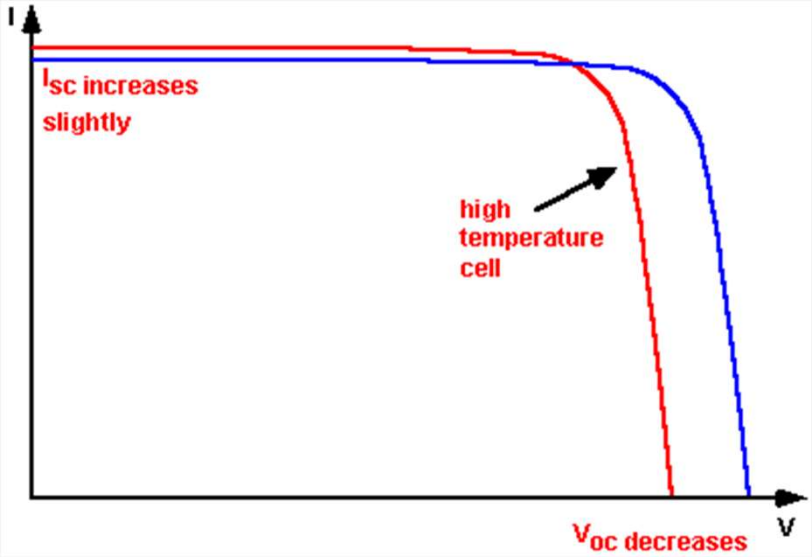
DAILY ENERGY PRODUCTION & CONSUMPTION

- Total energy production sum surpasses consumption by 65%
- Energy production trends down and consumption increase as summer months near





