Global Essay Competition 2024

Title: **Clean Energy, Hydrocarbons, and Climate Change. How to sustainably power the 21st Century?**

Essay:

Clean Energy, Hydrocarbons, and Climate Change. How to sustainably power the 21st Century?

The greatest threat to our planet is the belief that someone else will save it.

Robert C. Swan (British explorer and environmentalist)

Introduction

Carbon dioxide is the main contributor to global warming, accounting for approximately 75% of the total greenhouse gas emissions.[1] In 2022, the average concentration of CO2 in the atmosphere reached a record level of 417 particles per million (ppm), around 7% more than in 2010 and nearly 18% more than in 1990. Alarmingly, its average annual growth in the last decade increased to 2.4 ppm per year from 1.8 between 1993 and 2002.[2] The world is steadily burning more and more coal, oil, and natural gas to meet rising global economic demands, with these hydrocarbons producing more than 90% of CO2 emissions.[3]

From 2011 to 2020, the global mean temperature was 1.10 degrees Celsius higher relative to the second half of the 19th century. Projections suggest that the temperature will cross the critical threshold of 1.5 degrees Celsius between 2028 and 2035, implying substantially escalating climate hazards.[4] Moreover, the problems will amplify due to the loss of ice-albedo, methane release, and atmospheric vapor feedback loops. The ten warmest years on record (1880–2022) have all occurred since 2010, an already clear warning of imminent peril.[5] For example, six of the ten most destructive tropical cyclones to affect the United States have happened since 2012.[6]

Estimates show that 3.3 to 3.6 billion people live in areas affected by global warming, with people in low-income countries particularly vulnerable due to critical food and potable water scarcity.[7] Unless the world undertakes far-reaching and well-coordinated actions, the global challenges posed by climate change will aggravate bringing on the edge of survival millions of families and causing the extinction of myriad species of animals and plants. In this essay, I discuss why the world is in severe scarcity of clean energy sources, why countries need to strive substantially more to increase their availability on a global scale, and I determine whether it is possible to thrive without clean energy by using carbon capture and other CO2 abatement technologies.

Hydrocarbons and the scarcity of clean energy sources

In 2022, global energy consumption peaked at nearly 180 thousand terawatt-hours, around 17% more than in 2010 and 68% more than in 1990. In the last 30 years, the global economy has not shifted

[1] Numbers are based on Ritchie, Rosado, and Roser (2020a).
[2] Numbers and calculations are based on data from Lan, Tans, and Thoning (2023).
[3] Numbers are based on Ritchie, Rosado, and Roser (2020b).
[4] Mean temperature estimates and projections are based on WMO (2023, p. 8 and p. 11)
[5] Ranking of the ten warmest years is from NOAA (2023a).
[6] Ranking of the most destructive tropical cyclones to affect the US is from NOAA (2023b).
[7] Numbers and information is from IPCC (2023, p. 5).

significantly from coal, oil, and natural gas to clean energy alternatives. The share of these fossil fuels in global energy consumption has remained steady at around 77% during this time.[8] Both developed and developing countries highly rely on fossil fuels. For example, the share of oil, coal, and natural gas in the total energy consumption is still above 80% in the US, China, Japan, India, and Mexico and above 75% in Germany, the UK, and Türkiye.

A distinct problem for the environment is the combustion of coal. It produces nearly twice as much CO2 emissions per unit of energy as, for example, natural gas.[9] Although most developed countries (ex., the US, the UK, Germany, France, and Canada) substantially decreased coal consumption between 1990 and 2022, economic giants such as China and India still considerably rely on it.[10] In 2022, China burnt nearly ten and India two and a half times as much coal as the US, the latter representing the world's third-largest consumer of this hydrocarbon. The world is in stringent need of clean energy to power the global economy.

Economic theory has clear warning about non-intervention

Economic theory backed by empirical analyses warns that unregulated economic growth leads to environmental degradation (Copeland & Taylor, 2009; Taylor & Weder, 2023). The world faces a typical "Tragedy of the Commons" problem, increased to a global scale.[11] In the context of climate change, it highlights that nations lacking economically feasible clean energy substitutes to hydrocarbons will burn fossil fuels until it is too late! Thus, unless the world undertakes coordinated and far-reaching clean energy initiatives to combat global warming, we are heading towards a global-scale catastrophe that will affect each of us and every aspect of our lives.

