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Coal Transition in the UNITED STATES

*An historical case study for the project "Coal Transitions:
Research and Dialogue on the Future of Coal"*

2017



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*This is one of the 6 country case-studies commissioned to collect experience on past coal transitions.
The 6 countries are: Czech Republic, the Netherlands, Poland, Spain, UK, USA. Their role in the Coal Transitions
project was to provide background information for a Synthesis Report for decision makers, and provide general
lessons for national project teams to take into account in developing their coal transitions pathways for the future.*

A project funded by the KR Foundation

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Cite this report as

Irem Kok (2017), Coal Transition in the United States, IDDRI and Climate Strategies.

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Publishers: IDDRI and Climate Strategies

Editors: Pierre Barthélemy, Andrzej Błachowicz, Germana Canzi, Alexandra Carr, Oliver Sartor, Thomas Spencer

Graphic design: Ivan Pharabod

Introduction

Over the past decade, the US started to cut down the production and the use of coal, which was affected by unfavorable market dynamics and changing federal regulatory environment. Even before the shale gas revolution and uptake of renewables diminish the use of coal in power generation, coal communities were struggling to meet ends. The regional cost differences between producing states, such as the Appalachian and the Powder River Basins, indicates that coal-impacted communities and workers have lived through the impacts of coal transition at varying magnitudes and time periods.

In the period between 2014 and 2016, we have seen the crash of major US coal companies due to declining demand for US coal domestically and internationally. Furthermore, Obama administration's climate change policies negatively impacted coal-fired power plants with additional GHG emission requirements, contributing to declining domestic demand for coal. Combined with market downturn, US coal producers already struggle to

pay for high operational costs and legal liabilities under bankruptcy conditions. With underfunded state budgets, coal states are also grappling with financial exposure resulting from pension, healthcare and reclamation liabilities of bankrupt coal companies.

In 2016, former President Obama announced the Power Plus Plan to aid coal-impacted communities and workers to prepare for a low carbon future. The federal budget plan targeted diversification of local economies, funding of health and pension funds of miners and retraining for employment in alternative industries. Under Trump administration, potential regulatory relief might ease the pressure on the coal industry.¹ Still, President Trump's campaign pledge to revive the coal industry will require more than rolling back the environmental regulations and providing tax concessions to the coal companies. The question remains whether the impacts of coal transition will be managed by additional federal funds under the Trump administration.

The decline of the coal industry

The US coal production peaked in 2008 at 1172 million short tons. Between 2008 and 2015, total coal production declined sharply to 897 million short tons, a decline of 23% (see **Figure 1**). In this period, surface coal production declined by 28% whereas underground coal production by 14%. Simultaneously, natural gas production dramatically increased by 51%.²

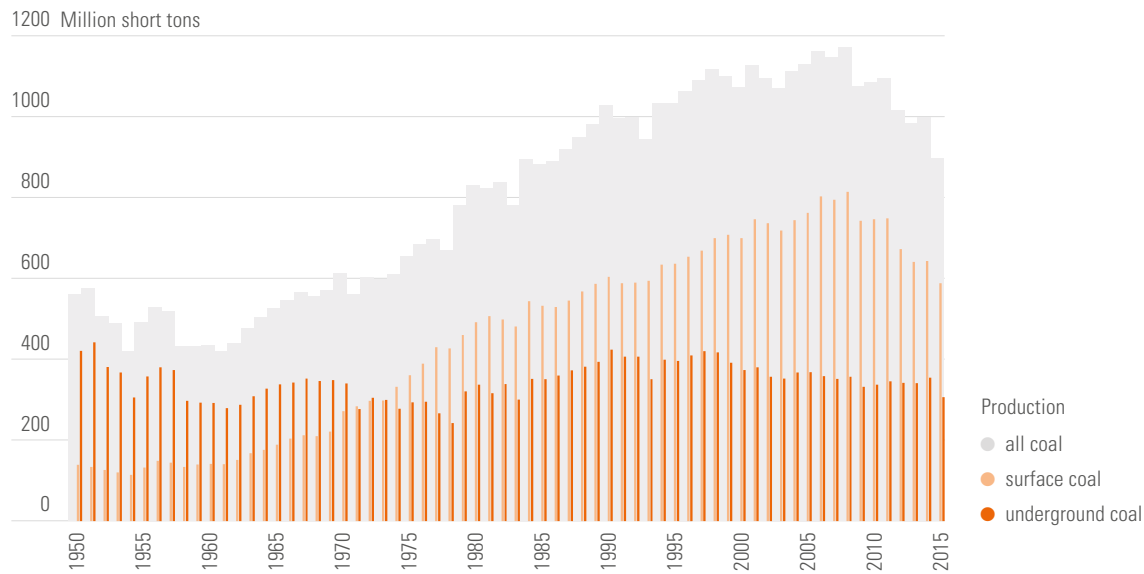
The decline of coal production can be explained by changing market dynamics and federal regulatory environment. Historically, key factors underlying the trans-

formation of US coal industry include: i) growing mechanization of coal mining; ii) the Clean Air Act of 1990 that adversely impacted the demand for Appalachian coal in favor of low-sulfur Western coal; iii) the shale gas revolution resulting in dramatic fall in natural gas

¹ IEFFA. 2017. Elections have consequences, but perhaps few that can save coal. February 09. <http://ieefa.org/ieefa-update-elections-consequences-perhaps-can-save-coal/>

² Culver, Walter and Mingguo Hong. 2016. Coal's decline: driven by policy or technology? *The Electricity Journal* 29(7): 50-61.

