# Global Renewables: Future Investment

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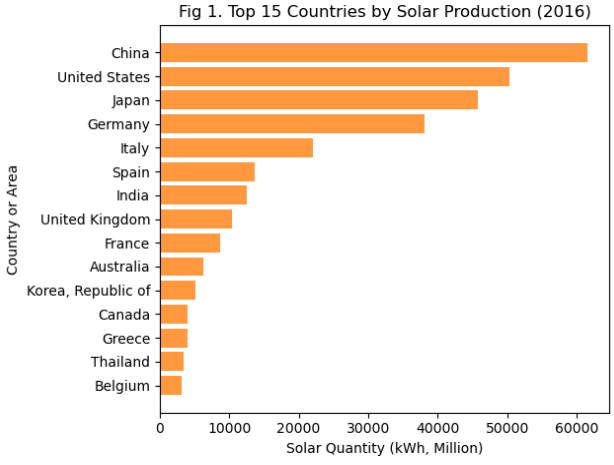
## Overview

The global energy transition from historical use of fossil fuel based electrical generation to renewable generation has increased in pace over the past decade with the advancement in technology, access to capital, and climate change affecting all life in real time. As a potential investor in future solar and wind generation projects we want to understand/analyze global trends in electrical production by solar energy, wind energy, and the investment in these generation capacities. In order to accomplish this we asked the following questions:

1. During the years 2016 and 2020 what countries produced the most electricity by solar and wind technologies?
2. During the years 2016 and 2020 what countries had the most investment in renewable energy overall?
3. During these same years does the highest amount of solar and wind electricity correspond to the highest investment in renewables?
4. With the results of the above three questions, where might renewable energy investment be a good idea in the near future if we wanted to see the most solar/wind electrical return for our investment?

## Summary of Findings

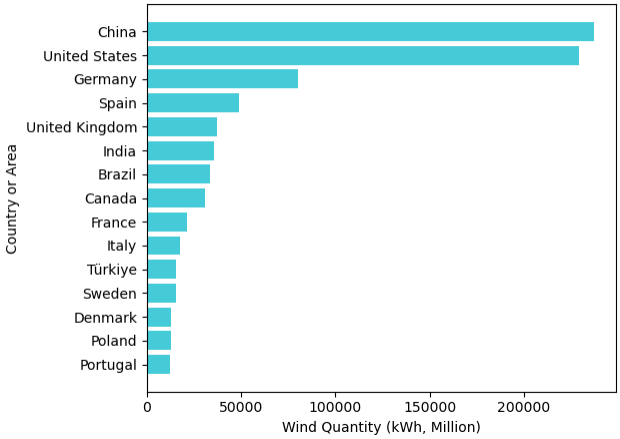
Question 1: During the years 2016 and 2020 what countries produced the most electricity by solar and wind technologies?




Figures 1-4 visually show the top 15 solar and wind producers by country from 2016 and 2020. The top 2 wind and solar producers of 2016 are pretty self explanatory. China and the US have the largest economies in the world and are also some of the biggest consumers of electricity so it is no surprise they would be (1) and (2), but

once one moves past these two it starts to get more interesting. Figure 1 shows that Japan, while being a drastically smaller nation land mass wise, has only approximately 10% less solar production than the US. Then looking at Figure 2, one can see that the US and China far outpace any other country in terms of wind production. Let's see if this continues in 2020.

Fig 2. Top 15 Countries by Wind Production (2016)




2020 looks similar to 2016 at the top. China and the US are (1) and (2) for both solar and wind production. Interestingly for solar, China pulled away from the US in 2020, producing over double the amount of solar electricity. Something else to note, is that India went from 7th to 4th place in the top solar producing countries and shows how quickly developing countries are breaking into renewable energy as well. These types of countries, burgeoning populations and economies, will be something to watch for in the investment analysis section.

Fig 3. Top 15 Countries by Solar Production (2020)