Which countries have to lead the global efforts to combat climate change?

The answer is the US, the European Union, other developed countries (including the UK and Japan), and China. One would expect their leadership as these economies significantly contributed to the accumulation of anthropogenic carbon dioxide in the atmosphere throughout time. For example, as of 2022, the US accounts for 25% of all CO2 emissions in the atmosphere, the EU 17%, China 15%, the UK 4.4%, and Japan 3.8%.[12] Yet, most importantly, these economies have the necessary clean technologies and financial resources to make a global difference.

As such, these economies can dilute their total CO2 emissions accumulated during the time with clean growth in developing countries fostered by their technology and funding. In this way, developing nations can escape faster the first phase depicted on the environmental Kuznets curve when economic growth leads to the degradation of the environment, transitioning quicker to the second phase when economic growth improves the quality of the environment.[13]

Striving for more economically feasible clean energy is the prime solution to climate change.

The world urgently needs to increase the availability of clean energy sources to substitute oil, coal, and natural gas by applying far-reaching and well-coordinated energy policies on a global scale. The success of several countries makes room for hope in this regard. For example, Sweden, Norway, Finland,

[8] Numbers and calculations are based on Ritchie, Rosado, and Roser (2020c).
[9] Information about pollution potential of different fuels is from MET Group (2020).
[10] Data on coal consumption by country is from Enerdata (2023).
[11] Copeland & Taylor (2009) represents a very useful paper explaining the "Tragedy of the Commons" problem.
[12] Information on cumulative CO2 emissions is from Ritchie (2023).
[13] Copeland & Taylor (2004) represents a very useful paper discussing the environmental Kuznets curve.

Switzerland, France, and Brazil are countries that cover energy needs preponderantly relying on clean energy sources, hydro and nuclear power playing substantial roles.[14]

As for now and the foreseeable future, the world has two economically feasible clean energy options to mitigate climate change. The first option on the table is hydropower. Even though constructing hydropower plants is expensive, this clean energy source is cost-effective in the long run. Moreover, it has other significant advantages, including no reliance on weather conditions, and increased flexibility for varying electricity demands. The environmental benefits of hydropower are significantly higher than the costs. According to Fatih Birol, the Executive Director of the International Energy Agency, hydropower is "the forgotten giant" of low-carbon energy generation.[15] The world presently does not realize half of the economically feasible hydropower potential.[16] We have to use it.

The second option is nuclear energy. The technology is well-known and has been in use since the mid-1950s. The electricity produced is relatively cheap and CO2-neutral. Yet, the wide availability of even cheaper fossil fuels and low CO2 taxes prevents the development of the nuclear energy sector, including in high-income countries such as the US (Davis, 2012). If considering increased security measures to prevent accidents, building plants in seismically inactive regions, and reasonably increase CO2 taxes, nuclear energy can substantially decrease the use of fossil fuels, reducing global carbon dioxide emissions. As hydropower facilities, nuclear plants require high initial investments.

Wind and solar energy can only complement hydro and nuclear power in our efforts to combat climate change. Although the world has had substantial success in these sectors since the 1990s, energy production and system costs are still very high under current technologies.[17] Estimates for Germany, for example, show that solar energy production and system costs per megawatt hour are higher by a factor of nearly 36 than the natural gas alternative and by a factor of 13 than nuclear energy. Onshore wind energy production is more expensive by a factor of 14 and 5, respectively.[18] Very few countries can afford these energy costs.

Can we thrive without clean energy sources? Are carbon capture and other CO2 abatement technologies an alternative solution to climate change?

Is it possible to decrease carbon dioxide emissions while still relying on hydrocarbons to cover the world's rising energy needs, in other words, to thrive sustainably without clean energy? In theory, it is possible. The solution is the removal of CO2 from the atmosphere. The simplest way to reduce the CO2 concentration is through planting enough trees. However, finding suitable land to plant trees on a global scale is a massive challenge, which can itself lead to a wide range of major social problems due to the displacement of people and the reduction of farmland, among others.[19] Planting new forests on a reasonable scale can only complement our efforts to combat climate change.

