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Vulnerability to decarbonization in hydrocarbon-intensive counties in the United States: A just transition to avoid post-industrial decay

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ABSTRACT

Over the next several decades, the world will undergo an energy transition as it shifts away from coal and oil to less carbon intensive energy sources. This process will create economic winners and losers, but these winners and loser will not be limited to corporations and their investors. Instead, communities that have developed around coal, oil, and gas extraction and processing will be negatively impacted if this energy transition occurs. Here, we provide first-order estimates of the socioeconomic vulnerability to decarbonization among U.S. counties. There are a small number of U.S. counties that appear to be highly vulnerable to decarbonization, and this suggests that policymakers could take a spatially-targeted approach to mitigating the socioeconomic impacts, similar to the approach of the Appalachian Regional Commission. Such a targeted approach may allow for a Just Transition to a low carbon economy.

1. Introduction

As of 2017, the decarbonization of the world's economy may have begun. The growth rate of the production of coal became negative in 2014 and has since trended downward. In 2016, world coal production decreased by 6%, the largest annual decrease for any fossil fuel since at least 1982 Fig. 1), and total hydrocarbon production decreased by 1.6% in 2016 on an Mtoe basis. The fact that this decline occurred after several years of global economic growth suggests that a significant technological shift in the way economies produce electricity may be underway.[1]

Because of the scale of the energy industry, it has often been assumed that the decarbonization of the energy sector will be slow [1]. However, Fig. 2 shows a potential future in which the growth of coal, oil, natural gas and renewables (solar and wind combined) follow their five-year 2012–2016 average growth rates over the 2017–2030 period. Between 2012 and 2016, renewables grew at an average rate of 20.9% per year, oil and gas increased at rates of 1.8 and 1.6%, respectively, and coal use declined by an average of 1.2% per year. Extending these rates through the 2020's, renewables would overtake natural gas and coal late in the decade and would overtake oil shortly thereafter. While the model depicted in Fig. 2 is not meant to be a prediction of the future, it is meant to illustrate the rate of changes occurring in the energy industry and suggests that if the energy industry follows its current trajectory, local economies that depend on hydrocarbon-related employment may change dramatically in coming decades (see also [2]).

The potential future depicted in Fig. 2 assumes a modest increase in the demand for petroleum in the coming decade, however, there are technological reasons to be cautious of predictions of sustained growth in the petroleum market. In 2017, GM and Tesla both released vehicles with ranges over 200 miles that sell for under $40,000, and they are expected to be followed by a Nissan Leaf and Hyundai Kona with similar ranges and prices in 2018. In 2019, most of the major European automakers including Volvo, Volkswagen, Porsche, BMW, Audi, and Mercedes Benz plan to offer electric vehicles with 200–300 mile ranges. Toyota and BMW both claim to be nearing commercialization of solid state batteries which may be in vehicles by 2021 or 2022 and would offer significant improvements in charging speed and energy density [3]. Investment analysis from UBS suggests that electric vehicles will reach price parity in Europe by 2018 with a true price parity (including OEM profit margins) in China, the world's largest market, in 2026 [4].

As technology has matured, policymakers have announced ambitious plans to phase-out gasoline powered vehicles. Norway plans to eliminate sales of combustion-driven cars by 2025, India has committed to eliminating the sale of gasoline cars by 2030, the UK and France plan to phase out gasoline and diesel vehicles by 2040, and a number of European cities are planning on banning diesel vehicles after 2025. In China, the government has launched a series of short term targets that

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[1] Of course, it is also possible that decarbonization is neither underway, nor imminent. This paper assumes that most nations take increasingly aggressive steps to reduce their fossil fuel use over the next several decades in line with stated commitments associated with the Paris treaty. Obviously, if decarbonization does not occur, then the socioeconomic impacts of decarbonization will not follow and the analysis presented here is moot.

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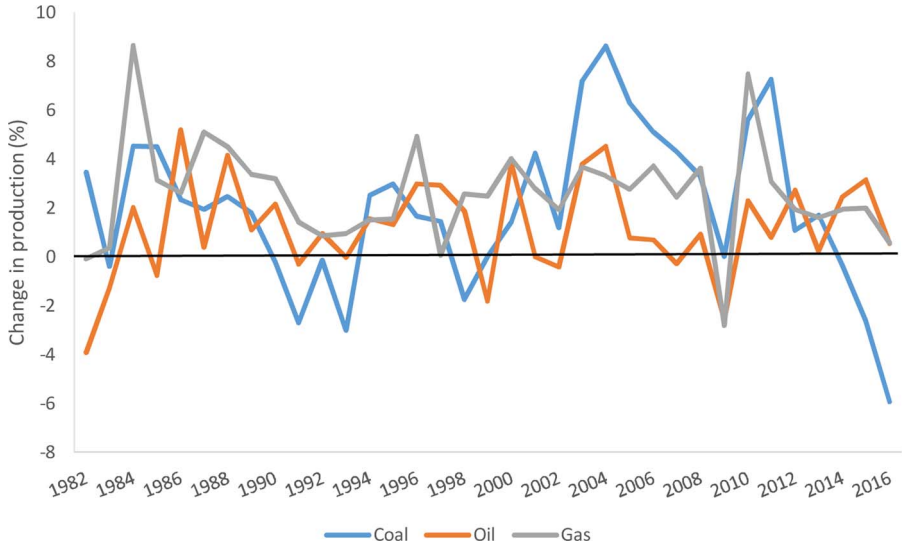

Fig. 1. Change in oil, gas, and coal production over time. Data from BP review of World Energy Markets.

