Washington Center for Equitable Growth

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Energy Transitions in the United States and Worker Opportunities Past, Present, and Future

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Explaining the "History of Technology" series and equitable growth

By Jonathan D. Moreno

"Let me recite what history teaches," wrote the 20th century American novelist Gertrude Stein. "History teaches."

Does history teach? In particular, does history teach about job destruction and creation? Can the study of history, both in case studies and in the broad strokes of trends, help us understand how structural changes in the U.S. economy have affected growth and inequality in the past? Can they give clues about what we can expect in the future?

The Washington Center for Equitable Growth set out to answer those questions by establishing a Working Group on the History of Technology. In a Washington, D.C. policy environment dominated by economists and political scientists, we wanted to see if the tools and concepts of the history of technology can be deployed in ways that complement those other disciplines. After all, historical precedents are routinely cited in policy discussions, but rarely are they subjected to the close analysis that professional historians can bring to the conversation.

Our working group of technology historians seeks to answer the question of whether there are elements of previous mass technological shifts that may aid in the management of workforce disruptions brought about by the post-high-tech revolution. The group considered this question in light of the overarching mission of Equitable Growth to investigate whether and how economic inequality affects economic growth and stability. By casting an informed look back to previous technology-driven job upheavals, we may find shifts in inequality and growth—shifts that indicate whether these phenomena are linked. If so, then perhaps answers to today's growing income and wealth gaps will lie in some combination of spontaneous forces and active interventions by government or through public-private alliances.

We did not look for technological speculation or "futurism" in our work. But any technology that is or has been in operation for the last couple of hundred years

has been fair game for our group, from the steam engine and railroad to nanoengineering, synthetic biology and microchip production, as well as the workforces related to those endeavors. Otherwise, in charging our group of historians, we brought no preconceptions in this regard. Nor do we think that there will necessarily be a clear line from previous experience to the future. Some past events and concepts might be a dead end, but some might provide a foothold, however modest, on understanding what lies ahead.

Whatever the case, historical lessons are too important to be ignored in considering the future of job creation in a post-high-tech world. In the words of the 18th century Scottish philosopher David Hume—a decidedly less musical but no less nuanced writer than Gertrude Stein—the future tends to resemble the past. The challenge, we might add, is ascertaining which tendencies will turn out to matter in the years ahead.

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Overview

Energy jobs in the United States figure prominently in the minds of policymakers across the political spectrum. The Obama administration made a large push for green jobs, particularly in his first term—an effort that excited many environmentalists but also led some to claim his job-creation estimates were overstated. Many conservatives favor the development of the Keystone XL pipeline, arguing that one of its compelling features is the creation of several thousand jobs during its construction, which draws criticism from environmentalists but also questions about the long-term job prospects for workers on the pipeline.

Meanwhile, jobs in traditional coal-mining regions such as Appalachia have been shrinking, leading to difficult conditions for communities in the region. Conversely, the boom (and recent bust) in shale oil development in North Dakota has created alternative costs and benefits including high wages, skyrocketing rent prices, and many of the social problems associated with boomtowns, such as spikes in alcohol consumption and prostitution—with a corresponding strain on social cohesion among long-time residents.

Clearly, changing job patterns accompany changes in the sourcing of energy across the country. And equally plain is the fact that a wide variety of energy transitions are currently underway in the United States—some that are more sustainable, such as the increasing adoption of renewable energy such as solar power, and some that retrench fossil fuel usage, such as rises in unconventional oil and natural gas exploration and extraction. But what do these changes mean for workers?

This paper examines the challenges and opportunities energy workers have faced in past energy transitions in the coal industry, the traditional oil extraction industry, and the electrical generation industry to help us assess the potential for new energy systems—specifically unconventional oil and gas development and solar energy—to contribute to the creation of more sustainable energy industry jobs that contribute to more middle-class jobs and thus equitable economic growth in the future. In doing so, the paper looks beyond the traditional focus of energy analyses—price signals, technological change, and environmental impact—to explore the factors that influence whether new energy systems are likely to offer the potential to enhance more equitable job growth in the coming decade.

Workers in previous energy transitions

Group of miners waiting to go to work at the Virginia-Pocahontas Coal Company, 1974.

BY JACK CORN, NATIONAL ARCHIVES VIA WIKIMEDIA COMMONS

The coal industry

Coal miners have experienced history's most complex relationships with the promises and perils of energy jobs. Without a doubt, coal mining has been one of the world's most dangerous occupations, with incredibly difficult working conditions and high accident rates. Mid-19th century anthracite coal miners in Pennsylvania, for example, had a less-than-even chance of surviving 14 years of mining without experiencing a crippling or fatal accident.[1] Even those who avoided being maimed toiled long hours in dark caverns performing heavy manual labor while being exposed to chronic levels of coal dust that frequently led to black lung disease. Historically, most people who have had opportunities to engage in other fields of work have chosen to bypass coal mining for these reasons.

