Using solar panels to deduce weather

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Contents

1 Introduction

There are several types of clean power sources in the world, solar energy, wind power, and water energy. This research paper takes photovoltaic modules (PV) as point of interest. PV commonly known as solar panels, works by having two silicon based semiconductors, namely a n-type and a p-type, which are great conductors in some circumstances and not so good in others. Semiconductors are surrounded by front and back contact, which allows for better energy flow and when exposed to photons which is used to create electricity [**?**]. Finally to protect solar cell from damage a thick glass is placed on top. Since PV generated energy cant be use directly because the energy generated by a solar cell is DC energy, it has to go through a inverter which converts DC energy to AC energy.

It has already been found that weather data to is relevant for any clean energy generating systems. For PV generating systems, when maximum power point tracking is used to maximize the power output, mainly temperature and radiation [**?**].

►BAsed on this we want to try to correlate power generated with cloud conditions◄

2 Related work

There has already been some research in measuring weather data by utilizing some of the sensor capabilities that arises from the increasing amount of technology in use.

OpenSignal have created the app WeatherSignal that utilized phone battery temperatures [**?**] to deduce information about the air temperature in heavily populated areas. They proved a strong relation between the temperature of a the phone batteries and the outside temperatures. The authors believe that the data can be further improved, if the data can be calibrated according to phone models and if the phone is inside or outside, as heating and air conditions bias the data.

A correlation between the radio signals used for phones and rain measurements has also been proved [**?**]. The radio signals can be used to measure the amount of rain in between two points. The measurements is fairly accurate, and

it's assumed that they can be further improved if improved for the signal loss due to wet antennas.

It is believe that the combination of various weather sensing techniques such as [**?**], [**?**] and measurement of clouds by PV systems, such as proposed in this article, is likely to have some useful potential. For instance the maximum power point tracking units of PV systems can be improved with weather data [**?**].

3 Setup

Setup which is used in this research paper is very simple. There are actually two setups, because there were a need to record cloud coverage data from somewhere, and at the same time there were a need to record solar panel data.
First setup which collects solar panel data is placed in a town named Mønsted which can be seen on a picture below. The setup consists of PV, inverter, and raspberry pi, which collects data into a Sql database.
The second setup which records cloud coverage data is placed inside Aarhus university, where a stationary computer is running and gathering data from OpenWeather.com api, and stores the data into separate sql database. Data which is gathered from OpenWeather api are coming from two different towns Stoholm and Karup where both towns are closest to first setups placement, and there are no way to force OpenWeather api to return data from the same town always.

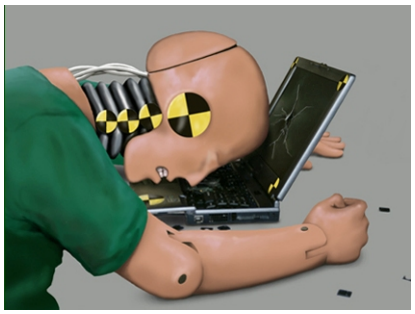

Figure 1: 3 towns where data is recorded

4 Data analysis

The expected data is to see a clear connection between the output of a PV and clouds[**?**]. The aparant view of things the data also seem to have a correlation as can be seen on figure 3. It seems likely from the graph that there is some correlation, between the clouds and the PV system, as there's a tendency for the effect to drop when there's more clouds.

However further analysis puts some doubt to that. The blue line in figure 3 shows the optimal effect measured at a given point of time in the day. To test that hypothesis a scatter plot comparing how far from the optimal the power generation is compared to the cloud coverage.

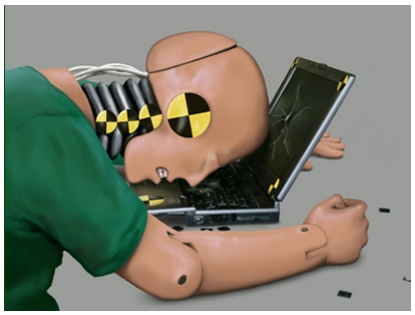

Figure 2: Noisy unfiltered data

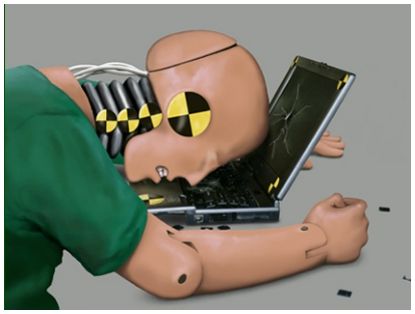

Figure 3: Cloud cover and averages of power generated (10 minute intervals)

►Boxplot comments, more analysis◄

That a single PV system is very sensitive to even small changes can easily be seen following the green curve on figure 2. It's apparent from the amount of fluctuations that even small things can influence the effect. Both [**?**] and [**?**] has data confirming that small scale PV systems are easily affected by things such as clouds, they still look at large systems in comparison with a personal system. Thus it is likely that even a flock of birds can influence it.

A larger area of PV systems and bigger PV systems can smooth out noise in the data [**?** **?**]. The effect of larger systems could be interesting if they can be accessed, for the approach of this project it would be an interesting addition to get access to more systems. The approach to have a larger area of PV systems is used is used to try and even out all noise caused from clouds [**?**], where the intend here would be to even out some, such that conclusions about correlation about the weather and effect can be made. The fact that the weather impact can be smoothed a lot, when it's done over areas of 250x250 and 500x500 km squares, but weather data is still quite apparent on 50x50 km squares [**?**], indicates both that a larger area than a single PV system will smooth the data, but without loosing the stronger connection with weather data as long as the area is relatively small.

5 Conclusion

►Write a proper conclusion◄

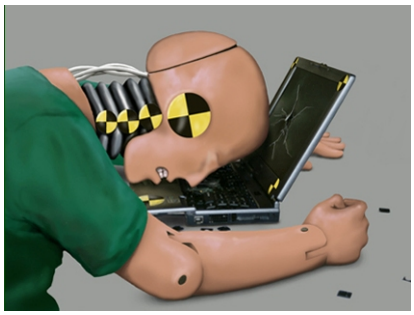

Figure 4: Scatter plot from comparing effect, cloud coverage and optimal effect

6 Acknowledgments

►**Lynderup senior - dad, Bouvin - computer scientist, supervisor, Karl Fischer - chemist**◄

7 Conclusion

►. . . ◄