Utrecht University

Computational Thinking,
Programming in Python and
Programming with Data

Renewable Energy

Python 4: Laura Verhoeven, Maarten van Osch and Emiel Robben

Research questions

1. How has the total avoided use of fossil energy due to wind power, changed over the period 2010-2018?What part of this avoided use of fossil energy can be assigned to wind power on land and to wind power at sea?

2. How much has the $C0_2$ emission in the Netherlands changed in the period of 1990 to 2018 and which renewable energy source has relatively reduced CO_2 emission the most?

3. What is the difference in usage of wood in a household regarding a freestanding wooden stove and a freestanding pallet stove?

4. Which energy source was the most efficient in terms of producing energy with the highest prevention of CO_2 emission?

Information about the program

Structure of the program

The program is structured so that you may first choose which topic you want to know more about. After that, it gives you the choice in which part of the topic you want to dive deeper in. The program has imported some modules, with often functions in it, which are called when you make this second choice. There is a while True loop implemented in the program, so after you are done with one topic, you can choose another.

Libraries used In the program

Matplotlib plays a mayor role, for this library is used to show the graphs.

Pandas has been used as well, especially for dataframing.

Results

1. The avoided use of fossil energy due to wind power has positively changed over the period 2010-2018. Absolutely, the avoided use was twice as big in 2018 in relation to 2010. Relatively, the avoided use (from 1.0% to 2.5%) grew in relation to the other energy sources, however the avoided use due to wind power is relatively small (in 2018 just above the 2.5%, as can be seen in Figure 4). The avoided use can be distributed amongst due to wind power at sea and on land, as shown in the bar graphs. A bigger assignment can be seen with wind power at sea, however wind power on land shows a big growth over the years. A look at Figure 2 gives the right impression.
2. CO_2 emission has changed a lot over the period 1990-2018, apart from some missing values (seen in the graph as the values are equal to zero). Especially from 2010-2018 the total avoided CO_2 emission has grown a lot and is still growing. For a graphical representation, take a look at Figure 3.
3. Households with a pallet stove use more biomassa than households with wooden stoves, the difference is not that big and both usages keep rising over the years, the rises are relatively the same tho. Figure 4 gives more information about this.
4. The energy efficiency has changed over the years. Efficiency is measured as Avoided Emission of CO_2 in Kton divided by Energy Consumption in TJoule. Especially the efficiency of solar power has increased as can be seen in figure 1, but wind power is still the most CO_2- efficient renewable energy source in 2018.
Also interesting is that efficiency of the researched sources decreased after 2015, and are now rising again. The line graph can be used by investors, to see which technology might be the most energy efficient in the future.

Conclusion

The avoided use of fossil energy keeps growing, the use of "green" energy is increasing, while this is positive unfortunately the rest is not so positive. CO_2 usage keeps rising and the usage of biomass in households keeps increasing. But there is also good news. The efficiency of in particular solar energy and furthermore wind energy are increasing. Now that we have this information, we can be more conscious over our footprint on the earth. We now know that even though we use more wind power etc. that doesn't automatically mean we are being better to the earth. We have to change on all aspects if we want the earth to heal, but at least data analysis is a good start for understanding our world better.

Future Work References

Our program could be used to raise awareness amongst people all over the world. People might think: "Oh I just switched to green wind power, now the world will be a better place." While of course there is so much more to do. Other people could also make programs of the same sort and also raise awareness. Everybody could see in a second what our progress as humanity is and how much more we have to do at certain topics. Everybody could see at any time how much everything is escalating and how big the relative changes are. Maybe it would be the extra wake up call to the people who have the mindset of "it will be fine, do not worry". Because those people are the people that could make the difference.

Data

We have used a dataset form CBS Statline. The link can be found in the references at the bottom of the poster. Following the link, you arrive at a page with a table with the name "Hernieuwbare energie; verbruik naar energiebron, techniek en toepassing."
We have downloaded a raw version of this table for our own use.

Figure 1

Figure 2

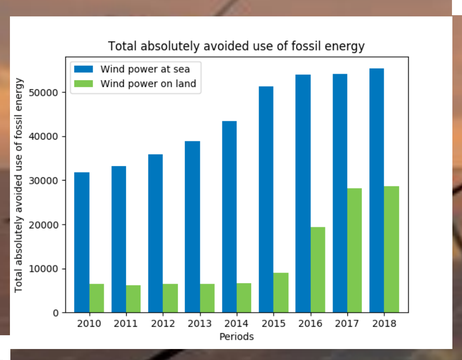


Figure 3

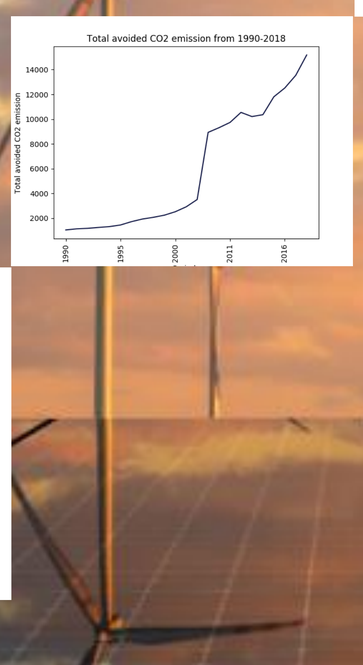
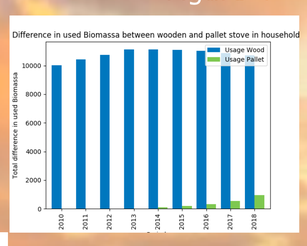


Figure 4



References

https://opendata.cbs.nl/statline/#/CBS/nl/navigatieScherm/thema?themaNr=51190