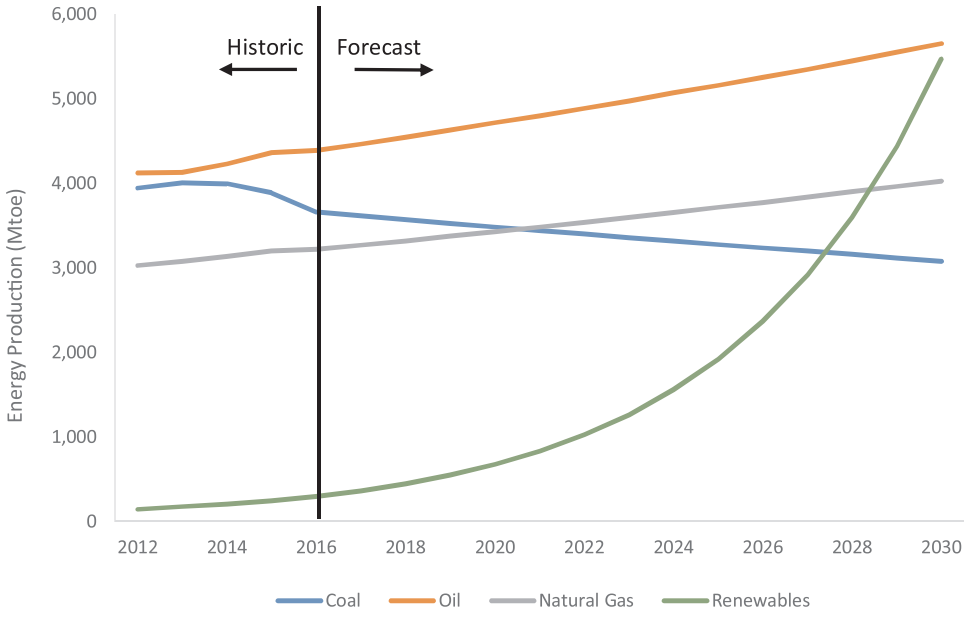

Fig. 2. A potential future in which coal, oil, gas, and renewable energy production follow their 2012–2016 average over the 2017–2030 period.

require electric vehicles to account for as much as 12% of sales by 2020 and reports have emerged that China is planning on banning the sale of gasoline and diesel powered cars, although a timetable has not been announced. In sum, by 2040 at least 40% of the current (2016) car market will be required to be composed of electric vehicles by government regulation (assuming all countries follow through and China eliminates sales of diesel and gasoline cars at or before 2040).

As a result of these investments, the International Energy Agency (IEA) projects that up to 20 million EVs will be on the road by 2020, and up to 70 million by 2025 [5]. By 2030, the multi-governmental Electric Vehicle Initiative (EVI) anticipates that electric vehicles will account for 30% of the market; while this may have seemed overly optimistic when the EVI was established in 2009, it now seems plausible due to rapidly improving battery costs, energy density, and economies of scale [6]. While the timing of transition to electric vehicles remains uncertain, the eventual transition away from petroleum-based fuels in the transportation sector is becoming increasingly certain.

In the U.S., declines in coal use are even more dramatic. From 2008 to 2016, coal production decreased by 38% and consumption by the electric power industry declined by 35%. The decline in U.S. coal use has been coupled with an increase in U.S. natural gas extraction as the power sector shifts from coal to natural gas. While coal production has decreased by 38% since 2008, natural gas production increased by approximately 38% from 2006 to 2016 as hydraulic fracturing opened new reserves to exploitation. Yet, over the same period, wind power generation increased over seven fold, and in four of the last eight years at least half of the new electrical generating capacity came from solar and wind [7]. Increases in U.S. oil production have also been dramatic due to hydraulic fracturing, yet U.S. oil consumption has decreased slightly from 20.6 million barrels per day in 2007 to 19.7 million barrels per day in 2016, even as the U.S. economy grew by 28% and the population by 7%. In sum, while it may be premature to argue that the U.S. economy is truly decarbonizing due to the growth of shale oil and gas, it seems likely that a major energy transition is already underway.

While a transition away from coal use in electrical generation and petroleum use in transportation may be good news for policymakers interested in limiting global climate change to less than 2 °C, an