Example of inquiry-based mathematical task in the course MA-171 Statistics and economy.

Project in Statistics using R programming on Solar Cells

This is a 5-week group project in the subject MA-171 Statistic and economy for Computer science and electronics. Each group has data from 10 different types of rooftop solar cells at Campus Grimstad. Each group get assigned with different weeks of data.

We use data from 2015, because we know that some of the data have faults.

In this project we want students to do as much as possible with the data using their knowledge from the theory they have learned in statistics. This is not a project about knowledge on solar cells, but about handling large amount of data.

They should be able to present for example:

- Efficiency versus temperature/weather/…
- Do regression
- Plot and discuss standard deviation
- Use R-programming
- Discover error in data
- And more

They will only be introduced to R-programming and regression. They will get info about where to find theory etc.

They need to find the data (correct week) themselves from a server.

The results need to be presented as a paper. As if they where to get it published to a proceeding of a conference. I am the reviewer and set a preliminary grade on their work. Then each group must defend their work with a poster session where I set the final grade on the project.

Students do get 3 different tasks to work on. These task where developed by our research team within renewable energy, but they could come up with their own strategy.

They were presented with a “conference template” in word format and the paper should be no more than 6 pages.

MA-171 Statistics Group Project 2018

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ABSTRACT: We analyzed data collected week 37 in 2015 from the PV array installed on top of the UiA Grimstad campus, with the intent to examine if the modules could produce energy close to the manufacturer's specifications. Additionally, we used models involving wind speed to graph a module's power output loss due to module temperature. The programming language R was utilized for analysing the data – which included ambient temperature, solar irradiance, PV module temperature, PV module maximum power point power (Pmax), temperature coefficient in relation to Pmax and hourly wind speed readings. We found that most of the panels were able to produce close to their specifications at their peak, and our target module(s) produced less power due to module temperature exceeding 25 °C.

1 DATA

1.1 Data Set

We were given a specific week worth of data from PV modules mounted on the roof of the UiA Grimstad campus. The data was segmented into files containing one day of data each. The data gave us information about solar irradiance, ambient temperature and readings from 10 different PV modules at regular intervals during each day. The number of observations were different each day, and varied from 55 to 727, taken approximately one minute apart.

Table 1, PV modules (in order of appearance in data set)

#	Brand	Type	P_{Max}, T-coeff.	V_{MP}, I_{MP}	V_{OC}, T-coeff.	I_{OC}, T-coeff.	Eff. Module	Area m^2
1	Uni-Solar US-64	a-Si	64W	16.5V, 3.88A	23.8V	4.8A	6.3%	1.01
2	BP Solar	Mono Si	85W	18.0V	22.03V	5.0A	13.5%	0.63

UNIVERSITETET I AGDER

Solarcell

Statistics dataprocessing

Background

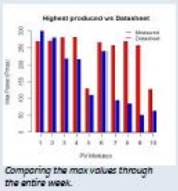
Solarpower is being used more and more in the world. Not only in the industry, but also in normal residental houses. How efficient are they? And how do you choose between the different kind of modules?

In this poster, you will get a quick overview on some of the modules that exist and their measured result.

Method/Design

To evaluate the different modules, previously meaurements were provided from the solarpanels at UiA. These measurements had to be organized and handled, using the R-language in R-Studio.

To compare the real values with the values provided from the manufacturer, a datasheet containing different values from each module were provided. The study focuses on the max power produced by each module every day and the whole week. The mean value of the max power and the standard deviation were taken into consideration when data from each module were processed.

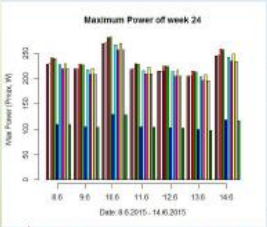


Comparing the max values through the entire week.

Module explanation for Highest Power figure

Results

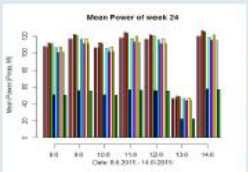
For presentation purposes, all values are ploted into one single diagram. To view the day-by-day values, check out the full paper.



The highest power produced from each module every day through the week.

As seen from the figure above, there is difference from day to day and from module to module. By comparing the same module every day, you see that there is a slighty difference i value because of the duration of the sun.

The figure to the left shows the compared max values between the datasheet provided and the data processed through R studio.



The mean of the power produced each day, by every Module.

This figure shows the mean value for each module on every day through the week. This figure gives a better view of the total amount of power recieved through the week.

The provided datasheet.

Module explanation

Conclusion

The mean values makes the most sense, based on the Pmax value from the datasheet. The mean should be steady below the Pmax.

The measured «Highest Power» value has some errors in it. This is because the measured value is, in some cases, actually higher then the max value, which is impossible. The reason for this were most likely due to an error during the dataprocessing in R studio.
The graph were still included to show the result of the processing.

To conclude, the measured data values is, or at least should have been, lower then the values gived by the datasheet. This makes sense due to different weather conditions and more material damage then the testing conditions.

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