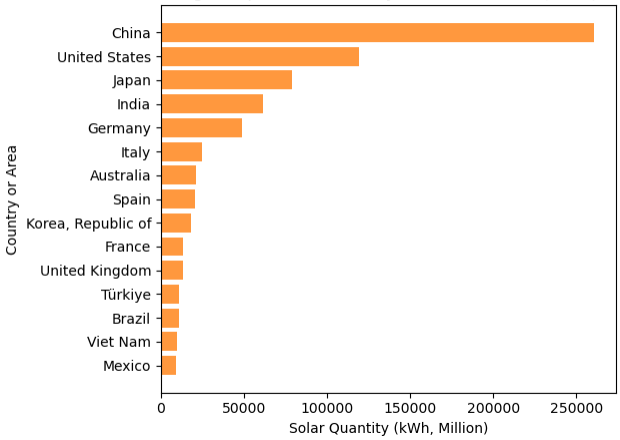
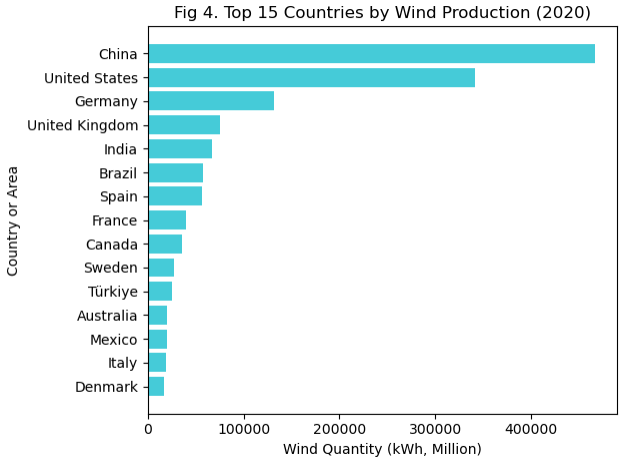
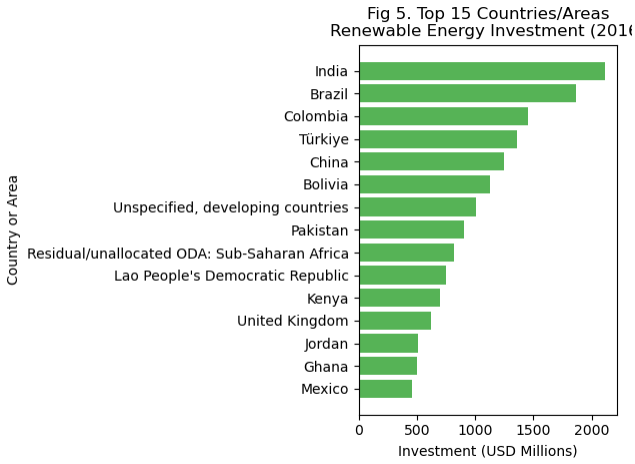



Fig 4. Top 15 Countries by Wind Production (2020)

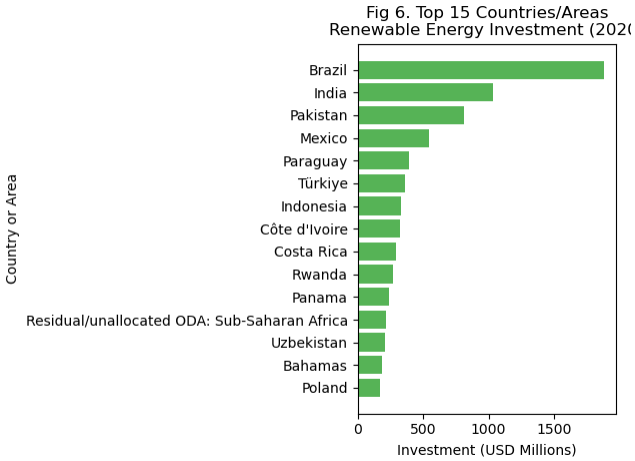


Question 2: During the years 2016 and 2020 what countries had the most investment in renewable energy overall?

Figures 5 and 6 visually show the top 15 countries or areas to receive renewable energy investment in 2016 and 2020. It's worth noting here that as a group we decided to use investment data for all types of renewables as a metric instead of just wind and solar. The reasoning for this is that the data for solely wind and solar investment was spotty and public investment in renewables in general tends to positively effect wind and solar.




India is the 3rd largest emitter of CO2 in the world and government officials are committed to decarbonisation. Government officials want to convert approximately 50% of the country's electricity from non fossil fuel based energy by 2030. India and Brazil lead the world in renewable investment substantially in 2016 (Fig 5). Colombia, Turkey, Bolivia, and China were approximately close in their investment amount. Unspecified, developing countries is a group of countries that investors invested in renewable energy without naming individual countries. In a sense, it was an outlier to the graph. The bottom half of the countries were very close in investments ranging from 500 million to 1 billion USD. In contrast to the 2020 investment graph, the top 15 countries invested a significant amount more USD in 2016 versus 2020.




In 2020 (Fig 6), Brazil became the largest investor in Renewable Energy in the World . Currently Brazil capacity to generate renewable energy is approximately 84%, higher than the world average of 38%. Brazil overwhelmingly led the World in Renewable Energy Investments. India fell to number two.

Pakistan increased investment improving into the top 3 in 2020. Mexico improved from the tail end of the top 15 in 2016 to the top 5 in 2020 . From Paraguay to Poland , none of these countries invested over 500 million USD on renewable energy, a distinct dropoff from the countries in 2016.

Question 3: During these same years does the highest amount of solar and wind electricity correspond to the highest investment in renewables?

As seen from the above figures, highest solar and wind production does not exactly match up with highest renewable investment. But the data and visualizations do show that some of the highest recipients of renewable investment were in the bottom portion of the top 15 of wind and solar production.

Via a series of aggregation by merging we were able to discern that 3 countries were present in all top 15 production dataframes as well as all top 15 investment dataframes. Those countries are Brazil, India, and Turkey.

Question 4: With the results of the above three questions, where might renewable energy investment be a good idea in the near future if we wanted to see the most solar/wind electrical return for our investment?