Figure 1. US Coal Production



Source: U.S. Energy Information Administration (EIA), 2016.

prices; iv) increasing competitiveness of renewables; v) competition from foreign coal imports and global oversupply of coal; vi) diminishing global coal consumption; vii) falling international coal prices.³

While the decline of the US coal industry is attributed to complex market dynamics, there are significant regional differences among coal producing regions, in particular between the Appalachia Basin and the Powder River Basin. Long before the shale gas revolution, Appalachian communities were experiencing the uneven regional impacts of decline in underground mining production and changing federal environmental regulations. Historically, the decline of Appalachia's coal industry already started with increased mechanization of coal mining in 1970s, when coal production shifted from underground mining to surface mining.⁴ Heavily mechanized surface mining in Montana and Wyoming yield 10 times more coal per worker than underground mines in Appalachian basin, resulting in increased coal production in Western basins.⁵

The Clean Air Act of 1990⁶, which limited SO₂ and NO_x gas emissions from power plants, further shifted coal production from Appalachia to the Powder River Basin. The cost of installing smokestack scrubbers ranged between 0.01 to 0.03 USD/MMBtu for coal power plants using sulfur-laden coal from Appalachian Basin, whereas the cost compliance for Powder River basin was half the cost of it.⁷ Combined with cheaper railroad trans-

portation to eastern markets, easy to extract surface coal, and expensive scrubbers to reduce sulfur dioxide under EPA rules, the cheaper and low sulfur coal from the Powder River Basin boomed.⁸ Between 1990 and 2008, coal production from Appalachia fell by 37% and Western regions increased by 20%.⁹

Most importantly, competition from shale gas led to further decline in domestic coal demand. Innovations in shale drilling technologies made shale gas production economically viable, unlocking unprecedented rush for shale gas production. In the period between 2008 and

³ Betz, Michael, Mark Partridge, Michael Farren and Linda Lobao. 2015. Coal mining, economic development, and the natural resources curse. *Energy Economics* 50: 105-116.

⁴ Cassidy, Alison. 2014. Complex market forces are challenging Appalachian coal mining. *American Progress*, October 06. <https://www.americanprogress.org/issues/green/reports/2014/10/06/98371/complex-market-forces-are-challenging-appalachian-coal-mining/>

⁵ Renner, Michael. 2016. Can coal miners become solar technicians? *GreenBiz*, December 01. <https://www.greenbiz.com/article/can-coal-miners-become-solar-technicians>

⁶ The Clean Air Act Amendment of 1990. <https://www.epa.gov/clean-air-act-overview/1990-clean-air-act-amendment-summary>

⁷ Culver and Hong, 2016.

⁸ Loh, Tim. 2016. Bust hits America's cowboy coal basin after 40 years of boom. *Bloomberg*, September 21. https://www.bloomberg.com/news/features/2016-09-20/bust-hits-america-s-cowboy-coal-basin-after-40-years-of-boom?utm_content=buffer7773&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer

⁹ Betz et al, 2015.

2015, US shale gas production increased by a factor of 6.2.¹⁰ A recent study by Culver and Hong (2016) shows that low gas prices easily outcompeted coal from the Appalachian, the Illinois Basin and the Rockies, and posed a serious threat to coal produced from the Powder River Basin between 2008 and 2015. In the period between 2012 and 2016, Henry Hub gas prices ranged between \$2.75/MMBtu and \$4.25/MMBtu, outcompeting the breakeven coal prices in these coal producing regions.¹¹ Furthermore, competition from foreign coal imports, diminishing global coal demand and falling international coal prices added upon the financial burden of US coal companies. For instance, cheaper and low sulfur Colombian coal at the price of 75 to 82 USD per ton was more desirable than Appalachian coal at the price of 79 to 86 USD per ton for Eastern US power plants.¹² In 2015, coal from Colombia accounted for 79% of total US coal imports in 2015.¹³

US coal imports peaked in 2007 at 36.3 million short tons and fell by 69% between 2007 and 2015 (See **Figure 2**). Whereas, US coal exports rose to record high of 125.7 million short tons in 2012, followed by a sharp decline to 74 million short tons in 2015, more than 41% decline in 3 years' time. As a net exporter of coal, the US coal producers suffered from decreasing global world coal demand, low international coal prices and rising coal output from competing coal-exporting

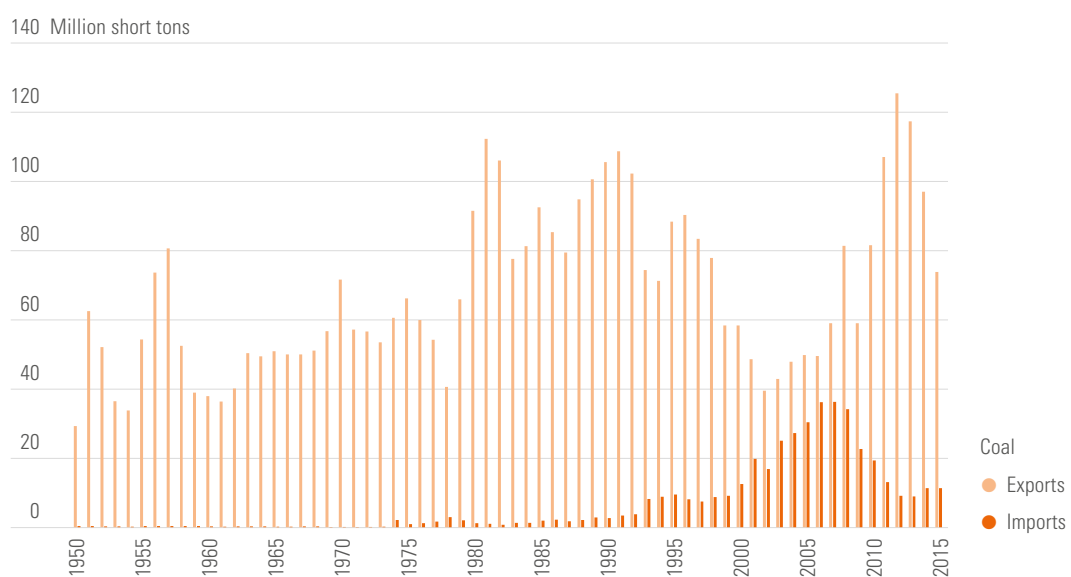
countries, such as Australia, Indonesia, Columbia and Russia.¹⁴