PANEL EFFICIENCY AND TEMPERATURE



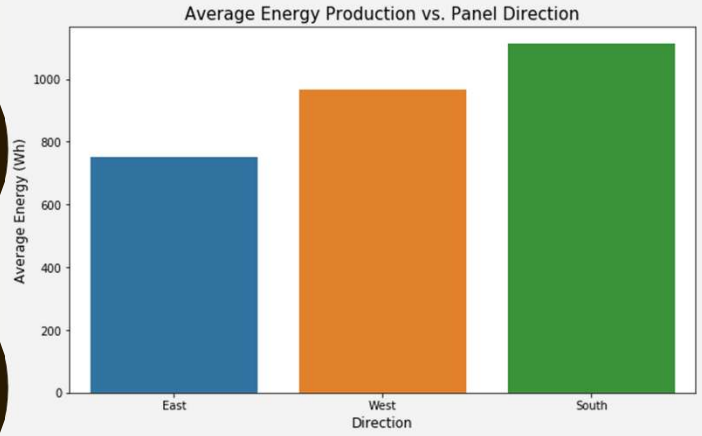
source: pveducation.org

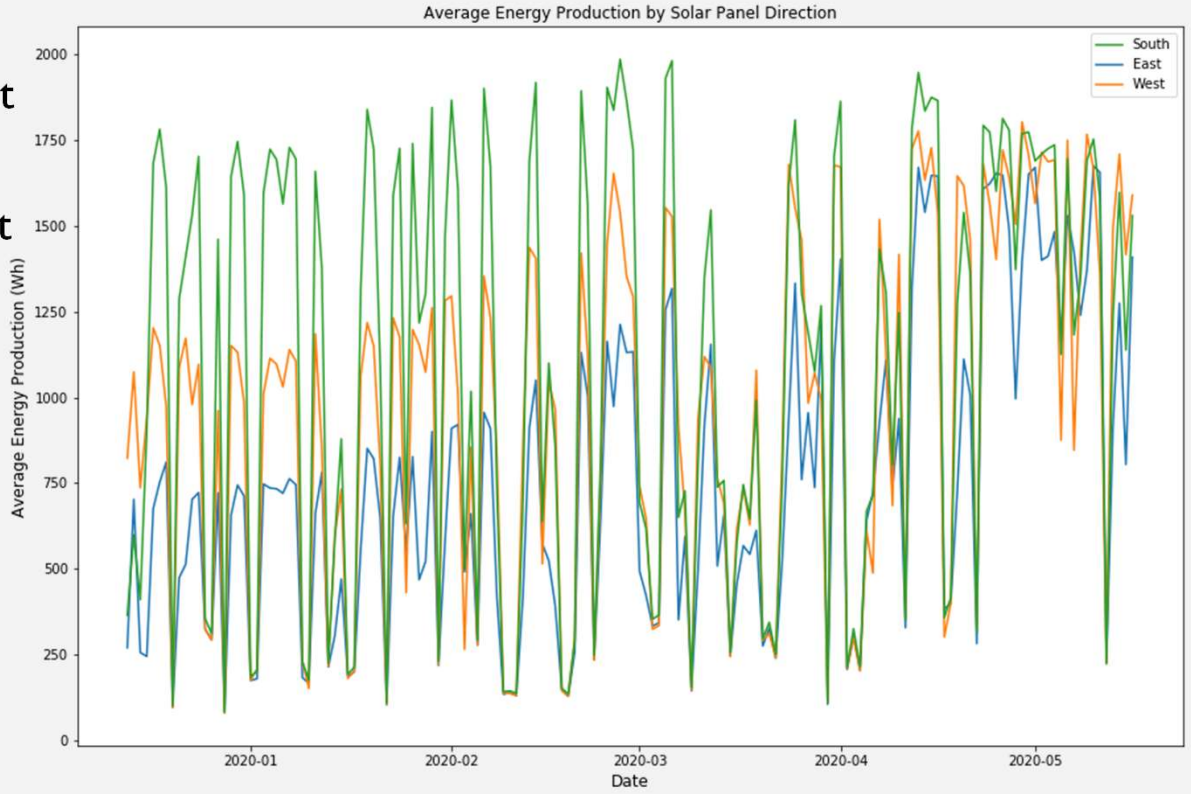
- As temperature of solar panel increases the output current slightly increases
- However, the voltage decreases more than the current increase
- Therefore, the overall power (V x I) decreases as the temperature rise above 77 F

- This explains the overall decrease in energy production during summer

ENERGY PRODUCTION VS PANEL DIRECTION

- Panels facing south performs best year round
- Panels facing east performs worst
- Panels facing east & west are catching up with south as daylight increases during summer