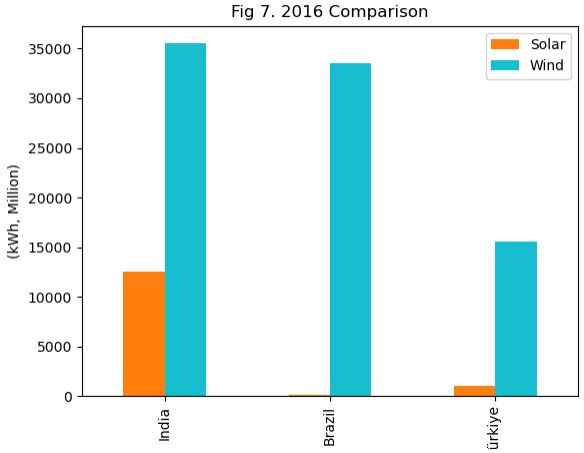


Fig 7. 2016 Comparison

From the data we compiled there were only 3 countries who were not only top producers of wind and solar in 2016, 2020, but also top recipients of renewable investment; India, Brazil, and Türkiye. These countries should be the focus of possible future investment.

All three of these countries are rapidly developing and some of the most influential societies in their respective global regions. India's population is the only other country with China that is over 1 Billion so their steep increase, especially in solar, makes a lot of sense.

Fig 7. and Fig 8. Solar vs Wind production of India, Brazil, Türkiye in 2016, 2020

Wind power technology harnesses about 50% of the energy that passes through them while solar power technology harnesses only about 20%. With this is in mind, it is interesting to see that in 2016 wind power was most popular for all three countries, but by 2020 solar was starting to catch up, especially in India. It would be a good idea to dig into the possible why's of this phenomena for knowledge about future investment potential.

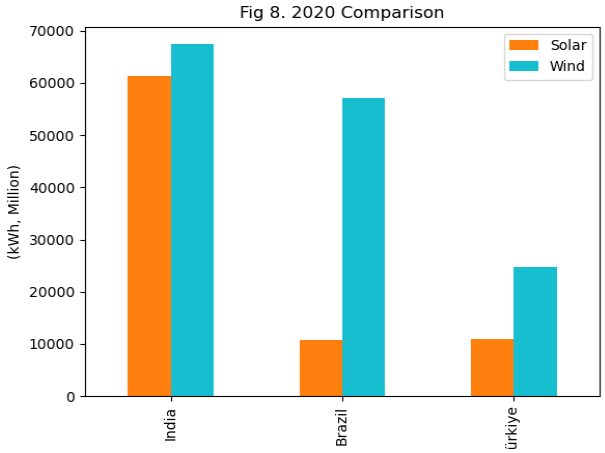
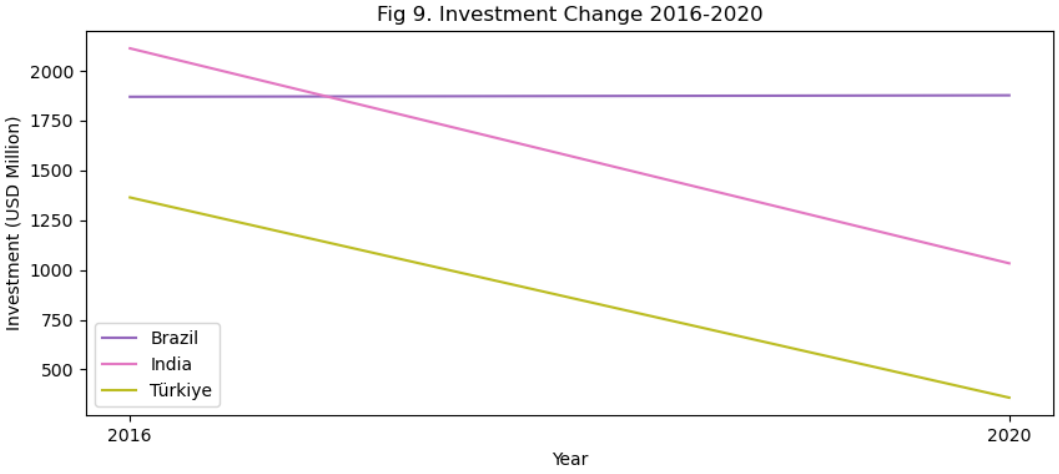



Fig 9. Renewable Energy Investment change in those same countries 2016 - 2020

This last chart is possibly the most interesting. While solar and wind electrical production is increasing over the time period 2016 to 2020 for the three above mentioned countries, investment is either relatively stagnant or declining during the same time horizon. One possible explanation is that production lags behind investment. One




invests money in a technology in 2016 and then doesn't see the results until 2020. Another reason could be global disruption that the COVID pandemic had on things across all of society.

Regardless, this system/situation seems to be more complex than this initial data analysis is able to insightfully show and means more data and more analysis is needed in order to make a truly informed investment decision. But with the information at hand, as a group, we

would invest in solar and wind in Brazil considering the investment amounts have seen consistency.