The dramatic decrease in US exports can be explained by the global peaking of coal consumption in 2013 and record low international coal prices (60% drop since 2011). Combined with stricter federal regulations and shale gas boom, these dramatic shifts in global energy markets sparked a new discussion on stranding of the US coal assets.¹⁵

Yet, coal producers continued to increase their capex in the expectation of a market upturn, and were ill-prepared to mitigate the structural challenges stemming from new technological developments, policy risks and market dynamics. As Carbon Tracker Initiative (CTI) put it, US coal producers perceived these challenges to be

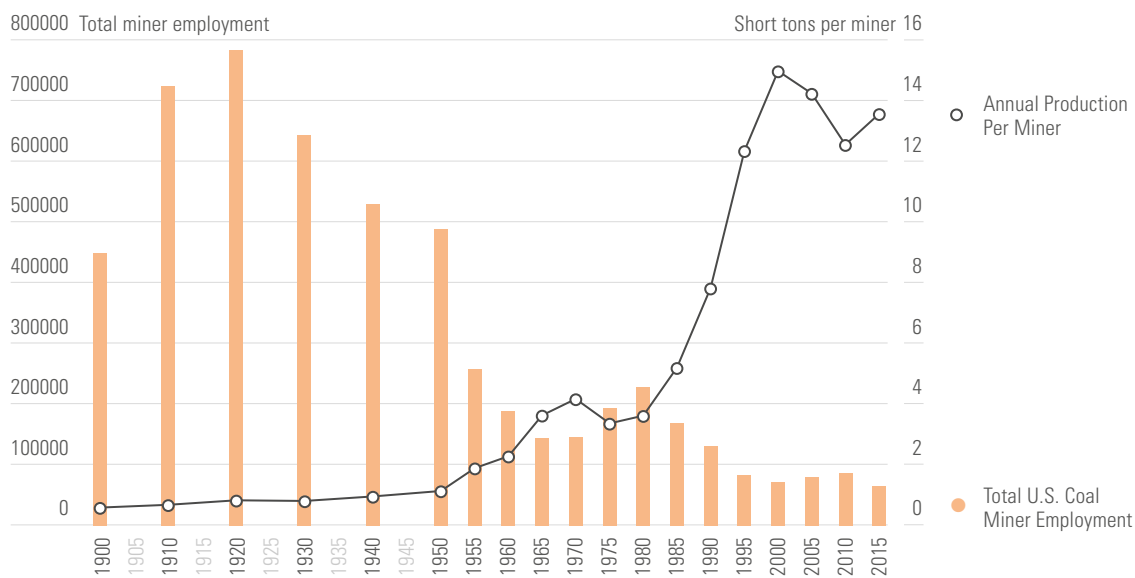
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- ¹⁰ US Energy Information Agency (EIA). 2016. Shale gas production. https://www.eia.gov/dnav/ng/ng_prod_shalegas_s1_a.htm
 - ¹¹ Culver and Hong, 2016.
 - ¹² Cassidy, 2016.
 - ¹³ US EIA. 2016. From what country does the United States import the most coal. December 07. <https://www.eia.gov/coal/data.php#imports>
 - ¹⁴ US EIA. 2016. U.S. coal exports declined 23% in 2015, as coal imports remained steady. March 07. <http://www.eia.gov/todayinenergy/detail.php?id=25252>
 - ¹⁵ Institute for Energy Economics and Financial Analysis (IEEFA). 2015. Past peak coal in China. November. http://ieefa.org/wp-content/uploads/2015/11/IEEFA_Peak-Coal_November-2015.pdf

Figure 2. US Coal Imports & Exports



Source: US EIA, 2016.

Figure 3. Historic us coal miner employment and annual production per miner



Source: US EIA, 2016.

transient or minor, expecting coal prices to restore in a cyclical fashion.¹⁶

Employment in the coal sector has declined by 71% in the last three decades, from 228,569 in 1980 to 65,971 in 2015. Historically, coal employment reached its peak in 1920 and continued to go downwards due to increasing mechanization that gradually replaced more labor.¹⁷ Between 1970 and 1980, the coal boom helped employment to rise by 74%.¹⁸ With the 1980s bust, employ-

ment declined 69% until 2000, and then increased 20% during 2000-2010 boom.

Even before the US coal production peaked in 2008, coal employment was in dire situation. Natural gas boom and increasing supply of solar and wind electricity put the coal sector under increasing pressure, leading to reduction in employment both at the mines and coal-fired power plants. Between 2010 and 2015, coal employment fell 23%.

Decline of coal in power generation

The recent decline of coal demand in the US is tied with decreasing share of coal in power generation. As seen in **Figure 4**, power stations have been the largest consumer for the US coal since the 1970s. Other historical uses of coal in residential, commercial, and transportation declined steadily. Apart from coal-fired power stations, the industrial sector continued to

consume some share of coal albeit at a diminishing rate from 1970 onwards.

