Editorial

Energy and the environment: Striking a balance

Energy and the environment have become tinderbox issues in the United States and many other countries. There is tension between energy availability and reliability and also demands that the net environmental consequences of generation and delivery are minimized to the extent possible. The ongoing and often heated debate associated with global reliance on fossil fuels has become a political issue. Many countries and stakeholders advocate all means necessary to implement the 2015 Paris Climate Agreement, which seeks to reduce the impact of global climate change and keep the world's temperature from rising to levels beyond 1.5 °C prior to the industrial revolution. International nongovernmental organizations are constantly reminding governments of their responsibilities to reduce greenhouse gas emissions (GGEs). Despite the goals of the Agreement, GGEs in several major industrial countries (most notably China and India) have been increasing since 2015. In contrast, GGEs in the United States have been decreasing, due largely to enacted regulatory controls. This imbalance illustrates the absence of international regulatory compliance directives in some countries that, though they may agree with the goals of the 2015 Agreement, have failed to take adequate steps to enact laws and policies aimed at meeting their commitments.

From a historical perspective, fossil fuel resources have largely created the industrialized world we know today. In the United States, a plentiful supply of coal, crude oil, and natural gas has powered the industrial sector for more than a century. Energy production using coal, oil, and natural gas continues to dominate in the United States, environmental impacts notwithstanding, and globally makes up about 84% of all energy output.

"There is hope that a balance between energy reliability and minimal environmental effects can be achieved."

Clearly, the world's reliance on fossil fuels is not ending any time soon, and this is increasingly alarming the scientists who have documented the environmental damages caused by the world's reliance on fossil fuels over the past century. Damage to the earth's ecosystems has been pervasive; adverse effects observed in the land, water, and air are many, supported by countless studies in the literature. The rise of environmentalism in the mid-20th century exposed the extent of environmental change and the damage caused by the world's quest for inexpensive energy. More recently, attention has shifted to the legal arena in many countries and international governing bodies, where communities are demanding compensation for and repair of environmental damages. In a striking example, in May 2021, a district court in the Hague, Netherlands, issued a decision that a major global oil and gas company was partially responsible for climate change. The court ordered Royal Dutch Shell PLC to curb global carbon emissions by 45% by 2030.

The landmark court decision raises several questions: Is there a proven cost-effective technology that would facilitate achievement of a 45% reduction in GGE within 10 years? What are the net environmental benefits if the 45% reduction is accomplished? Do we have the tools necessary to predict the utility and consequences of large investments in environmental control technologies when imposed on industry? Is implementing the precautionary principle the most prudent policy choice?

Advocates for the Agreement and some governments argue that countries dependent on fossil fuels have a duty and obligation to accelerate the development of energy delivery via renewable power technologies, particularly wind power and solar energy. However, a pure and so-called 100% clean energy technology and delivery network that is free of environmental impacts does not exist at present. Hydroelectric dams have the potential to harm migratory fish populations, many of which are endangered. Wind power turbine blades cause bird and bat injuries and mortality both on- and offshore. Further, delivery of wind- and solar-based energy has not been proven to be reliable and free of interruptions in some cases.

A competent and resilient energy delivery network must also be able to withstand extreme weather events, as the potential consequences of failed energy delivery for human life are very real. The catastrophic energy debacle in the US state of Texas during the winter of 2021 illustrates the seriousness of a fragile and unsound energy network: At least 151 people died due to the lack of heat and/or clean drinking water during the crisis.

Scientists, stakeholders, and policymakers must insist on comprehensive energy life-cycle assessments (LCA) in the evaluation of new energy technologies and policy decisions affecting the future of energy sourcing and delivery. LCA has long been used to evaluate, from cradle to grave, the environmental costs of industrial production and manufacturing. A recent example of the value of LCA is the recent report by the International Energy Agency (IEA), "The Role of Critical

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Minerals in Clean Energy Transitions" (IEA, 2021). The IEA supports an overall "net-zero" carbon emissions policy by 2050, largely through pervasive shifts to renewable energy sources. With respect to energy storage and the growing focus on battery technologies, the IEA report calls attention to the challenges of obtaining sufficient volumes of the key minerals and elements needed to support the development of renewable energy. Wind, solar, and battery technologies are built from an array of "energy transition minerals" that must be mined and processed. A substantial increase in the global extraction of lithium, manganese, graphite, nickel, and other rare-earth minerals would be required. The sources for many of these minerals are in developing countries that do not currently have environmental safeguards comparable to countries such as the United States, Canada, and Australia. Further exacerbating the challenge, according to the IEA report, are the large volumes of water required for mining and mineral processing in regions of the world that are experiencing significant water deficits.

Despite these concerns, many countries are committed to making investments that would mitigate potential adverse effects of renewable energy delivery. Improvements in photovoltaic systems that convert direct sunlight into electricity through the use of solar cells, for example, may allow regions with ample sunlight to capitalize on that asset by installing solar farms. The US federal government and the State of Massachusetts took a significant step forward together recently by approving one of the nation's largest offshore wind energy projects, and many companies are also making significant investments in wind-based energy delivery. During 2020, just under 17 000 MW of wind power was installed, and now wind energy has surpassed hydroelectric-based electrical output.

Careful assessment and predictions using LCA and supported by robust, data-rich, and well-calibrated numeric environmental models will be invaluable to business and governmental communities involved in national- and global-level energy transition. Uncertainties are inevitable, but making the successful shift to reliance on renewable energy sources—to the extent technically possible and cost-effective—is an undeniable move that is recognized by the 195 nation signatories to the Agreement. We must be vigilant, however, to modernize and create a resilient energy generation and delivery network. Without a reliable network, technological advances in renewable energy may be fruitless if extreme weather events and/or periods of high energy demand cripple the very network serving as a lifeline to communities around the world.

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REFERENCE

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