

Accelerating the Future: Analyzing the Growth, Costs, and Global Progress of Renewable Energy in Climate Change Mitigation

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Abstract: *Climate change poses an urgent threat, with greenhouse gas emissions driving impacts like rising temperatures, extreme weather, and sea level rise. The transition to renewable energy sources like solar, wind, and hydropower is critical for mitigating climate change and reducing emissions. This paper analyzes the growth of renewable energy and the costs and benefits associated with shifting away from fossil fuels. Global progress on renewable energy is reviewed, with a focus on leaders like China and the United States. India's renewable expansion is also examined as an example of a developing country with ambitious clean energy aims. A cost analysis case study finds that while the upfront investment in renewables is substantial at around \$4.5 trillion globally, costs are falling sharply. The environmental and economic advantages of renewable power are weighed against disadvantages like intermittency and land use. With supportive policies, renewable energy can realistically expand to meet a majority of the world's electricity needs and help curb climate change. Accelerating the transition to affordable, low-carbon energy systems is an urgent priority. This paper underscores the importance of renewable energy in achieving climate change mitigation goals and building a sustainable future.*

Keywords: Renewable energy, solar power, wind power, climate change mitigation, energy transition, renewable energy costs, renewable energy policies

1. Introduction

Our Climate affects nearly every aspect of our lives, from our food sources to our transport infrastructure, from what clothes we wear to where we go on holiday. It has a huge effect on our livelihoods, our health, and our future. The Climate is the long-term pattern of weather conditions in any particular place and hence its prominence is of magnitude importance

The potential future effects of global climate change include a rise in temperature, leading to more frequent wildfires, melting of glaciers resulting in more floods, longer periods of drought in some regions and an increase in numbers, durations and intensity of tropical storms.

Causes of Climate Change:

- 1) Humanity's increasing use of fossil fuels for energy - When fossil fuels such as coal, petroleum, and oil are burned, they release large amounts of carbon dioxide (a greenhouse gas) into the air. Greenhouse gases trap heat in our atmosphere, causing global warming. This is called the greenhouse effect, which increases the earth's temperature as more heat is trapped in the atmosphere than reflected back.
- 2) Deforestation- trees absorb and store carbon dioxide. If forests are cleared, or even disturbed, they release carbon dioxide and other greenhouse gases. Forest loss and damage are the cause of around 10% of global warming. Deforestation also causes soil erosion, which can go on to pollute lakes and leave less fertile soil for more trees to grow.
- 3) Increasingly intensive agriculture- this emits greenhouse gases like methane and nitrous oxide which cause the greenhouse effect.

Consequences of Climate Change:

Climate change affects all regions around the world. Polar ice shields are melting and the sea level is rising, resulting in flooding and erosion of coastal and low-lying areas. In some regions, extreme weather events and irregular rainfall showers are becoming more and more common while others are experiencing more extreme heat waves and droughts.

The changing environment is expected to cause more heat stress, an increase in waterborne diseases, poor air quality, and diseases transmitted by insects and rodents. This also results in an increase in the frequency and intensity of extreme weather events, such as heatwaves, droughts, and floods. For example in Mumbai itself in the early 2000s, the temperature used to be around 27 Celsius. Nowadays, the temperature average is around 32 degrees Celsius. In today's time, there are a lot of extreme weather conditions plaguing our nations that continue to deplete our climate due to their irregularity in pattern. For example, floods in Germany and the June of 2021 was the hottest June recorded in the United States in more than a century, about four degrees hotter on average.

Global Perspective:

As the prices of coal, petrol, and fossil fuels, in general, keep rising exponentially, a majority of the world's population is shifting towards renewable energy sources for the future.