From 1980 to 2008, the share of coal in electricity generation has dramatically increased by 83%. Majority of coal-fired power stations were built before 1980, followed by additional natural gas-fired units in 2000s and renewable units in late 2000s.¹⁹ Coal-

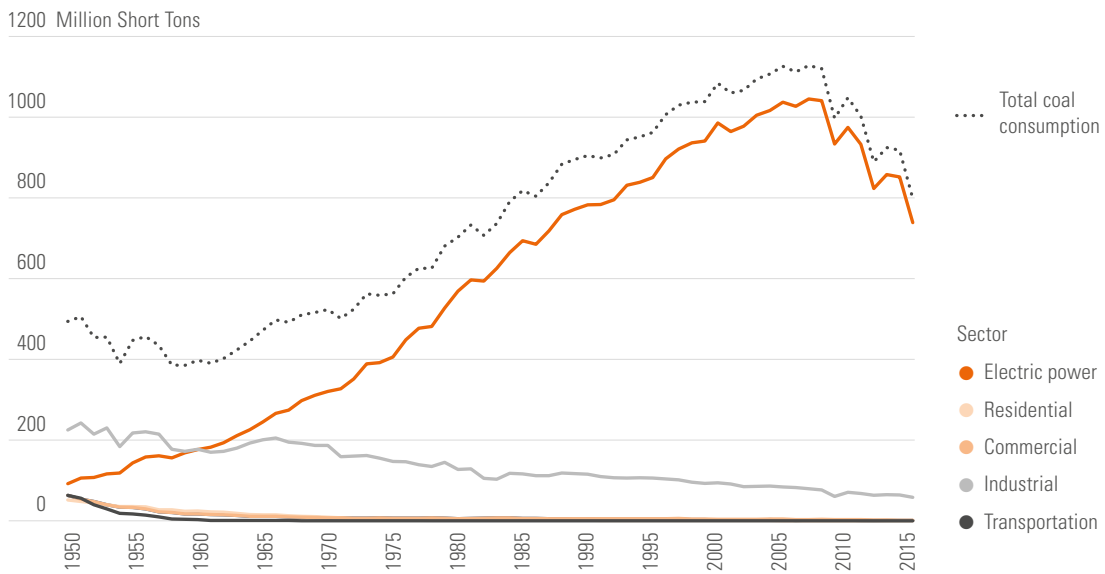
¹⁶ Carbon Tacker Initiative(CTI). 2015. The US Coal Crash: Evidence for Structural Change. May. <http://www.carbontracker.org/wp-content/uploads/2015/03/US-coal-designed-Web.pdf>

¹⁷ Dix, Keith. 1988. *What's a Coal Miner to Do? The Mechanization of Coal Mining*. Pittsburgh: University of Pittsburgh Press.

¹⁸ Black, Dan, Terra McKinnish and Seth Sanders. 2005. The economic impact of the coal boom and bust. *The Economic Journal* 115(503): 449-476.

¹⁹ US EIA. 2011. Age of electric power generators varies widely. June 16. <http://www.eia.gov/todayinenergy/detail.php?id=1830>

Figure 4. Historic US Coal Consumption by Sector



Source: US EIA, 2016.

fired power plants makes use of 93% of US coal to generate electricity domestically.²⁰

Recently, coal-fired units have been affected by federal environmental regulations and the shale gas revolution. The Obama administration's decarbonisation efforts set out under the Clean Power Plan (CPP) has put further limits on carbon dioxide and other greenhouse gases emissions from coal-fired power plants.²¹ Although the political discourse has focused on the impact of CPP on the decline of coal, there is little empirical evidence to suggest that stricter environmental regulations were the reason. The EPA's smokestack emissions dates back to 1990s, which has not been changed since then and was detached from coal consumption in electricity generation. The CCP introduced the first national limits on carbon pollution (33% CO₂ reduction goal by 2030) from the power sector.²²

The main outline of the CCP can be traced back to George W. Bush's election campaign pledge to regulate CO₂ and traditional air pollutants from power plants.²³ Although Bush administration did not fulfill its campaign promises, the Supreme Court ruling in 2007 followed by the EPA's decision in 2009 opened the possibility of regulating the GHG emissions under the Clean Air Act. On August 03, 2015, the CCP imposed more specific carbon-cutting performance goals for 47 states, which takes the GHG emissions released during electricity gen-

eration in 2012 as a baseline.²⁴ These performance goals were not limited to smokestacks, but also incentivized energy savings in residential homes and conversion of coal plants to natural gas.²⁵

The biggest decline of coal in power generation has happened after 2008 due to increasing competitiveness of alternative fuels in the utilities sector (See **Figure 4**). Between 2006 and 2015, total electricity generation from utilities has increased slightly by 0.3%. While the share of coal consumption in total electricity generation went down from 49% to 33%, the share of natural gas dramatically increased from 20% to 33% and renewables from 3% to 7%. This was the result of shale gas revolution, when large quantities of domestically produced natural gas increasingly forced the coal sector out of

²⁰ Culver and Hong, 2016.

²¹ Cama, Timothy. 2016. EPA chief: US must help coal country transition. *The Hill*, May 6, <http://thehill.com/policy/energy-environment/279056-epa-chief-us-must-help-coal-country-transition>

²² Environmental Defense Fund. 2015. A New National Clean Power Plan. <https://www.edf.org/climate/a-new-federal-clean-power-plan>

²³ Dlouhy, Jennifer and Andrew Harris. 2016. Obama's Clean Power Plan Heads to Court: What to Know. *Bloomberg*, September 23. <https://www.bloomberg.com/news/articles/2016-09-23/obamas-clean-power-plan-heads-to-court-what-to-know>

²⁴ US EPA. 2016. Clean Power Plan State-Specific Fact Sheets. <https://www.epa.gov/cleanpowerplanttoolbox/clean-power-plan-state-specific-fact-sheets>

²⁵ Dlouhy and Harris, 2016.

power generation. Lower capital costs and extension of renewables tax credits also made wind and solar competitive with coal prices and its share is expected to increase in total share of power generation.²⁶ For instance, power generation from solar energy dramatically increased from 508 to 24,893 thousand megawatt hours between 2006 and 2015.²⁷ Therefore, the increasing replacement of coal with natural gas and renewables in power generation can be explained by changing market dynamics rather than

regulatory restrictions on greenhouse gas emissions. One direct consequence of CPP is that building new coal power plants will become costlier than natural gas power stations and renewable plants. According to the US EIA, the impact of CPP will be more retirements of coal-fired plant capacity to comply with mass-based or rate-based reduction in CO₂ emissions.²⁸ Although natural gas emits less CO₂ than coal, it does not replace as much GHG emissions as the renewable plants does.