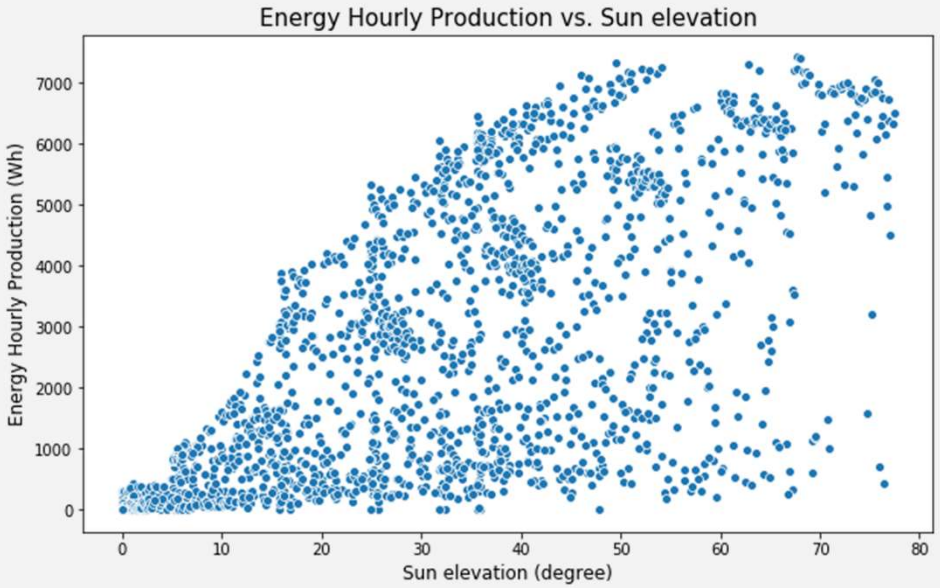


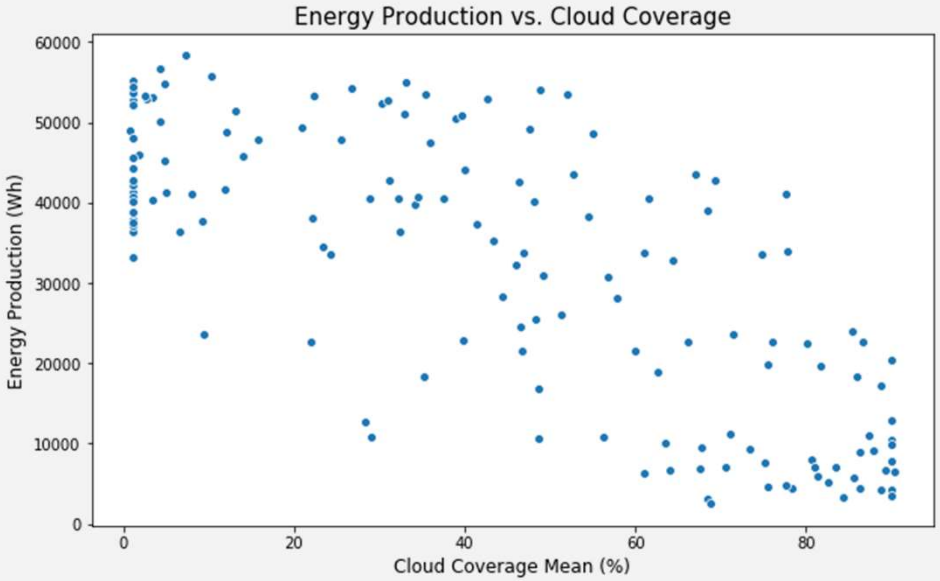
ENERGY PRODUCTION PARAMETERS

	Positive Parameters	Negative Parameters
1st	Sun elevation	Could coverage
2nd	Sun azimuth	Humidity
3rd	Temperature	Rain

- Energy production has a positive correlation with sun elevation due to increasing daylight during spring months
- It has a strong negative correlation with cloud coverage, humidity & rain

ENERGY PRODUCTION - DAILY





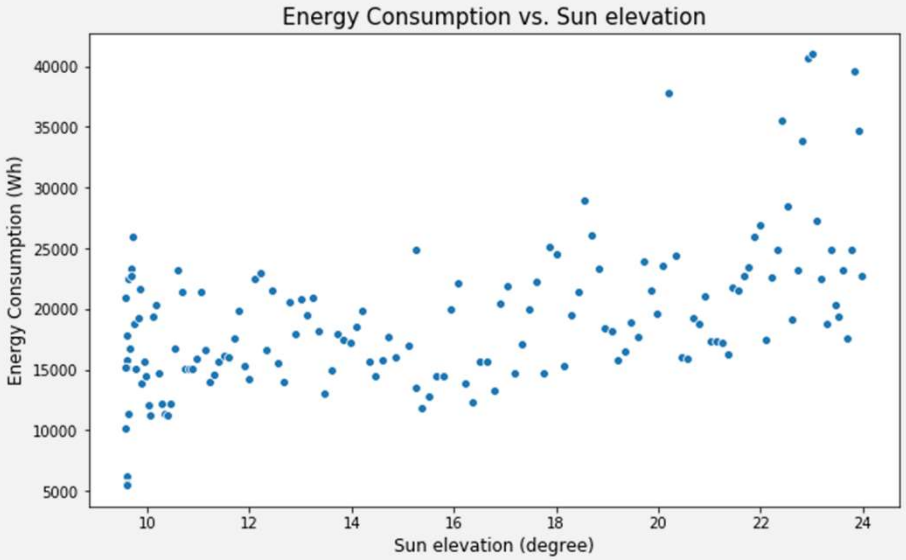
- Hourly energy production has a positive correlation with sun elevation due to increasing daylight and having east and west facing solar panels getting more sun exposure
- It has a negative correlation with cloud coverage since it blocks sun light

