Electricity Analysis Suggestions Ensemble

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EASE
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Background / Challenges

Electricity is one of the major energies being utilized in governmental, residential, and Industrial sectors. Electricity can be generated from either conventional source (petroleum, coal, natural gas) or unconventional source (wind, hydro, solar). Conventionally generated electricity is accompanied by high CO_2 emission, often associated with different levels of CO_2 taxation depending on the state. Unconventionally generated electricity is often accompanied with various degree of costs (Installation, maintenance, and operational costs) and limitations such as weather, location, and technology.

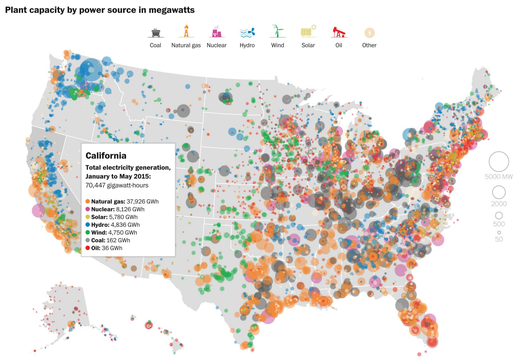

Figure 1. united states electricity generation map

EASE is conceptualized based on the idea stemming from building a cleaner world with less greenhouse gas emission. Realizing that electricity is the major source of energy being consumed, and that the major component of the greenhouse gas is CO_2 when generating electricity from conventional sources. The proposal in introducing clean energy as electricity generation source as future industries thus become our major client pool. Therefore, EASE is developed with an aim to spread the principle of using cleaner energy sources for the better of our future.

The challenging parts are mainly come from the relationship analysis among input parameters, as well as how they affect the output of the model. Choosing a proper machine learning method to train and fit our real-world datasets can ensure the effectiveness and particularity of the predicted outcome. Additionally, being able to realize any inter-relationships between parameters prior to choosing the proper machine learning algorithm is the key to EASE success.

Objective

The objective of EASE is to develop a suggestion model for industrial users who desire to construct an electricity generation plant to offset long term cost from buying electricity from the Government. EASE compiles user input weather and capacity information, outputs the best electricity generation source that is resource optimized, lowest cost, highest efficiency, and cleanest.

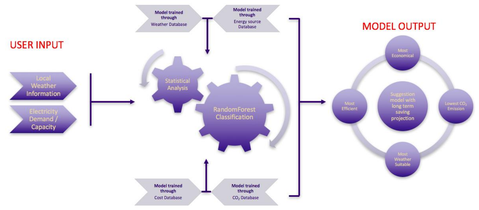

Figure 2. High level EASE model workflow

Machine Learning (RF)

Machine Learning (ML) is a method of data analysis that automates analytical model building. Using algorithms that iteratively learn from data thus allows computer to find hidden insights without explicit directions. Among all other machine learning classification algorithms, RandomForest is meta estimator that fits numerous decision tree classifiers on various sub-samples *($m < M$)* of the dataset with bagging methods to improve the predictive accuracy and control overfitting through randomizations.

In EASE, a 260,000 by 6 (rows by columns) weather database is used to train the RF model. With user input weather information, EASE can then predict relative location and thus extrapolate possible energy resources that can be used as electricity generation. These possible energy resources will then be filtered through statistical analysis using p-values with $\boldsymbol{\alpha}$ = 0.05 to ensure model outputs an realistic suggestion sources.

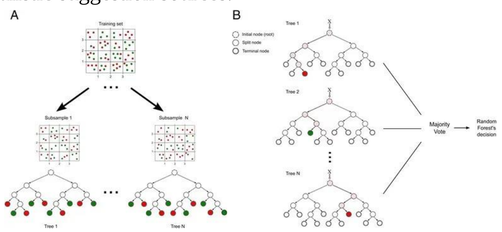

Figure 3. A schematic of RandomForest Classification

Workflow

GUI Input Panel

↓

Data Mining
construct a dataframe contains weather information

↓

RandomForest Classification
tree number = 5000
split data into 80:20 for training and testing

↓

Statistical Analysis (P-value) for Source Filtration
α = 0.05
average capacity (per resources) as sample mean
average plant capacity (per resources) as population mean

↓

Saving Evaluation Based on Cost Analysis Database
Saving (2018 - 2050) = (Electricity sale price – self-generated cost – CO_2 Tax) × Capacity

↓

Resources Suggestion & Respective Revenue plot
Prioritize resources with highest P-value
compare input capacity with average plant capacity

↓

clean energy resources exist & input capacity ≤ average plant capacity	clean energy resources exist & input capacity ≥ average plant capacity	no clean energy resource
↓	↓	↓
use top ranked clean for electricity generation and plot clean saving	use top ranked clean and conventional for electricity generation, plot conventional, clean and total saving	use top ranked conventional for electricity generation and plot conventional saving

↓

EASE Suggestion Output

Figure 4. EASE workflow

Results

EASE logo utilized a green outlet to symbolize electricity generation via green energy sources.

EASE GUI first displayed license page in a pop-up window, then askes user to input weather and capacity information necessary for prediction and analysis.

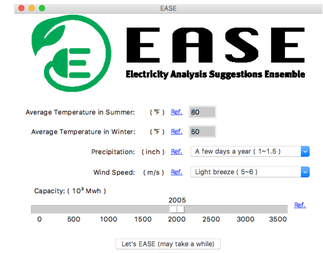

Figure 5. EASE GUI interactive panel

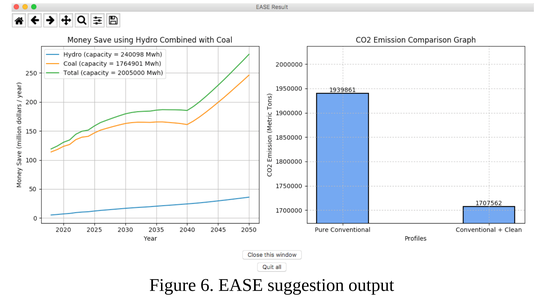

Figure 6. EASE suggestion output

EASE GUI output a suggestion on clean energy source and conventional source for electricity generation, provide long term cost analysis and CO_2 emission using conventional and an discouragement for pushing green.

Discussion

EASE is developed with an aim to ease greenhouse gas that contributes to the ongoing global warming trends. By targeting electricity generation, one of the major energy conversion that impacts every daily activities, EASE provides energy source suggestions combined with an cost analysis for building a better future. EASE utilized RandomForest Classification algorithm from SciKit-Learn, and other statistical methods to provide realistic output suggestions. The cost analysis model from EASE is largely built on 2015 plant capacity, cost, and electricity sale price values. An even more realistic approach of EASE can be done through acquiring a full set of the above mentioned values ranging from 1995 to 2015, and use them to create a time series prediction. Further development of EASE can be focus on tuning down the assumptions made in version 1.0 with time series predictions.

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