Measures to ease transition

Electricity Consumers

Between 1995 and 2002, the US electricity industry went through massive restructuring. The utility sector used to be regulated and vertically-integrated monopolies that controlled the entirety of operations from electricity generation to collection of bills.²⁹ The electricity restructuring allowed non-utility generators to sell electricity to utilities and end-use customers.

While the economic rationale behind electricity deregulation and market based structure was to improve efficiency and lower consumer prices, it led to discrepancies between market-based states and regulated states.³⁰ As put by Borenstein and Bushnell, the electricity restructuring resulted in rent-transfers and significant efficiency improvements, yet other exogenous market factors, such as falling natural gas prices and technological breakthroughs, explains the decline in electricity prices.³¹

Moreover, there has been a shift in consumption of energy patterns, enabled by increasing efficiency, decreasing

demand per capita and rapid expansion of renewables.³² Still, the burden of electricity costs falls disproportionately on the low income households, whose electricity expenditures has risen by 1/3. Over the last decade, the lowest 20% of income households spend 9.92% of their income on electricity, while the highest 20% spend 1.38% of their income on electricity consumption.³³

Over the last couple of years, US energy policy shifted away from coal in favor of alternative clean energies. Apart from subsidies and assistance programs for switching to renewable energy, these policies do not consider the cost of conversion and its impact on the utility bills of low income families.³⁴ Even though the cost of electricity from fossil fuels is cheaper than renewables³⁵, the new renewable portfolio standards creates additional barriers for low-income families to benefit from non-renewable resources, increasing their utility bills by 23%.³⁶

²⁶ Martin, Laura and Jeffrey Jones. 2016. Effects of the Clean Power Plan. June 20. http://www.eia.gov/outlooks/aeo/section_issues.cfm#cpp

²⁷ Martin and Jones, 2016.

²⁸ Martin and Jones, 2016.

²⁹ Borenstein, Severin and James, Bushnell. 2015, The US electricity industry after 20 Years of restructuring. National Bureau of Economic Research, Working Paper. April. <http://www.nber.org/papers/w21113>

³⁰ Borenstein and Bushnell, 2015.

³¹ Borenstein and Bushnell, 2015.

³² Spector, Julian. 2016. Where America's poor pay the most for electricity. *The Atlantic City Lab*, April 14. <http://www.citylab.com/housing/2016/04/electricity-bills-by-city-low-income-costs/478155/>

³³ Sabol, Patrick. 2016. From power to empowerment: plugging low income communities into the clean energy economy. http://groundswell.org/frompower_to_empowerment_wp.pdf

³⁴ Maxwell, Megan. 2015. Can low-income families afford alternative energy? Institute for Economic Inquiry, April 6. https://www.creighton.edu/fileadmin/user/EconomicInstitute/Research_Scholars/Alternative_Energy_White_Paper_-_4-6-15.pdf

³⁵ In 2015, the cost of electricity from solar PV was cheaper than coal, whereas electricity generation from other fossil fuel sources, i.e. nuclear, natural gas, was still lower than solar PV and solar thermal. See US EIA. 2017. Annual Energy Outlook. http://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf

³⁶ Maxwell, 2015.

Several energy bill assistance programs target low income families to lower their utility bills. At the federal level, the Low Income Home Energy Assistance Program (LIHEAP) (1981) and the Weatherization Assistance Program (WAP) (1976) offer financial assistance to low-income households to cover their home energy bills and increase energy efficiency. Despite less cumbersome structure and added benefits, the participation to these direct subsidy programs have been quite low – 5.5 million families received assistance from LIHEAP and 100,000 families per annum from WAP, due to poor community level engagement.³⁷

Other federal subsidy programs, such as the US Clean Energy Tax Credits for residential energy property and the Residential Energy Conservation Subsidy Exclusion, and state level programs like the California Energy Commission with fund solar systems and the New York Sun

Initiative provide tax benefits and low-interest loans for switching to alternative energy-efficient home improvements.³⁸ Despite the appeal of these subsidy programs, the cost of conversion is still high for low-income families.

Alternative clean energy programs target expanding solar market customer base with innovative community solar models, which rely on group purchasing, crowd financing and community investment and donations.³⁹ These programs could provide access to 49% of households and businesses who cannot afford to own rooftop solar systems, and lower electricity bills by power purchase agreements and alternative credit checking systems.⁴⁰ As most of low-income families are ineligible to take advantage of federal, state and local tax credit systems, these alternative financing mechanisms could foster large scale adoption of solar energy.⁴¹

Coal Workers and Communities

The decline of the US coal has already evoked a nationwide debate on compensation of coal workers and communities. Over the past couple of years, several federal, state and local level adjustment schemes are designed to offer compensation for coal workers and coal-impacted communities, funding new community projects that will help local economies to diversify and create new economic activities.