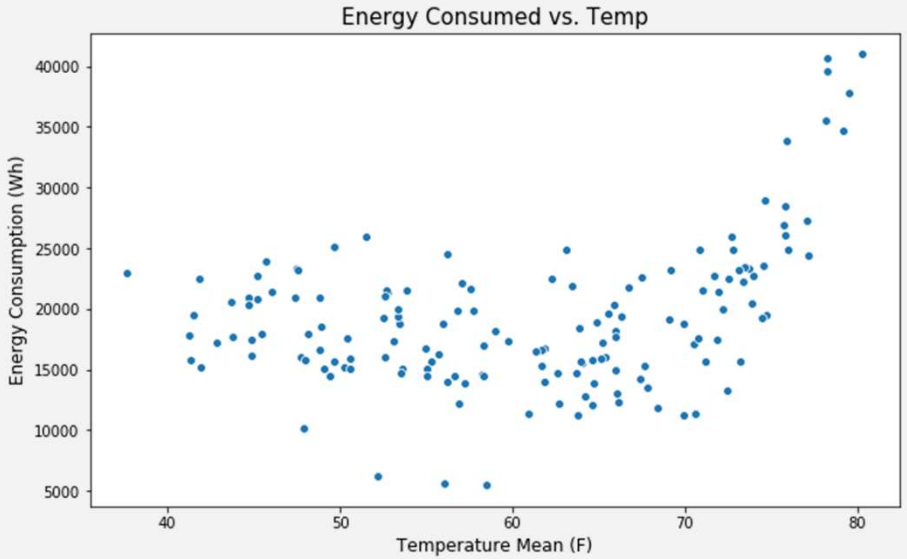
ENERGY CONSUMPTION PARAMETERS

	Parameters Increasing Consumption	Parameters Decreasing Consumption
1st	Sun Azimuth	Pressure
2nd	Sun elevation	Humidity
3rd	Temperature	Wind

- Energy consumption also has a positive correlation with sun with longer daytime and increasing temperature
  - Air conditioning draws highest electricity usage
- It has a negative correlation with atmospheric pressure, humidity and wind
  - Possibly due to relationship with cloudier days and lower temperature

ENERGY CONSUMPTION - DAILY





- Energy consumption increases with temperature above 70F – mainly driven by air conditioning
- It also increases with sun elevation – positive correlation between sun elevation and temperature