Currently, countries such as China and the USA are trying to implement more renewable energy stations and are thriving with the success of their results. China sees renewable sources as both a source of energy security and a way to reduce carbon emissions. China is thriving by toying with renewable energy projects, with the country leading the world in electricity production from renewable energy sources, with over double the generation of the second-ranking country, the United

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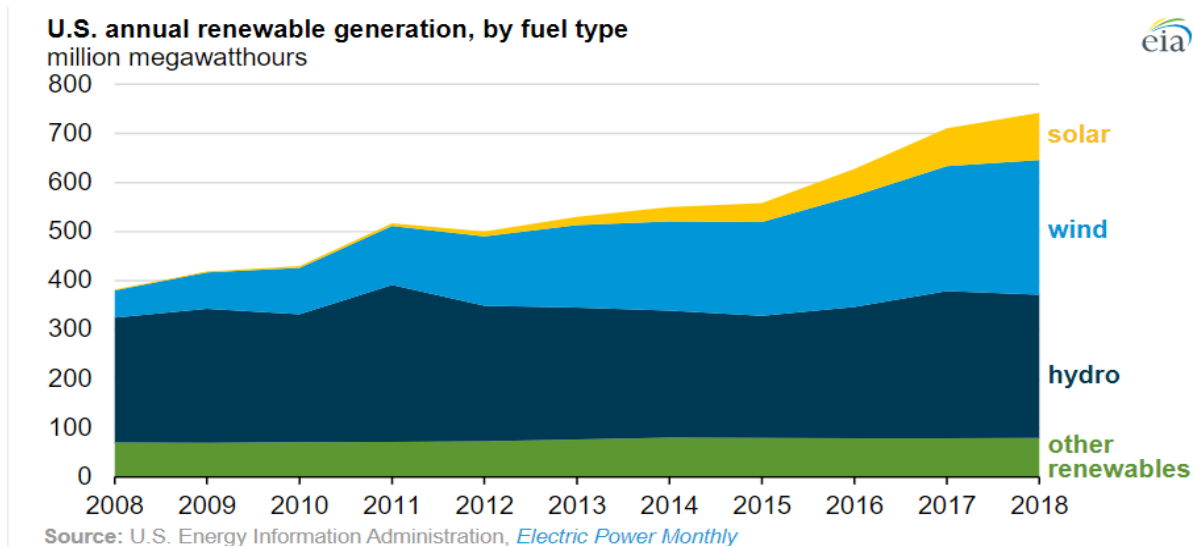
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States. China also spent \$83.4 billion so almost a quarter of the total energy produced by China would be cultivated from renewable sources. Sweden too has ambitiously set a target of 50% more efficient energy use than their current amount by 2030, and 100% renewable energy production by 2040. They also aim to have 0 emissions of greenhouse gases by 2045. Hydropower (water) and bioenergy are the top renewable sources in Sweden.

As of now, the total USA's renewable energy production and consumption was a record high in 2020, providing 11.6

quadrillions Btu (British Thermal Units) as their output. In 2019, 11% of the USA's total energy came from renewable sources and 17 % of the electricity produced by the USA is now renewable. Renewable energy resources have become one of the most competitive energy sources in many areas due to rapid technological advancements and falling costs, as well as the growing competitiveness of battery storage. However, the most prominent cause of renewable energy dynamic success is the reduced harm it causes to our environment, and how its usage helps prevent more damage and conserve non-renewable resources for future generations.



Graph 1: Shows the trendline of the U.S. Annual renewable power generation

Local (Indian) Perspective:

India has seen rapid growth in renewable energy in recent years and has ambitious targets for further expansion. With the world's third-largest electricity consumption, India aims for renewables to make up 57% of its installed power capacity by 2027, up from 39% today. This would require capacity additions of 15-20 GW per year - a pace India is on track to achieve. In 2021, India added a record 15.5 GW of solar capacity, surpassing the previous high of 9.4 GW in 2020.

India's renewable energy capacity has jumped over 280% since 2014 due to supportive policies like accelerated depreciation, tax credits, net metering, and federal auctions. By 2030, India aims to have 500 GW of renewable capacity and reduce the emissions intensity of GDP by 45%. Major investments are supporting this transition, including \$500 billion expected in the next 5 years. Domestic firms like ReNew Power and foreign companies like Total Energies are leading this investment. India's ambitious renewable energy goals hold promise for meeting electricity demand growth while curbing carbon emissions and air pollution.