At the federal level, former President Obama's the Power Plus Plan (2016) proposed a comprehensive budget plan for coal communities to adapt to the changing energy landscape. The Power + Plan specifically addresses lost jobs in the coal sector and other legacy costs including: i) funds for economic diversification, job creation and employment in other sectors, and ii) investments in health and pension funds of mineworkers, and clean-up costs for abandoned mines.⁴² Under the Power + Plan, a multi-agency initiative called the Power Initiative⁴³ supervises the allocation of federal funds to aid coal-impacted communities and workers.⁴⁴ The initiative targets local projects that help job creation in alternative economic activities and workforce development programs for training coal workers in cleaner jobs, such as energy efficiency auditors, energy contractors and solar panel installation.⁴⁵

The Power Initiative works with the Appalachian Regional Commission (ARC) in administration of awards given

to the local projects. Examples of funded local projects include partnership with the Cool & Connected Initiative to expand technical support to 10 Appalachian coal communities located in Alabama, Ohio, Pennsylvania, Tennessee, Virginia and West Virginia, which will benefit from broadband services to revitalize small-towns by cultural and recreational amenities to attract investment

³⁷ Sabol, 2016.

³⁸ Maxwell, 2015.

³⁹ Feldman, David, Anna Brockway and Robert Margolis. 2015. Shared solar: current landscape, market potential, and the impact of federal securities regulation. National Renewable Energy Laboratory, April. <http://www.nrel.gov/docs/fy15osti/63892.pdf>

⁴⁰ Sabol, 2016.

⁴¹ Low Income Solar Policy Guide. March 11. http://www.lowincomesolar.org/wp-content/uploads/2016/03/Low-Income-Solar-Policy-Guide_3.11.16.pdf

⁴² The US White House. 2016. Investing in coal communities, workers and technology: the POWER + Plan. https://www.whitehouse.gov/sites/default/files/omb/budget/fy2016/assets/fact_sheets/investing-in-coal-communities-workers-and-technology-the-power-plan.pdf

⁴³ US Economic Development Administration (EDA). 2016. The partnerships for opportunity and workforce and economic revitalization (Power) initiative. <https://www.eda.gov/power/>

⁴⁴ US EDA. 2016. Obama administration announces \$65.8 million available for economic and workforce development in coal-impacted communities. March 17. <https://content.govdelivery.com/accounts/USEDABulletins/13d897c>

⁴⁵ Volcovici, Valerie. 2016. Obama administration sends \$28 million to aid coal regions. *Reuters*. October, 26. <http://www.reuters.com/article/us-usa-coal-idUSKCN12Q2MM>

and diversify local economies.⁴⁶ Other projects target drug abuse and health issues, strategic planning for small business activities, and training activities for new industry clusters such as tourism, construction, solar, manufacturing and health-care business.

The disappearance of jobs and health issues are interrelated in Appalachian coal communities. In areas such as Eastern Kentucky, high rates of obesity, smoking, drug abuse, hypertension, diabetes and heart disease affect life expectancy of these communities.⁴⁷ The longevity of life in coal counties in Eastern Kentucky is 6 years shorter than the national average, and combined with the quality of life measures, the state ranks among the bottom 10.⁴⁸ The poverty rates in these coal communities were already high in the glory days of coal industry. In Beattyville, Kentucky, the poverty rate is 44% is higher than the national average with more than half of households living below the poverty line.⁴⁹ Declining coal revenues and shrinking tax base adds upon to the growing demands on local governments in the coal country. Therefore, economic diversification is critical to generating new revenue streams to overcome societal and health issues, as well as to sustain livelihoods that are deeply affected by overreliance on the coal industry. As the notion of “just transition” has attained increasing attention among policy and political discourse, campaigners, civil society groups and governments become more cognizant of distributional impacts of low carbon transition on coal communities.⁵⁰ For instance, the Black Mesa Coalition works with Arizona’s Navajo tribe to create new economic opportunities, such as bringing the traditional wool to the markets, which would help the tribe to move away from coal.⁵¹ Similarly, the Impact Experience project works towards developing a regional economic transition strategy in Williamson, West Virginia by connecting the local leaders with the investors, entrepreneurs and universities.⁵² Sierra Club’s Beyond Coal Campaign collaborates with local partners in Appalachia to drive public and private investment in job creation related to clean energy, energy efficiency and infrastructure.⁵³

Other forward-looking low carbon adaptation plans include retraining coal industry workers for employment in solar photovoltaic industry. As the coal industry became less competitive in electricity generation, the uptake of solar PV has been remarkable and resulted in generation of twice as solar jobs as coal jobs.⁵⁴ A study by Pearce⁵⁵ shows that the growth of solar jobs could absorb coal-industry lay-offs and offer long-term employment in a low

carbon economy. The coal workers (including miners, power plant operators and administrative workers) could be retrained as manufacturing engineers, commercial solar technicians and mechanical assemblers, yet maintain the same work status and social status with a 10% salary increase.⁵⁶

For the young coal workers, the cost of retraining could be financed by state and federal governments, which could range from \$180 million to \$1.87 billion depending on the coal transition scenario.⁵⁷ Other support payments could be made for older laid-off coal miners, who could benefit from health and pension benefits until they retire.⁵⁸ Former president Obama’s 2017 budget allocated \$75 million, which includes retraining costs and investments in pension funds of laid-off workers in Appalachia.⁵⁹

As we have seen in the recent US presidential elections, the federal support programs for coal-impacted communities and laid-off coal workers became a hot debated

⁴⁶ The US White House. 2016. Fact sheet: administration announces new economic and workforce development resources for coal communities through POWER initiative. August 24. <https://www.whitehouse.gov/the-press-office/2016/08/24/fact-sheet-administration-announces-new-economic-and-workforce>

⁴⁷ Greenblatt, Alan. 2016. In life after coal, Appalachia attempts to reinvent itself. December. <http://www.governing.com/topics/finance/gov-coal-trump-appalachia-economy.html>

⁴⁸ Lowrey, Annie. 2014. What’s the matter with Eastern Kentucky? *The New York Times*, June 26. <https://www.nytimes.com/2014/06/29/magazine/whats-the-matter-with-eastern-kentucky.html>

⁴⁹ McGreal, Chris. 2015. America’s poorest white town: abandoned by coal, swallowed by drugs. *The Guardian*, November 12. <https://www.theguardian.com/us-news/2015/nov/12/beattyville-kentucky-and-americas-poorest-towns>

⁵⁰ Newell, Peter and Dustin Mulvaney. 2013. The political economy of the “just transition”. *The Geographical Journal* 179(2): 132-140.

