# California leads on sustainability innovation while Trump digs coal

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Last week, the California legislature voted to move to completely decarbonize its electric grid by 2045. As Ivan Penn observed in the *New York Times*:

"The state's aggressiveness comes as the Trump administration is moving to loosen or abandon environmental regulations and promoting a revival

of the coal industry. And it follows a year in which catastrophic wildfires that many attribute to climate change have been responsible for dozens of deaths in the state, destroyed homes and businesses and cost billions of dollars…California joins Hawaii, which passed legislation in 2015 calling for 100 percent carbon-free electricity by 2045. Massachusetts, New Jersey, New York and Washington, D.C., are also considering such a mandate…"

California has led the nation and indeed the world on environmental policy for over a half a century. The urgency of the climate crisis is driving this policy initiative. While most of California's greenhouse gasses come from motor vehicles, decarbonizing the grid makes electricity a renewable resource. This, in turn, means that the transition from the internal combustion engine to the electric vehicle becomes an even more important goal for the state. While there have been proposals to ban the internal combustion engine in California by 2040, it is not clear that an outright ban will be needed. If electric vehicles are better and cheaper than those powered by the internal combustion engine, market forces will drive fossil fuel powered vehicles into the junkyard. A ban might accelerate the process, and France, Germany, and Norway have already enacted long-term bans of fossil fuel powered vehicles. In this country, the combination of carbon-free electricity and electric vehicles that will be the signature accomplishment of California's path-breaking climate policy.

These two measures will require new technologies and represent a stretch goal for the state, but if accomplished will not only make California a climate leader, but a less polluted and more cost-effective leader of the world's economy. Fossil fuel free energy will ultimately be less expensive than the current energy system, and electric vehicles will be less expensive to run and maintain than those powered by the internal combustion engine. This will help the state's ability to compete in the global economy. Once the technology has arrived and the new vehicles

have proven themselves, the tax system could be used to accelerate the demise of the internal combustion engine. People could be rewarded for retiring the old vehicles and replacing them with new electric vehicles.

Europe and California are moving forward and their markets are large enough to motivate automakers to continue to invest in electric vehicles. The wildcard in this game is the backward facing policy of the Trump Administration to promote the extraction and burning of fossil fuels. At a recent Trump rally, the posters in the background proudly proclaimed that "Trump Digs Coal". The fossil fuel industry, like the tobacco and gun industries, has a well-deserved reputation for aggressive and effective influence campaigns. The most regressive parts of the fossil fuel business have effectively taken over energy and environmental regulatory policy in both the Environmental Protection Agency and in the Department of Energy. This will not help accelerate the transition to renewable energy, but it is unlikely to prevent it.

Economic growth over the past several centuries has been driven by technological innovation and then the diffusion or adoption of new technologies throughout society. Typically, we see a gradual process where new technologies disrupt and displace existing technologies. Let's take the example of home entertainment: For sound and video, we have moved from records and videotapes to CDs and DVDs and from physical media to streaming media. While people still use DVDs and CDs, tape cassettes and videotapes are gone. It's true that some musicians like Neil Young prefer the sound quality of vinyl records, but that technology has largely disappeared. There are thousands of examples of less visible technological changes throughout the economy, and even the motor vehicle is not exempt from these forces. Today's motor vehicle includes many technologies that did not exist twenty-five years ago.

Governments that hope to encourage long-term economic prosperity

need to understand this process of technological change and both embrace it and encourage it. The current U.S. President and his team have demonstrated no understanding of how these forces operate or how important they are to our economic well-being. The Trump Administration has attacked rather than supported America's scientific research community. Efforts to cut funding, discourage immigration and diminish the quality of the President's science advice have impaired the morale of America's research community. The issue for the American economy is: How dependent is our technological development on the federal government? Traditionally, our defense budget and research support from the National Science Foundation and National Institutes of Health along with other federal agencies has helped support America's research universities. These independent research institutions and America's environment of freedom of inquiry and free speech have created a culture that reinforces and supports technological innovation. In addition to research universities, the federal government also supports a number of high-quality National Laboratories. Up until now, Congress has prevented the White House from cutting research funding, although the anti-science, anti-education and anti-immigration bias of the President remains a threat.

While America's national government looks to the past and seems unaware of our dependence on science and technology, there are some forces in the world moving in the other direction. China, for example, is building its universities, and the quality of the global research community on every continent continues to improve. America's growing defense budget could result in additional spending for whatever basic science and technology can be justified by military needs. The military has long been a source of science funding and many of the technologies we now rely on were developed by the military (the internet, GPS, semiconductors, etc.). Our military bases need to be engineered to adapt to climate change, and it is easy to see the military usefulness of electric vehicles. Even if the ideology of Washington rejects climate science, our

military is compelled to deal with the real climate challenged world.

Finally, we don't know the long-term impact of states like California that set stretch goals for transitioning from fossil fuels to renewables. While no states are as aggressive as California, many states have set greenhouse gas reduction goals. According to the Center for Climate and Energy Solutions:

"For years, U.S. states and regions have been addressing climate change in the absence of stronger federal action. A wide range of policies have been adopted at the state and regional levels to reduce greenhouse gas emissions, develop clean energy resources, promote alternative fuel vehicles, and promote more energy-efficient buildings and appliances, among other things… Twenty states plus the District of Columbia have adopted specific greenhouse gas emissions targets."

These goals create a market and motivation for new renewable energy technologies. A large group of America cities, corporations, and nonprofits have embraced sustainability goals and are moving to reduce their use of fossil fuels, implement water and energy efficiency measures, and reduce or recycle their waste stream.

While we are not certain that the technology we need for a sustainable economy will be developed in time, the probability is high. Over the past decade, we have already seen impressive improvements in battery, solar cell, and wind technologies. Computer controlled energy systems are gradually being put in place. The price of renewable energy is now generally competitive with fossil fuels, and the long-term costs are trending down. The image of California's Governors Brown and Schwarzenegger smiling and happily joining together to promote a clean California, contrasts with the angry and sullen image of President Trump shouting at one of his "made for TV" rallies hoping to resurrect an industry whose time has passed.