Another feasible way to reduce CO2 emissions is to significantly increase productivity per unit of used hydrocarbons on a global scale. In other words, if the world learns how to produce goods and services more efficiently, countries can enjoy the same or even larger welfare while burning less coal, oil, and natural gas. Economic theory discusses mechanisms to increase productivity per unit of fossil fuels through environmental regulation (Copeland & Taylor, 2004) or international production specialization (Benarroch & Weder, 2006). The regulation motivates businesses to reduce emissions by implementing different carbon abatement technologies, or it can relocate production from more towards less polluting

[14] Information on energy consumption by source by country is from Ritchie and Rosado (2023).
[15] The quote from Mr. Birol is available here: IEA (2021, p. 2). Lai (2023) discusses the advantages and disadvantages of hydropower.
[16] The evaluation of hydropower potential is from IEA (2021, p. 8)
[17] Ritchie and Rosado (2023) provide data about wind and solar energy sources. For example, in 2022, these sources covered nearly 5.4% of global energy consumption, compared to less than 0.02% in 1990.
[18] Information about production and system costs of green energy is from Eisenring (2023).
[19] Fleischman et al. (2020), Bastin et al. (2019), Holl & Brancalion (2020), and Buis (2019) discuss challenges related to planting trees on a global scale.

firms. International specialization exploits the benefits related to increasing returns to scale, which lowers the use of fossil fuels to produce a given quantity of goods.

Real-world tendencies confirm these theoretical findings. The growth in CO2 emissions produced by developed countries over the last three decades stopped or significantly declined relative to the 1990s. For example, in 2022, the United Kingdom emitted nearly 47% less carbon dioxide than in 1990, Germany 35% less, Sweden 34%, and France 24%. CO2 emissions in the US and Japan stayed more or less flat.[20] The income levels substantially increased in these countries over the same time. One may argue that these countries produce less carbon dioxide emissions as they offshored "dirty" industries to developing economies. Yet, recent studies about CO2 (Copeland, Shapiro, Taylor, 2022) and other closely related air pollutants (Shapiro & Walker, 2018; Najjar & Cherniwchan, 2021; Brunel, 2017) show little support for this claim, concluding that technological advancement, stricter environment regulations, or within-industry reallocation to cleaner plants caused the reduction of air pollution in these countries. As technological transition is a slow-moving process, it can take decades for developing countries to reach the productivity levels of high-income economies. Thus, this option only complements the hydro and nuclear power solution.

We may also not need clean energy sources and thrive without them if carbon capture and storage (CCS), direct air capture (DAC), or similar technologies start removing CO2 from the atmosphere on a substantially large scale, which is unlikely to happen in the foreseeable future as these technologies are relatively new, in many cases representing prototypes as International Energy Agency highlights.[21] Moreover, the Agency suggests that the degree of uncertainty in the further scaling of these technologies is very high, and thus, intensively relying on them to combat global warming can lead to missing the CO2 emissions targets in the future.

Far-reaching transition from combustion to electricity

The economically feasible prime solution to climate change is to shift from hydrocarbons to clean electricity produced by hydro and nuclear power plants. As such, the world must prepare for profound changes and invest in electric technologies to substitute, where possible, fossil fuels from economic processes. For example, countries should ensure that power infrastructure is easily accessible to the public if they engage in a coordinated global-scale effort to foster the transition to electric vehicles.

Conclusions

With growing climate change pressure, countries face acute scarcity of economically feasible clean energy sources to sustain economic growth. The prime solution to this issue is the transition to hydro and nuclear power on a global scale. It can make a substantial difference already now. We must complement this solution by expanding solar and wind power, planting new and preserving existing forests, and transferring production technologies from high-income countries and China to developing economies. However, note that these actions can only complement and not replace the current need to shift from fossil fuels to economically feasible hydro and nuclear power.

Developing countries, in turn, should gradually implement higher CO2 taxes and stricter environmental regulations in exchange for hydro and nuclear infrastructure investments and technology transfers. Moreover, China and many developed economies, including the US, must raise CO2 prices to foster the global transition to clean energy alternatives. Robert C. Swan precisely warns in the above quote that indifference is the greatest threat to our planet. We need to overcome our narrow and selfish interests and engage in far-reaching and well-coordinated climate change actions on a global scale to escape the "Tragedy of the Commons" fate.

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[20] Calculations are based on Ritchie, Rosado, and Roser (2020a).

[21] IEA (2022, p. 49 – p. 50) assesses the carbon capture technologies' potential.

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