⁵¹ Yeo, Sophie. 2017. Clean energy: the challenge of achieving a ‘just transition for workers’. Carbon Brief, January 04. <https://www.carbonbrief.org/clean-energy-the-challenge-of-achieving-a-just-transition-for-workers>

⁵² Impact Experience. 2016. The Williamson Learning Journey. <http://www.impact-experience.com/williamson/>

⁵³ Sierra Club. Fair and just transition from fossil fuels to clean energy. <http://www.sierraclub.org/labor/fair-and-just-transition-fossil-fuels-clean-energy>

⁵⁴ Korosec, Kristen. 2016. In the US, there are twice as many solar workers as coal miners. *Fortune*, January 16. <http://fortune.com/2015/01/16/solar-jobs-report-2014/>

⁵⁵ Louie, Edward and Pearce, Joshua. 2016. Retraining investment for U.S. transition from coal to solar photovoltaic employment. *Energy Economics* 57: 295-302.

⁵⁶ Louie and Pearce, 2016.

⁵⁷ Louie and Pearce, 2016.

⁵⁸ Renner, 2016.

⁵⁹ US White House. 2017. Investing in coal communities, workers and technology: The Power + Plan. https://www.whitehouse.gov/sites/default/files/omb/budget/fy2017/assets/fact_sheets/Investing%20in%20Coal%20Communities.pdf

issue in election politics.⁶⁰ Democratic presidential candidate Hilary Clinton's pledge to spend \$30 billion for boosting economic development by bringing clean and sustainable jobs to coal communities did not gain popular support.⁶¹ The election results shows that Republican president Donald Trump's promise to "bring the coal jobs back" resonated with the coal country. In an open letter to Trump, the coal workers asked for provision of relief aids to the coal communities and a new legislation to protect miners' health and retirement benefits.⁶² President Trump's coal strategy mainly includes rolling

back Obama's Clean Power Plan, lifting the moratorium on leasing deals for coal mining on federal lands and stripping other environmental regulations affecting the coal mining and coal-fired power plants.⁶³ Even though these measures might slow down the decline of coal, it will not suffice to revive the coal industry. The adverse global coal market dynamics, major US coal companies wrapped in bankruptcies and competition from natural gas and renewables for electricity generation will make it difficult for Trump administration to rescue coal-impacted communities and workers.⁶⁴

Corporations

Sustained low coal prices and demand resulted in major write-downs and bankruptcy filings among major US coal producers. Between 2015 and 2016, 25 publicly listed US coal producers, including majors like Peabody Energy, Arch Coal, Alpha Natural Resources, filed for bankruptcy.⁶⁵ The decline of US coal is further hastened by legacy and pension liabilities of these coal companies. These bankrupt coal producers and coal states are grappling with the challenge of funding these liabilities during restructuring of company debts.

To date, coal operators in the Powder River Basin (PRB) has enjoyed direct tax and coal lease subsidies despite the market downturn. A study by CTI and IEEFA shows that coal companies operating in PRB received a total of \$4.17 per tonne of annual production in tax breaks, which includes subsidies for self-bonding of rehabilitation costs, tax credits for investments in clean coal, taxpayer funding of black lung costs, income tax exclusions for payments to disabled coal miners, and coal leasing and royalty subsidies on federal lands.⁶⁶

As the burden of paying the environmental, employee and retiree obligations adds upon the costs of operations, coal producers resort to bankruptcy to remain in the business. The US bankruptcy code allows for reducing the costs of retirement and health benefits for the workers.⁶⁷ As the courts suspend some of bankrupt companies' obligation to pay retiree benefits, the coal union members seek federal funding to bail out underfunded worker's pension and health payments.⁶⁸

The reclamation obligations are also bigger part of cost of coal mining companies, whose financial situation cast a doubt on their ability to pay these costs. In Wyoming, Peabody's reclamation obligations are \$866 million.⁶⁹

Recently, Peabody struck a deal with state regulators in Wyoming on paying 17.5% of its established reclamation liabilities in the bankruptcy court.⁷⁰ Similarly, bankruptcy judges granted Arch and Alpha leave to pay a portion of their reclamation obligations during restructuring. These deals are expected to reduce the financial risks of these coal companies, while shifting the cost of reclamation to underfunded state budgets.

⁶⁰ Schreyer, Natalie. 2016. The other war on coal: thousands of retired miners could lose their health care and pensions. *The Mother Jones*, October 20. <http://www.motherjones.com/environment/2016/10/umwa-retirement-pensions-health-care>

⁶¹ Davenport, Coral. 2016. Coal country is wary of Hillary Clinton's pledge to help. *The New York Times*, August 28. https://www.nytimes.com/2016/08/29/us/politics/coal-country-is-wary-of-hillary-clintons-pledge-to-help.html?_r=0

⁶² Egan, Matt. 2016. Top coal exec to Trump: 'temper' your coal job promises. *CNN*, December 16. <http://money.cnn.com/2016/12/16/investing/trump-coal-jobs-murray-energy/>

⁶³ Trumbull, Mark. 2016. Trump energy team: heavy on oil and gas, lighter on coal. *Christian Science Monitor*, December 13. <http://www.csmonitor.com/Environment/Inhabit/2016/1213/Trump-energy-team-heavy-on-oil-and-gas-lighter-on-coal>

