

## Ten Challenges to De-Carbonizing Our Energy Supply

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Proponents of alternative energy were left scratching their heads last December [over a report](#) that the town council from Woodland, N.C., rejected a proposal to rezone a parcel of land to allow a proposed solar farm. Several reasons were given, including threats to human health, the notion that the community would not directly benefit, and worries over the impact to housing values.

A month earlier a Luzerne County, PA Court [denied an appeal](#) by a firm planning to construct a windfarm of up to 25 turbines in Foster Township. Locals were concerned that the turbines would be injurious to their health, safety and welfare – and that a windfarm was not consistent with other permitted land uses.

Those actions came against the backdrop of global concerns over climate change caused by burning fossil fuels. Climate change was a centerpiece of Pope Francis' recent [Encyclical](#). Last month's Climate Change Conference in Paris led to an [agreement](#) by 195 countries to voluntarily shift away from fossil fuels and shift to non-carbon renewables like solar and wind.

Some demand an immediate end to fossil fuel development. Given current domestic political and economic pressures, geopolitical realities, consumption patterns, and the energy infrastructure of the United States, an immediate end to fossil fuel developments appears unfeasible. Change must come, but it will likely take decades. Even plans [to run the US on wind, solar, and water developed by Stanford engineering professor Mark Jacobson and his colleagues](#), list a timetable of 2050 for the transition.

We believe that a more rapid transition is hindered by ten challenges.

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1. Over [80% of our energy comes from fossil fuels, according to the U.S. Energy Information Agency](#). They have many benefits: convenient to transport and use, loaded with energy, produce largely invisible pollution, and are reliable. Ten gallons of gasoline – approximately 60 lbs – can propel a family of four 300 miles in their own private compact car. What other fuel can do that?
2. Developed countries use energy – mostly as fossil fuels – for nearly all facets of life. In the U.S., [we use 95-100 quadrillion BTUs each year](#); 35 as petroleum products for transportation and industry, 27 as natural gas for electricity, residential, and commercial use, and 18 as coal for electricity. Take away those fossil fuels right now, and people go cold, hungry, and are extremely constrained in their travel – [among many other sacrifices](#).
3. Fossil fuel reserves are at a high point, and cost to the customer is currently low. [People rejoice when gas prices go down](#). How do we incentivize people to give up their gas-powered car, when price per gallon is hovering at \$2? Prices of fossil fuels promise to be low for the foreseeable future, making it harder to switch to another source. *We could* implement carbon taxes to better account for the externalities associated with burning fossil fuels, as many advocate. Doing so would make renewables cost-competitive. But implementation of such taxes should not adversely impact the poor and elderly.
4. Many, [especially those holding a politically conservative philosophy](#), wrongly believe that fossil fuels do not contribute to climate change, a number that varies from 20-40% depending on the survey. They eagerly offer their own global climate datasets or interpretations of existing data that run counter to the prevailing scientific narrative. For example, [some focus on](#) climatic data showing that global temperature increases began in the late 1800s – before massive use of fossil fuels seen today. [Others assert](#) that temperature increases have remained flat over the past 17 years. [Still others maintain](#) that an accumulation of Antarctic ice will cause sea levels to drop. Refutations of those claims by mainstream scientists are easy to find with some searching. Still, the argument rages in the blogosphere and certain media outlets. Along the way, those who accept climate change are labeled as misguided – or worse – having ulterior sociopolitical or personal motives. That argument successfully raises doubts about the reality of climate change to those open to such a message.
5. The fossil fuel industry receives enthusiastic support from think tanks like the American Enterprise Institute, the Heartland Institute, the Heritage Foundation, and the Manhattan Institute, and trade groups like the American Petroleum Institute, American Natural Gas Alliance, as well as elected officials at all levels who are committed to fossil fuels. Industry funding underwrites the [development of documents](#) and the [formation of a complex social network](#) that promote fossil fuels and cast doubt on climate change – an assertion that [some argue](#) deserves congressional investigation. Perhaps the most articulate defense of fossil fuel philosophy can be found in a 2014 book, “The Moral Case for Fossil Fuels,” authored by the founder of the for-profit Center for Industrial Progress Alex Epstein. He argued that without the benefits of fossil fuels, mankind would revert to pre-industrial conditions.

