



## The Future of Clean Energy Innovation in a Changing U.S. Policy Environment

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A diversified energy portfolio that includes alternative and renewable energy sources like wind or solar power offers several benefits, including energy security, a better environment, and reduced vulnerability to supply shocks affecting any one source. Recognizing the need for new energy sources, a coalition of governments – including the United States – agreed at the 2015 Paris climate talks to double funding for renewable energy research and development to reach \$20 billion over the next five years. In a changing political climate where such funding may be cut, what are the most important lessons policymakers should keep in mind to promote clean energy innovation? How might changes in energy policy at the federal level under the Donald Trump administration affect clean energy innovation?

### A Tale of Two Market Failures

Understanding how policy influences the development of clean energy technologies involves the study of what economists call “market failures.” As a result, market forces alone will not optimally allocate resources, justifying government intervention. Two market failures are particularly relevant to energy and environmental technology:

- **Environmental externalities.** Because the market does not put a price on pollution, firms and consumers have little incentive to reduce pollution without policy interventions. The market for technologies that reduce emissions will be limited unless public policies alter economic incentives – as, for example, when carbon taxes or a cap-and-trade system are used to make market actors pay for harmful environmental externalities.
- **Knowledge spillovers.** At the same time, the “public good” nature of knowledge creates spillovers that benefit the public as a whole, but not the innovator. Because they do not reap the reports of these spillovers, potentially innovative private firms and individuals perform less research activity than would otherwise be desirable. Science policy to support research performed in both the private and the public sectors helps bridge this gap. Examples include direct government funding of research projects and indirect support such as tax credits for private-sector research and development.

A large body of evidence shows that directly addressing environmental externalities is most important for promoting clean technology innovation. Science policy plays a supporting role, but environmental policies are the main driver of clean energy innovation. Unless policies reflect the cost of damages caused by pollution, dirty energy sources will be disproportionately profitable. As long as that remains true, clean technologies will not spread through the marketplace, leaving investors little incentive to develop them.

### Which Policies?

Understanding how different policies affect incentives is important. Although economists often favor broad-based policies such as a carbon tax or tradable emissions permits to reduce the price gap between low- and high-carbon sources of energy, politicians often choose more narrowly focused options. Popular policies include feed-in tariffs, in which governments guarantee a fixed price above market prices for energy from renewable sources, and renewable portfolio standards that require a minimum percentage of electricity to be generated using renewable sources.

The impact of such narrowly focused policies varies, depending on whether or not the policy lets market forces decide which technologies can be used to meet policy goals.

- Broad-based policies such as renewable portfolio standards or a carbon tax favor the development of wind energy. Of the various green technologies, wind is “closest to market” because it has the lowest cost and is very nearly competitive with traditional energy sources. It is thus the cheapest way to comply with a broad policy target.
- In contrast, direct investment incentives have effectively supported innovation in solar energy. Solar is less competitive with traditional energy sources than wind, and in most cases is not profitable without guaranteed revenue from a feed-in tariff or other subsidies.

State governments have taken a leading role promoting clean energy. Cap-and-trade policies in California and the Northeast cover a substantial part of the population, and 29 states use renewable portfolio standards to promote clean energy. Note that all of these policies favor wind energy. In Texas, TXU Energy offers its customers a pricing plan with free electricity at night due to the abundance of wind at that time. Consumers will not easily give up on such options, even if national political directions change. Even if the new Trump administration rolls back the Obama administration’s Clean Power Plan, incentives for wind energy are here to stay.

## Future Challenges

Despite this optimism, the changing political climate does present challenges for renewable energy innovation. Support for technologies further from the market, such as solar energy, is likely to fall. Government research funding is needed to further develop these technologies not yet close to market, as well as to support complementary projects such as a smart grid and clean energy storage. The federal government is in a better position to fund energy research and development spending, both because it is better able to diversify risk and because federal research spending also avoids potential duplication of research programs across multiple states. Yet, cuts in renewable energy research at the federal level seem likely.

It is also important to consider how policy uncertainty affects investment in new energy technologies. These investments require a planning timeline of 30 years or more. Investors need policy done by legislation, not executive order. Simply rolling back the Clean Power Plan without a replacement will not bring on a surge in construction of coal-fired power plants. Utilities need to know what policies will remain in place in the next administration and beyond. That there will be no climate policy is not a credible long-term policy strategy. Any administration wishing to have a long-term impact on the energy sector must be prepared to offer new legislative action locking in policy for the next decade and beyond.

**Read more in David Popp, “Economic Analysis of Scientific Publications and Implications for Energy Research and Development,” *Nature Energy* 1, no. 4 (2016): 1-8.**