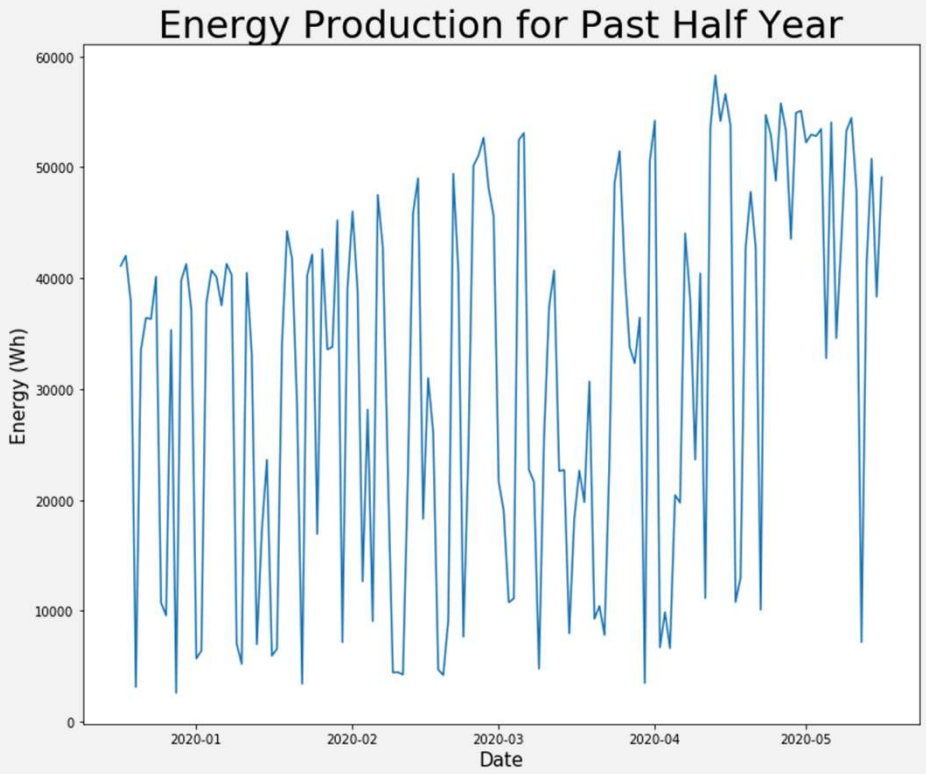
BUILDING A MODEL AND PREDICTING FUTURE

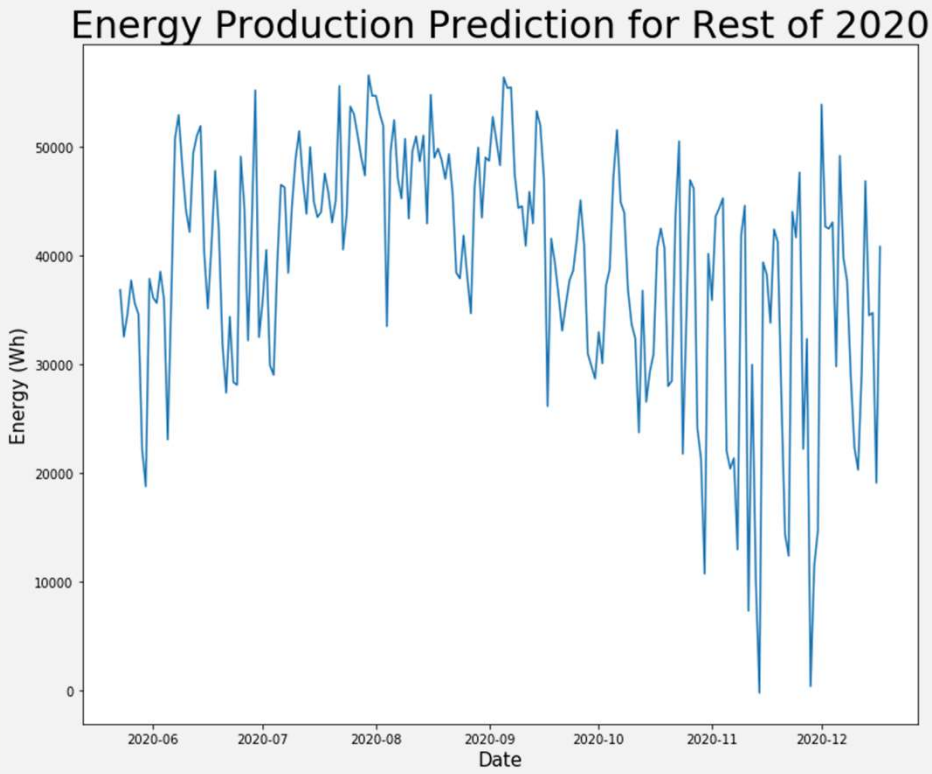
MODEL AND PREDICTION

- Started with simple regression model
- Daily energy production and consumption model had a low score (< 0.5) due to insufficient data
  - 170 rows of daily weather and production data
- Hourly production model had a better score (> 0.7) having more data

- Used previous years of weather data to make prediction
  - Assuming weather pattern on average will be similar year-to-year

