SolarSource

A framework to evaluate rooftop solar potential

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1. Motivation and Goal

Fossil fuel based electricity production is responsible for over one quarter of greenhouse gas emissions, acknowledged by the IPCC as the primary driver for global climate change [1]. Despite the shrinking cost of solar panels, solar energy (a renewable source) accounts for only 0.4% of all US electricity [2]. A solar installation can yield savings on electricity and reduce greenhouse gas emissions.

If a homeowner today were interested in installing solar panels, she would likely hire a contractor to perform a site evaluation. The problem is that the contractor, as a salesman, might not give an honest estimate. Our goal is to provide homeowners with a simple, free, and accurate framework to determine the most cost-effective solar panel installation. In doing so we hope to reduce CO_2 emissions as homeowners see the financial benefits of solar energy, prompting a switch from grid to rooftop, and from fossil fuels to the sun. We view locally generated renewable electricity as an essential aspect of climate change mitigation. A user-friendly framework to evaluate a home's solar potential is a first step in that direction.

2. Problem Background and Related Work

Many commercial apps have been built to answer the question "how much could I save by installing solar panels?" In April 2015, Google released Project Sunroof. The app combines a 3D model of your house with weather data to generate a roof analysis. Using the roof analysis and your monthly electricity bill, it recommends a solar installation to generate 100% of your home's electricity use. Project Sunroof does not take into account patterns of electricity use, relying instead on a generic monthly total to generate its recommendation.

Companies like Bidgely and PlotWatt monitor home electricity usage and offer suggestions on improving energy efficiency. While Bidgely can, for example, perform energy disaggregation to distinguish grid electricity from solar, none of these companies evaluate the home's potential to support solar.

We recognize three areas as missing from previous efforts in the "software-for-solar" field: universal coverage, consumption-specific recommendations. and information sharing. This leads us to our approach.

3. Approach

Our approach is to combine home consumption data and roof analysis from the user end with third-party APIs and prediction software on the back end, and then perform an analysis based on that integrated data model.

Two key ideas underlie our approach. The first is that we can get an accurate profile of a home by having the user do it herself. By monitoring home electricity consumption using a Wattvision sensor, we get a precise view of the electricity demands to inform our recommendation. We will combine the home electricity profile with a roof profile, taking into account shade, pitch and directional orientation.

The second idea underlying our approach is that crowdsourced user data is valuable. We will implement a platform to crowdsource performance and cost savings of existing solar arrays. This aspect has a dual benefit. First, it provides prospective installers with comparable performance data and helps remove the first-adopter stigma. Second, we can use the crowdsourced data to inform the overall energy assessment, incorporating installation performance of a home with a similar roof or energy consumption analysis.

4. Plan

The work on SolarSource will be divided into three areas among our team (composed of myself, Gregory Magana, and Emily Speyer): roof profiling, home consumption profiling, and the backend recommendation engine. The profiling steps will be part of an Android mobile app while the backend will be implemented as a RESTful API. I will be tackling the backend portion, which includes a platform for crowdsourcing user data.

1. (Already completed) Evaluate availability of APIs for electricity prices, weather data, GPS location, landscape of solar market, and future prediction of installation performance.
2. Create home data model using information from the roof and the home energy profiles.
3. Develop algorithm for home energy assessment. The issue is how to generate the best (i.e. most cost-effective) recommendation for a solar installation. Our approach is to integrate the home model with data from third party APIs to create a complete energy assessment, then perform an analysis based on that model.
4. Build support for crowdsourcing platform: set up MySQL database and integrate crowdsourced data in recommendation algorithm.

5. Evaluation

We plan to evaluate the success of our framework by testing it on 2 houses in Princeton with solar panels already installed. Comparing the actual electricity bill (obtained from PSEG) to the projected costs if the homeowner had used our recommendation, we can determine if the framework would actually save the user money. We choose cost as the primary evaluation metric because our goal is to convince homeowners that solar energy is cost-effective. Concern for the planet's wellbeing will not drive widespread change in electricity generation. We must appeal to the homeowner's economic interest if we want to expand solar. 2 homes is an admittedly small sample size for our evaluation. Time-permitting, we will look into testing on a wider scale.

References

[1] U. Cubasch, D. Wuebbles, D. Chen, M. Facchini, D. Frame, N. Mahowald, and J.-G. Winther, *Introduction*. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2013, book section 1, p. 119–158. [Online]. Available: www.climatechange2013.org

[2] US Energy Information Administration, "Monthly energy review," September 2015.