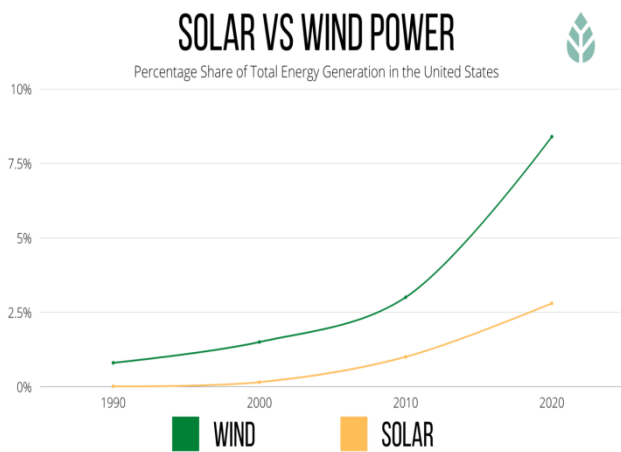
Case Study- How much will the change to renewable energy really cost?

With global momentum building around renewable energy adoption, an important question arises - how much will this transition cost? Recent analysis helps provide an answer. To

understand how much the change will cost us we need to understand what renewable energy exactly means.

Pinning down figures can be difficult to do; the numbers often depend on whom you ask. But According to research conducted by Yale University, the cost to switch to renewables would be around **\$4.5 trillion dollars**. This number may seem daunting, but context is important. For comparison, the world spent \$5 trillion subsidizing fossil fuels in 2020 alone. There are also long-term savings - a study by the International Renewable Energy Agency found transitioning to 97% renewables by 2050 would reduce overall energy costs by up to \$1.6 trillion per year. While the upfront investment is substantial, costs continue to fall as technology improves and economies of scale kick in.

Nowadays, making power plants for renewable energy is becoming cheaper than the cost of even the cheapest coal power plants. The cost of clean energy sources is falling year on year and will continue to do so as infrastructure develops. Solar power is falling by 13% year on year, and wind by 9%. Increased use of clean energy can only help the economy to grow and prosper. It creates jobs, reduces the cost of energy, and improves human welfare. This is helpful as it motivates more people to enter the industry, due to it no longer being extremely expensive or risky. Due to this, there have been 10,000 new power deals signed in 2019 alone.



Graph 2: Showcases the increase in the use of Solar and wind power technologies from 2010 to 2020 in the US

Advantages to switching to renewable energy:

- This energy will never run out, unlike oil, which is finite. renewable energy sources are infinite and can easily be replenished.
- It will cut energy costs immensely. Solar and wind are free resources that can be converted into energy and available to everyone whereas oil and other fossil fuels are costly and not available to everyone.
- The third upside is that it is extremely environmentally friendly, owing to the fact that there are no carbon emissions, unlike fossil fuels which have a large carbon footprint. Without carbon emissions, the reduction of global warming will increase drastically as the greenhouse effect will have lesser carbon sources to occur from

Disadvantages of switching to renewable energy right now:

- The first downside is the cost alone, it will be extremely expensive to switch to renewable energy. According to research conducted by Yale University, the cost to switch to renewables would be around **\$4.5 trillion dollars**
- The second downside is it will need a large amount of place, for example for solar energy, you need an extremely large amount of land for the solar panels to generate a sufficient amount of energy
- The third downside being not all places are suitable for renewable energy, as it depends on a lot of factors like seasons, wind speeds, and the weather. Like if a certain country does not have sun throughout most of the year and hence cannot have solar energy.

Possible Course of Action and Conclusion

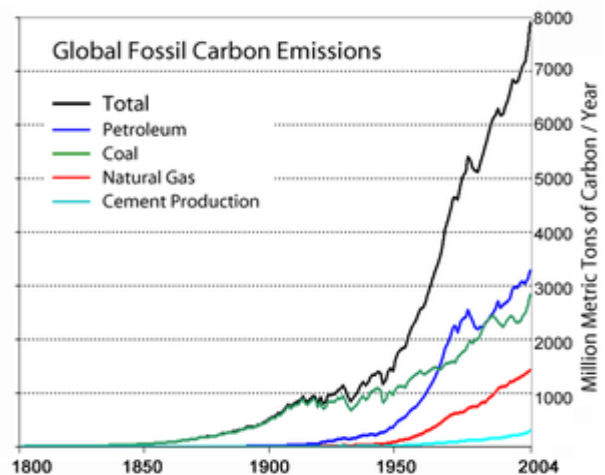
Since the year 2000, there has been a 50% increase in carbon emissions. But, there is still hope. We can reduce our emissions massively while still developing new ways to inculcate renewable energy into our daily lives. Energy intensity is how efficiently we use energy, and thus the more efficient a product is, the lesser energy it requires. So being more and more efficient is a very good way of reducing the world's CO₂ emissions. Some quick ways to be more efficient

at home are switching off TVs, lights, fans, electronics, gadgets, and water heaters when not in use. Keep the lights in the room turned on just when they're needed, and unplug any electrical equipment that isn't in use.