6. The fossil fuel industry receives significant subsidies and favorable legislation from the federal government and many states. A report by [Oil Change International](#) pegged the figure at \$452 billion in subsidies per year for the last two years. While renewables certainly receive subsidies of their own, the amounts are only one quarter of that given to the fossil fuel industry, according to the report. In terms of legislation, it is true that many states have targets for renewables, and the federal government seeks to limit carbon emissions and mandate conservation. However, other laws arguably promote fossil fuel development. For example, under what is often called the “Halliburton Loophole”, the Federal Energy Policy Act of 2005 [exempts gas drilling and extraction from EPA oversight](#) under the Safe Drinking Water Act of 1974, though use of diesel fuel in the mix does trigger federal oversight. Similarly, [a provision of the Clean Water Act](#) allows fill material from mountaintop mining to be placed in adjoining valleys, thereby burying miles of streams in Appalachia and facilitating coal extraction there. Legislative support for fossil fuels can also come indirectly in the form of [policies that reportedly undermine renewables, especially at the state level](#).

7. Developing countries want to industrialize and live as we do. While some countries, e.g. Sweden, Denmark and the Netherlands, have dramatically expanded their use of renewables, most still burn fossil fuels. Many opponents to Marcellus shale development claim that Pennsylvania gas will be exported, to the detriment of American industry and the locals who must put up with the risk. If true, then the importing countries will certainly burn it.

8. Energy production is often hidden in complex societies such as ours. Most of us do not have to think much about where our energy comes from. We flip the switch and the light turns on. Where it comes from and how it gets to us is black-boxed. This is not the case in “developing” countries where energy production is more localized. Nor is it the case in the “sacrifice zones” of the United States where extractive industries conduct their business and process these raw materials. The environmental and social costs of these processes are unevenly distributed and altering our energy system means changing deeply rooted social and infrastructural dynamics.

9. Local opposition to the deployment of alternative energy remains strong. Many groups have arisen to protest [wind, solar](#) and other renewable projects. These NIMBY activists might represent the most significant hurdle to efforts to de-carbonize our energy supply because they can pit local concerns against broader environmental benefits.

10. Change is hard and will likely be costly. An array of cognitive biases, common ways of thinking that push us away from logical choices, complicates our ability to change systems as complex as our energy system. Preferences for the status quo and misguided beliefs about sunk costs stand in the way of rational decision-making. Much time and financial resources have gone into building our current energy infrastructure. Abandoning that investment seems foolish, and the [costs associated with developing a carbon-free system appear prohibitive](#) – at least for the short term. While it is true that the existing system can’t be instantly replaced, it is also likely that its continued operation and maintenance is more costly than other alternatives if longer-term costs are included.

So vexing problems remain. But humans can overcome problems. Certainly, improved technology and lower prices should allow alternative energy sources like wind and solar to become more cost competitive with fossil fuels. And people must be more willing to accept their presence. Increased use of geothermal energy can reduce costs in the long term, depending on location. Improvements in [carbon capture and sequestration](#) could be an important part of the picture. We should take another look at nuclear energy, perhaps using [thorium instead of uranium](#) or new reactor types, such as those based on [molten salt technology](#). Harnessing the potential of fusion would be a real game changer. Emerging technologies, including smart metering, microgrids, and LED lighting, may help us be more energy-efficient, without painful conservation measures. Innovations in energy storage can allow us to take advantage of periods in which energy supply exceeds demand. We can make more use of the tides and ocean currents – ideally with minimal effect to ocean life. And new systems of transportation can help us reduce reliance on 2-ton vehicles – especially where mass transit is not a convenient option.

We have a minds-on opportunity for current and future generations – and energy education is a key. Part of that education should focus on helping students understand the mathematics associated with energy production and consumption, and provide them with tools to understand costs and benefits of various alternative strategies (e.g., 1000 1.5 mW windmills would be needed to replace a single 1500 mW natural gas plant). But focusing educational efforts on the next generation requires time that we may not have. So, attention to the education of business leaders and policy makers is paramount. The ten challenges identified here can give focus to those educational efforts, and themes that cut across many of these issues deserve special attention.

Solutions will come by working together, and continuing to support research and practices to lead to the energy transformation that must be put in place before mid-century. We must enhance our efforts to diversify our energy platform and increase energy efficiency. Those convinced that climate change and sustainability represent real problems see the switch as essential for those reasons alone. But for others, diversifying our energy mix and enhancing conservation will have economic and societal benefits for our generation – and those into the future.

Reducing our discussions of our energy future into a liberal vs. conservative debate is not productive, and those who insist upon doing so condemn us to gridlock. All Americans and citizens of other countries need short-term and long-term solutions that will help us achieve a secure future in terms of energy, economy, and our environment. The future of humanity depends on it.