## *Executive Summary - Power City, USA Energy*


***By***

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Much has been made about the need to expand renewable energy infrastructure in the United States, as well as abroad. The latest figures released by the Environmental Protection Agency (EPA) estimate that 6,457 million metric tons of carbon dioxide were released in 2017 alone. Carbon dioxide, along with other greenhouse gases trap heat in the atmosphere and have been tacitly linked to adversely impacting earth's climate and a primary driver of global warming. In the United States specifically, the primary sectors responsible for climate change include transportation, electricity production, industry, and commercial and residential sectors. These four sectors were responsible for 91% of the total greenhouse gas emissions in 2017 according to the EPA.

A 2013 article published in *Applied Energy*, a peer-reviewed research journal covering topics related to energy engineering, Arent et. al. argued that renewable energy may be able to meet 80 percent of the United States' electricity needs and reduce current greenhouse gas emissions by as much as 50 percent. There are two key challenges for implementing renewable energy nation-wide, 1) inconsistent energy production and 2) reliance on specific weather conditions. If renewable energy is to be a long-term, viable option, then methods must enable accurate long-term predictions of renewable production while also forecasting energy consumption needs to enable efficient load management to reduce the risk of brown-outs and black-outs.

The attached technical report focuses on the fictional Power City, USA which plans to implement wind turbine and solar array energy production to offset energy needs. Power City has a population of 105,018, the building footprint covers an area of approximately 2.64 square miles, and consists of eight sectors (food service, healthcare, k-12, lodging, office, residential, grocery, and stand-alone-retail). To accurately forecast energy needs for a given day and hour, the models need to understand weather conditions which impact wind and solar energy production and the ebbs and flows of the population's energy consumption.

Our analysis found that ensemble machine learning techniques performed the best on the datasets; XGBoost worked best for the wind and solar production data while random forest worked best for consumption data. The best models were used to predict production and consumption of energy for six days throughout a scenario year. Comparison of model predictions for those six days reveals solar production out performs wind production, but considering solar is not a viable resource for night time hours wind energy can support nighttime energy needs. Renewable energy cannot accommodate all energy consumptions needs, but it can cover a good portion during the middle of the day during peak solar production. The three models generated can provide invaluable tools for the city to forecast energy needs and potential energy production based on weather conditions and their current population demographics.