"Is it too late?" is a question that is very frequently asked when talking about climate change and the action to be taken to battle climate change. Some say that we are too late to prevent catastrophic climate events, while some still are unable to accept its reality. Elon Musk, CEO of Tesla and chief engineer at SpaceX said that even if we stopped all the carbon emissions in the world right now it would not be enough let alone the fact that if that is done the world would come to a halt. So the question is, **is it too late?** As one can see, the amount of carbon in the atmosphere has gone into a vertical climb in recent years, despite a downward spike in the year 2020. This is because of the restrictions imposed on travelling and other activities due to the pandemic, and scientists predict numbers will skyrocket as things go back to normal. So, it may be too late as we see extreme events more and more often like the floods in Germany where nearly two months worth of rain fell in just 24 hours, leading to flash floods that tore through buildings. However, this does not mean we should stop trying to tackle the issue of climate change as we can still try to stop it.

What we can use is one of our biggest leverages, which is today's advanced technology. We can leave nuclear plants online for longer and we can also give subsidies to the renewable energy industry. To discourage large amounts of our emissions one can tax the firms who produce large emissions.

The path to Solving climate change will be extremely complicated, but all we need to do is take action towards our climate immediately by being efficient and understanding how to decrease the production of fossil fuel energy sources without harming our industries. This change will not happen overnight, but it needs to change as soon as possible and it is still very possible.



Graph 3: Global Emissions in Million metric tons vs Time

Recent Breakthroughs and Future Scope:

While renewable energy faces some persistent challenges like intermittency and land use, exciting new technological breakthroughs aim to address these issues:

- Battery storage innovations are enabling smoother integration of intermittent solar and wind power. Startups like Form Energy are developing ultra-low-cost batteries capable of storing power for 100 hours to provide electricity around the clock.
- Floating solar farms placed in reservoirs can reduce land usage, save water from evaporation, and boost solar output. India and China have already deployed multiple 100MW scale floating solar projects.
- Agrivoltaics integrates solar panels into agriculture, providing shade and protection for crops while also generating power. Successful pilots have been demonstrated across horticulture and aquaculture.
- New materials like perovskites can make solar cells over 25% more efficient while reducing manufacturing costs. Perovskite-silicon tandem panels are approaching efficiencies of 30%.

With supportive policies and continued innovation, these technologies can make renewable energy more feasible and cost-effective. Projections show renewables plus storage attaining a cost of \$20/MWh in most markets by 2030 - cheaper than even the most competitive fossil fuel plants. The future is bright for renewables to continue their exponential growth trajectory while unlocking further cost declines.

2. Conclusion

In conclusion, the transition from fossil fuels to renewable energy is imperative for mitigating the climate crisis while providing sustainable and affordable electricity globally. As this paper has shown, countries around the world are recognizing the environmental and economic benefits of renewables and rapidly accelerating adoption. However, the window for avoiding catastrophic climate change is fast closing. Achieving the Paris Agreement goals of limiting warming to 1.5C requires steep emissions cuts over the next decade - cuts only possible through aggressive renewable energy deployment accompanied by energy efficiency. Recognizing both the urgency and feasibility of the renewable transition, global investment and policy support must be scaled up dramatically. Although the upfront cost is substantial, it pales in comparison to the costs of unabated climate change. Renewable energy offers one of our best hopes for building a zero-carbon future and securing the health and prosperity of current and future generations. The evidence shows that with ambitious policies, innovation, and public-private collaboration, deep decarbonization led by renewables can be achieved. The renewable revolution has begun - now it must be accelerated. Our collective future depends on the energy choices made today.

3. Source Analysis

Almost all the sites used were published by government organizations, non-profit organizations, or reputable universities. The sources were reliable as they released all their authors, cited other sources and the research had been conducted by prestigious universities. However, some websites released information without authors or dates, raising doubts about the data's legitimacy and dependability because no one could predict when it was recorded. Some sources seemed like they had a vested interest in the topic. Also, some articles talk more from a personal view which gives it a personal tone and bias.

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