⁶⁴ Bryant, Chris. 2016. Trump cannot stop the Energy Revolution. *Bloomberg*, December 25. <https://www.bloomberg.com/gadfly/articles/2016-11-09/trump-cannot-halt-the-march-of-clean-energy>

⁶⁵ Nair, Arathy. 2016. Peabody chapter 11 tops string of US coal bankruptcies. *Reuters*, April 15. <http://www.reuters.com/article/us-usa-coal-bankruptcy-idUSKCN0XC2KQ>

⁶⁶ CTI. 2015. Assessing the thermal coal production subsidies. September. <http://www.carbontracker.org/wp-content/uploads/2015/09/Thermal-Coal-Prod-Subsidies-final-12-9.pdf>

⁶⁷ Joyce, Stephanie. 2016. Nation's largest coal mining company files for bankruptcy protection. PBS, April 13. <http://www.pbs.org/newshour/run-down/nations-largest-coal-mining-company-files-for-bankruptcy-protection/>

⁶⁸ Schreyer, 2016.

⁶⁹ Joyce, 2016.

⁷⁰ Sanzillo, Tom. 2016. Peabody Energy's five-year business plan to emerge from bankruptcy is not credible. IEEFA, August 31. <http://ieefa.org/wp-content/uploads/2016/09/IEEFA-memo-on-Peabody-Bankruptcy.pdf>

Other regulations and rules that affect the costs of bankrupt coal producers can be summarized under three headlines: The Coal Act of 1992, The Black Lung Act of 1973 and Pension Benefit Guaranty Corporation.⁷¹ The Coal Act that requires coal producers to make contributions to the Social Security Administration could be modified under the bankruptcy code. The Black Lung Act allows for coal miners suffering from black lung disease to make a claim for health expenses from the coal producer. The Pension Benefit Guaranty Corporation (PBGC) is expected to pay reduced pension benefits to employees of bankrupt company that is obligated to pay \$1250 per affected worker for three years to the PBGC.

⁷¹ Deutsch, Douglas. 2015. The coal industry: emerging issues in bankruptcy cases. Chadbourne, September. https://www.chadbourne.com/Coal_Industry_Emerging_Issues_Bankruptcy_Cases_projectfinance

Appendix I. Transition strategies — Typology (US)

Compensation or grandfathering (backward-looking)	Structural adjustment assistance (forward-looking, narrow)	Adaptive support (forward-looking, broad)
Consumers/ households		
Federal tax credits (i.e. US Clean Energy Tax Credits) and the Residential Energy Conservation Subsidy Exclusions offer partial tax incentives to encourage renewable energy investments in home improvements.	For low income families, LIHEAP and WAP federal programs offer financial assistance to pay energy bills and increase energy efficiency, including funding for energy conversion to renewable sources. At state level, California Energy Commission partnership with fund solar systems for equitable access to solar programs and the New York Solar Initiative which offer low-interest loans for switching to alternative energy-efficient home improvements.	Community solar business models (or shared solar) allows buying cheaper solar energy from the power grid, lowering utility bills. These programs are funded via group purchases, crowd financing and community investments, and offers income benefits to low-income households who cannot host rooftop solar systems.
Workers		
The Coal Act, Black Lung Act and Pension Benefit Guaranty Corporation sets out transitional payments to workers employed in coal companies that went out of business. Obama administration Power Plus Plan also sets out plans for underfunded for health and pension fund.	Limited federal funding of retraining in alternative industries.	Federal and state level government funds for retraining for employment in solar jobs, manufacturing, infrastructure and other alternative industries.
Communities		
Federal funding for health, pension and clean-up costs in coal communities in Appalachia.	Power Plus Plan sets out a federal budget to fund local projects that targets economic diversification and tackling with health issues.	Small scale local projects supported by state and civil society groups, to investigate viable alternative businesses and strategies to diversify.
Corporations		
Clean Power Plan adversely affects the coal-fired power stations. The coal industry has been recipient of tax subsidies for reclamation, pension and health expenses, land leasing subsidies and investments in clean coal.	State and federal level compensation during restructuring of pension and health liabilities and other legacy costs for bankrupt coal companies.	Low tax and deals with state regulators.

Source: Table content by the author(s). Table concept by Fergus Green.

Conclusion

The decline of US coal industry has dire consequences for coal miners and coal-impacted communities, whose livelihoods depend upon extractive economies. While all major producing states are adversely impacted by the decline of coal, the negative impacts of job losses and shrinking local economies are quite visible in impoverished communities in Eastern Kentucky. Jobs losses are also intrinsically linked with numerous health and drug abuse issues. Federal and local government support is necessary to mitigate social and economic impacts of coal transition.

During second term of Obama administration, climate change became a top priority and phasing out coal was seen critical in transition to a low-carbon economy. The distributional impacts of coal transition were addressed in several federal compensations schemes. Especially, the Power Plus Plan set out a structural adjustment program for coal-impacted communities. In partnership with local governments, the PPP allocated federal funding for local projects that aim diversification of local economies and address health issues in Appalachian coal communities. The question remains whether these federal programs will continue under new administration.

The concept of “just transition” has gained traction among different levels of government and civil society in the US. Several small-scale local projects give support to alternative businesses, (i.e. tourism, manufacturing, solar, health centers), and retraining programs for employment in these new sectors. In particular, absorbing job losses from coal in the solar industry is a viable adaptive transition strategy. Pilot projects that support local businesses and energy efficiency programs also promises successful outcomes in coal-impacted communities.

Compensation of laid-off coal miners poses a big challenge given the market downturn and declining state revenues from the industry. Allocation of federal funding for pension, health and clean-up costs might shift the financial burden from bankrupt companies and underfunded state budgets to the federal government. Even if Trump administration stick with his campaign pledge to revive the coal industry with coal lease subsidies and direct tax breaks, it is quite unlikely that coal jobs will be brought back.

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