Exploring the impact of climate change on energy systems at both a global and regional scale

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Over the past few decades, scientists have become increasingly aware of the adverse effects that human activities are having on the environment

and climate on Earth. These environmental and climatic changes have several consequences, impacting both the health of living organisms and more practical aspects of society.

Among other things, recent studies suggest that climate change is impacting energy systems, increasing transport costs or making it harder for suppliers to meet regional demands due to unpredictable and adverse weather conditions. Technologies that use natural resources to produce electrical energy, such as solar panels and wind turbines, are highly dependent on a region's climate, so radical climatic changes can prevent them from generating enough energy.

More conventional technologies for producing energy can also be affected by climate change. For instance, unusually high temperatures can impair the functioning of cooling systems and potentially decrease turbine efficiency on thermal plants (e.g., fossil fuel power stations, nuclear plants, etc.).

Moreover, climate change can increase the overall demand for energy, as people may use heating and cooling systems more frequently due to intolerable or extreme climatic conditions. It can also increase competition between energy suppliers and companies operating in other sectors who require access to resources that have become scarce due to unfavorable climates, the most vital of which is water.

Although some past studies have explored the effects of climate change on individual energy systems, so far, very few have looked at these effects as a whole and on different scales. To address this gap in the literature, researchers at Utrecht University, Wageningen University and other universities worldwide have recently reviewed past research investigating the impact of climate change on energy systems at the global and regional levels. Their review paper, published in *Nature Energy*, could prove particularly useful for scientists investigating

climate change in the context of energy supply and demand, or could inform the development of strategies to best deal with some of the challenges currently faced by the energy sector.

"There is a general understanding in the scientific community that climate change may impact energy systems, and studies here and there randomly point to that," Saleshi G. Yalew, lead author of the paper, told Phys.org. "However, there is really no comprehensive understanding of the extent and magnitude of that impact, especially at regional and global scales. The objective of this review was to see if we could capture some regional and/or temporal trends and identify further research gaps through an extensive literature study."

In their paper, Yalew and his colleagues analyzed the results of 220 past studies that investigated how climate change is affecting or may affect energy systems in the future. These analyses specifically focused on three elements: energy supply, energy demand and integrating systems.

In the context of energy supply, the researchers focused on renewable energy systems, ranging from hydropower to solar, wind, bioenergy, and thermoelectric sources. Power supply chains using natural gas, coal or other substances are known to be less affected by climate changes, thus they were excluded from the study.

When analyzing the impacts of climate change on energy demand, Yalew and his colleagues focused on the increasing demand associated with a greater use of heating and cooling systems. Lastly, they examined how changes in climate might impact the costs of integrating different energy systems.

"We searched, achieved and filtered scientific articles published since the early 2000s on how climate change impacts these different sub-categories both at regional and global scales," Yalew said. "Then, we

collected climate change impact results on energy systems reported by each article and conducted a meta-analysis, aggregating studies per region, per impact period and per warming levels."

Yalew and his colleagues observed that while there are a large number of studies on this particular research topic, the exact extent to which climate change can impact energy systems is yet to be determined. This is especially true for wider geographical regions, which are often of greater interest for general policymaking than for operational decisions.

"The findings of our analysis imply that we may not be actually responding appropriately to opportunities and challenges in regard to future climate changes," Yalew said. "For example, we found that future energy systems typically focus on the challenge of being carbon neutral in order to reduce or avoid climate change. However, it will also be important to make future energy systems climate proof, in order to ensure that they are resilient to future climates."

The recent work by Yalew and his colleagues could be a point of reference for other teams who are exploring the effects of climate change on energy systems. In their next studies, the researchers also plan to examine other socio-economic challenges associated with climate change, such as the impacts of climate change on the distribution of water and other resources.

"I am currently investigating climate and other socio-environmental impacts on integrated water resources management," Yalew said. "I plan to continue focusing on the impact and implications of climatic changes on the water-food-energy nexus in particular."

More information: Impacts of climate change on energy systems in global and regional scenarios. *Nature Energy* (2020). DOI: 10.1038/s41560-020-0664-z

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