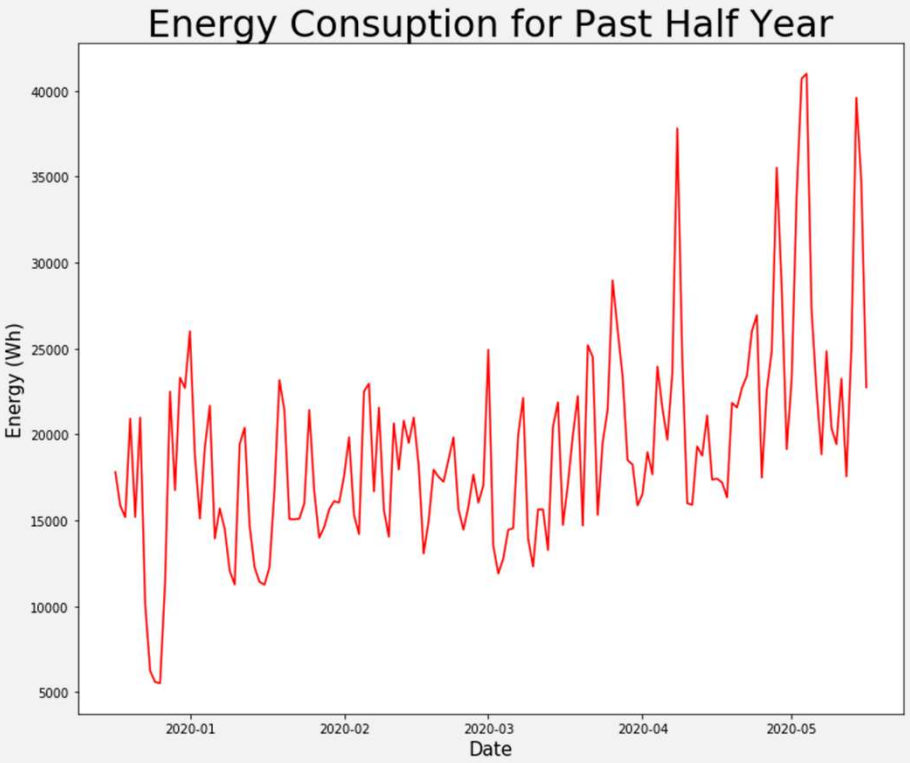
ENERGY PRODUCTION PREDICTION

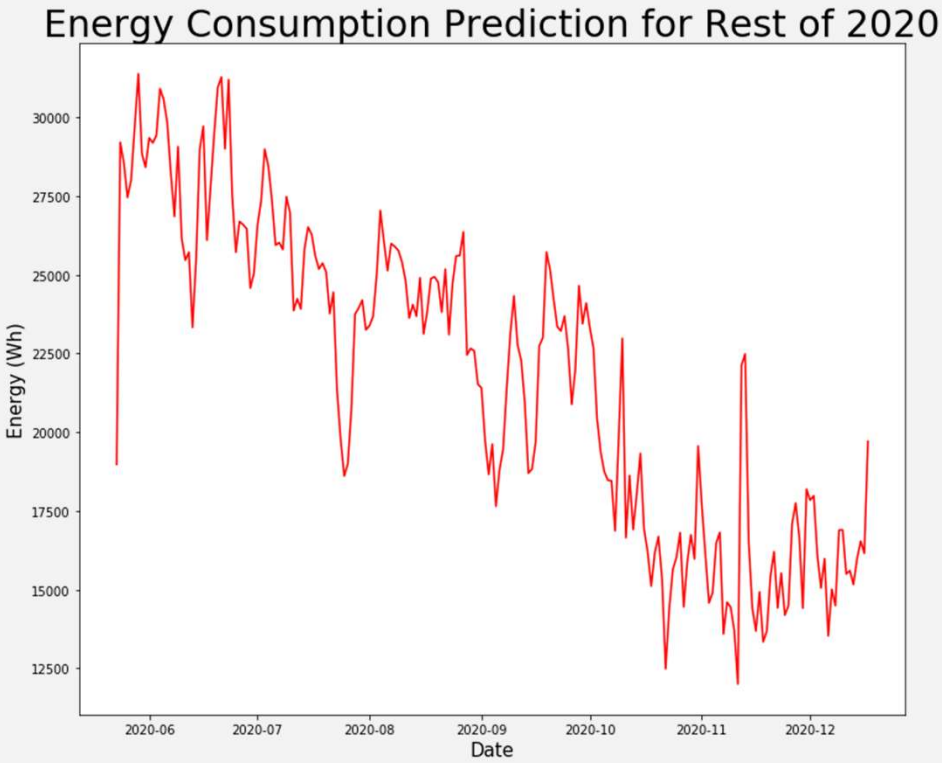




- Energy production prediction for rest of 2020 was made by using previous year's weather data
- Predicts peak in production in fall of 2020

ENERGY CONSUMPTION PREDICTION





- Energy consumption prediction for rest of 2020 was made by using previous year's weather data
- Predicts increase during summer time and decrease for fall season

SUMMARY

- Solar panel energy production data and household energy consumption data was collected for first part of 2020
- Energy production and consumption is closely related to sun elevation, temperature and cloud coverage
- The production dip during winter is due to lack of sunlight
- The production dip during summer is due to solar panel efficiency drop at high temperature
- Successfully modeled energy production and consumption using Data Science
- Predicted energy production and consumption using previous years weather data average