From coal to gas: How the shift can help stabilize climate change

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A transition from coal-based energy to cleaner-burning gas has long been viewed as a staple of many climate action plans, despite concerns over leakage and possible harmful emissions. A recent study published in the journal *Nature Climate Change* finds that not only is such a shift central

to meeting climate targets and stabilizing global temperature rise, but that the benefits of cleaner-burning gas outweigh its possible risks.

Led by Katsumasa Tanaka, a senior climate risk researcher at the National Institute for Environmental Studies in Japan, the study examined global scenarios for transitioning from coal to gas using a novel approach that applied metrics developed for climate impact assessments to the coal-gas debate for the first time. Focusing on the world's leading power generators—China, Germany, India, and the United States—the study examined the impacts from a variety of direct and indirect emissions of such a shift on both shorter and longer timescales ranging from a few decades to a century.

"Many previous studies were somewhat ambivalent about the climate benefits of the coal-to-gas shift," said Tanaka. "Our study makes a stronger case for the climate benefits that would result from this energy transition, because we carefully chose metrics to evaluate the climate impacts in light of recent advances in understanding metrics."

"Given the current political situation, we deliver a much-needed message to help facilitate the energy shift away from coal under the Paris Agreement," Tanaka said. "However, natural gas is not an end goal; we regard it as a bridge fuel toward more sustainable forms of energy in the long run as we move toward decarbonization."

Concerns about methane leakage from natural gas have been intensely debated, particularly in the United States given the increasing use of fracking over the past decade. Recent scientific efforts have improved understanding of the extent of methane leakage in the United States, but its potential impacts remain highly uncertain in the rest of the world.

"Our conclusion that the benefits of natural gas outweigh the possible risks is robust under a broad range of methane leakage, and under

uncertainties in emissions data and metrics," Tanaka said.

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Multiple metrics to simultaneously examine short- and long-term climate impacts

Emissions metrics, or indicators to evaluate the impacts to climate change from a variety of emission types, are useful tools to gain insights into climate impacts without the need for climate model runs.

These metrics work like weighting factors when calculating CO_2-equivalent emissions from the emissions of a variety of greenhouse gases. However, the resulting climate impacts observed through CO_2-equivalent emissions are sensitive to the specific metrics chosen.

"Because the outcome can strongly depend on which metrics are chosen and applied, there is a need for careful reflection about the meaning and implications of each specific choice," said Francesco Cherubini, a professor at the Norwegian University of Science and Technology. "Each emission type elicits a different climate system response. The diverging outcomes in previous studies may well stem from the type of metric that was chosen."

The study combined multiple metrics to address both short- and long-term climate impacts in parallel. It was found that natural gas power plants have both smaller short- and long-term impacts than coal power plants, even when high potential methane leakage rates, a full array of

greenhouse gases and air pollutants, or uncertainty issues are considered.

"Our study uses a set of metrics jointly, unlike many studies using just one, to consider climate impacts on different time scales—one metric for a few decades and another one for approximately a century", said Otavio Cavalett, a colleague of Cherubini. "This allowed us to consider the host of pollutants that can affect the climate on different time scales."

"In practice, we departed from metrics available from the latest IPCC report and focused on those that are most consistent with the Paris Agreement temperature goals," Cherubini said. The authors' choice of metrics aligned with recent recommendations by the United Nations Environmental Programme and the Society of Environmental Toxicology and Chemistry. It is the first application of such recommendations to the coal-to-gas debate.

Regional differences

To ensure that possible regional differences were accounted for in the global study, the study compared global metrics with regional metrics to more precisely examine impacts.

"We considered a suite of so-called short-lived climate pollutants (SLCPs), such as SOx, NOx, and black carbon, that can be emitted from these plants," said Bill Collins, a professor at the University of Reading, in the United Kingdom. "This required a regional analysis because climate impacts from SLCPs depend on where they are emitted, due to their short lifetimes in the atmosphere."

Future directions and policy relevance

The study by Tanaka and coauthors is part of a growing body of literature that reaffirms the need to phase out coal in order to mitigate rising global temperatures and slow or reverse negative impacts of climate change.

Future related work could consider supply chains and trade within and across nations and other environmental factors, in addition to work on improving the consistency of metrics for evaluating climate impacts.

"Air quality is not part of our analysis, but including it would likely strengthen our conclusion," said Tanaka. Other environmental effects, such as drinking water contamination and induced seismic activities, could also add important dimensions to the debate."

More information: Asserting the climate benefits of the coal-to-gas shift across temporal and spatial scales, *Nature Climate Change* (2019). DOI: 10.1038/s41558-019-0457-1 , www.nature.com/articles/s41558-019-0457-1

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