Yet coal miners have helped produce some of the most powerful labor unions in American history—organizations that helped produce broad-scale democratic reforms along with relatively high wages and social benefits for their members. As scholars including University of Colorado, Boulder history professor Thomas Andrews and Columbia University professor Timothy Mitchell show, the strength of coal unions came in part from the geographic separation of workers and managers.[2] Coal miners labored underground; managers and owners stayed aboveground. The lack of regular supervision, combined with camaraderie forged out of shared experiences in dangerous working conditions, helped generate the solidarity that allowed coal miners to unionize despite enormous opposition from their employers and the federal and state governments at the time.

While these union-organizing efforts were slow, halting, uneven, and often fueled by disastrous mine accidents, they improved wages, increased mine safety, and obtained a host of social benefits including federal compensation for black lung disease in America. Much of what made coal mining so undesirable turned out to facilitate labor organizations that fought to earn concessions that offset—partially and incompletely, to be sure—some of these challenges.

Two major shifts in the geography of U.S. coal production over the past several decades have unraveled many of these benefits. One was the regional move away from Appalachia to central and western coalfields and the transition from underground to surface mining. Appalachian miners have historically had higher union rates than other regions. In 2013, despite many decades of decline for union members, 27 percent of the region's coal came from union mines, double the average rate of 13 percent in the central and western regions.

The second, the transition to surface production—strip-mining and mountaintop removal—has even further eroded union strength. Only 9 percent of surface coal production in Appalachia is extracted by union members compared to 35 percent for underground. Nationally, union membership for surface coal production is half the rate for underground production.[3] Such trends present concerns for whether coal mining can be considered a reliable sector for equitable jobs in the future.

The traditional oil industry

The history of labor in the oil industry presents instructive contrasts. Two salient differences stand out. First, oil can be produced with far less labor than a comparable quantity of coal. Second, laborers remain aboveground where they are directly subject to management oversight. The lower labor requirements of the oil industry are rooted in the material contrasts between coal (a solid) and oil (a liquid). Once a well has been drilled and connected to pipes, pumps, and storage tanks, oil can be continuously extracted using mechanical energy rather than physical labor due to its propensity to flow. The oil industry, therefore, requires a much smaller workforce (one that drills wells and maintains equipment).

Moreover, these workers labor in plain sight of managers, making it easier for overseers to disrupt labor organization efforts. As a result of these conditions, labor unions have played a less prominent role in the oil industry than in the coal industry, and represent less than 5 percent of workers today.[4] While many skilled (petroleum geologists, chemists, and engineers) and semi-skilled (drillers and many refinery

employees) oil workers obtain highly attractive wages, the quantity of these positions remains relatively low, thereby decreasing the broader social benefit for workers.

Wages in the contemporary oil industry do exceed national averages by a wide margin. Average hourly pay in the sector in 2015 is approximately $42 an hour, highlighted by median salaries of approximately $150,000 for geoscientists and petroleum engineers. Wellhead pumpers, refinery operators, gaugers, and other semi-skilled workers receive median wages between $50,000 and $60,000. And roustabouts—unskilled oil and rig operators—earn average rates of approximately $18 an hour or $37,000 per year.[5] These relatively higher wages, however, come at considerable risk of injury: Fatalities in the oil and gas industry occur at seven times the national average.[6] Many jobs in the petroleum industry, therefore, offer workers a difficult balance between high wages and personal safety.

Average hourly pay in the contemporary oil industry in 2015 is approximately $42 an hour.

Electricity

The history of electricity is often told through tales of its idiosyncratic innovators—famous figures such as Thomas Edison and Nikola Tesla. Yet maintaining a continuous flow of power to homes and businesses relies on numerous workers operating power plants, monitoring production and consumption, and maintaining the grid. Electrical utilities, therefore, employ a wide range of laborers from switchboard operators to plant managers to plant repair personnel to electrical engineers to crews that repair electric wires suffering from age, storms, or their most frequent and surprising source of damage: squirrels.

While all energy industries entail some level of personal risk, the immediate dangers surrounding handling high-voltage electricity mean that the large majority of utility employees have a significant amount of training and are therefore in skilled or semi-skilled positions. And in contrast to the petroleum industry, a relatively high percentage of these positions are unionized. The Bureau of Labor Statistics notes that utilities have the highest level of union membership (22.3 percent) of any private industry.[7]

High union membership in utilities reflects the distinct political economy in the United States for electrical sales. For the past century, utility companies and governments have broadly agreed that in exchange for monopoly access to consumers, utilities would consent to provide reasonable rates and services while being subject to many regulations. The removal of direct price competition in most

markets decreased opposition to unions, resulting in wages that are significantly higher across the board. Electricians at utilities earn salaries averaging $70,000—30 percent above than the mean wage of $53,760 for electricians employed in the construction industry.[8]

Many utility electricians likely hold a greater number of certifications, though this is in part a product of the fact that many utility companies consistently offer benefits such as tuition assistance and work release that enable employees to acquire new skills. Workers in utilities, therefore, have acquired some of the best jobs in the energy industry.

Fracking the Bakken Formation in North Dakota.

BY JOSHUA DOUBEK, VIA WIKIMEDIA COMMONS

What can U.S. workers expect from emerging energy systems?

Recognizing that previous energy regimes offer different levels of benefits to workers suggests we ask questions of emerging energy systems related to the type of workers they are likely to employ and the opportunities for these positions to create attractive career paths. In this paper, I look at two of these new energy systems: hydraulic fracturing for oil and gas as well as solar energy.

Unconventional oil and natural gas fracking

The most recent surge of growth in fossil fuel energy in America stems from

unconventional oil and gas development, predominantly oil and natural gas trapped in shale formations. In conventional drilling, a single well can tap a large pool of gas or oil and extract it in great quantities, often over a period of several decades. By contrast, accessing the energy stored in shale formations requires the hydraulic breakup of shale formations to allow the gas or oil to flow and be collected. Such "fracking" involves immense amounts of sand, water, and chemicals that are pumped deep underground at high pressures to create fractures in the shale formations that release the oil and gas.

Fracking necessitates a much greater number of wells than in conventional development because they do not produce as much per well, require repeated fracturing over time, and have shorter productive lifetimes (a typical half-life is two years for a fracked well). As a result, industry advocates repeatedly emphasize that fracking will produce a significant expansion in employment as the industry grows and develops.

Are fracking jobs good jobs? From the perspective of wages, it appears the answer is yes. Similar to the past, wages in the oil and gas industry exceed national averages by a wide margin. Average hourly pay for all oil and gas workers in 2015 was approximately $42 an hour.[9] In regions with relatively small populations and large expansions in fracking, such as North Dakota, labor shortages have generated many reports of unskilled workers obtaining jobs paying more than $25 to $30 an hour and even cases of semi-skilled employees earning more than $100,000 per year.[10]

Increasing the development of new fracking wells undoubtedly creates jobs across the pay spectrum. But in comparison to conventional oil extraction, fracking requires a larger number of unskilled and semi-skilled workers that earn lower salaries. This is due to the particular labor process involved in fracking wells. Many more wells need to be dug and maintained, but much of this work is comparable to construction jobs: clearing land and laying concrete for drilling operations. Outside of exceptional areas such as North Dakota where uncharacteristic labor shortages exist, compensation for this type of labor is more in line with construction than the oil and gas industry: average wages of $15 to $25 an hour rather than $42.[11]

Similarly, the reliance on continued application of water, sand, and chemicals to keep wells active entails many trucking jobs to deliver these materials to wellheads. Heavy trucking jobs also offer wages that are far below the averages in the oil and gas industry: approximately $20 an hour and median annual salaries of $41,240 in 2014.[12]

In addition, many jobs in the fracking industry writ large come at considerable cost in terms of health risks, volatility, and community life. Accident rates in the traditional oil industry are extremely high, with seven times the national average of job-related fatalities.[13] While some of these deaths are caused by exploding wells, many more occur in a pattern much more akin to the construction industry. Due to the continual use of heavy equipment and the need to supply wells with large quantities of water and sand, worker injuries and deaths often result from vehicle crashes, falls from drilling platforms, and being crushed by heavy machinery.

The frequency of vehicular accidents has increased as much as fourfold in many fracking counties due to the need to move so much material by truck and the fact that many truck drivers are sleep-deprived as a result of working overtime.[14] In addition, the federal Occupational Safety and Health Administration has discovered that persistent exposure to silica dust (up to 99 percent of the content of most fracking sand) can cause the lung disease silicosis. The agency's analysis reveals that 47 percent of workers in the fracking industry regularly received doses higher than OSHA standards.[15]

In the second quarter of 2015 alone, it is estimated that 35,000 fracking jobs were lost across the United States.

These positions also come with a great deal of volatility. In the last year, significant reductions in the global prices of crude oil have threatened many fracking developments such as in North Dakota's shale oil belt. In the second quarter of 2015 alone, it is estimated that 35,000 fracking jobs were lost across the United States.[16] For workers, this volatility is expanded because the industry relies on the heavy subcontracting of jobs. In 2005, two-thirds of oil and gas employees were protected by unemployment insurance, but this percentage decreased to 55 percent in 2010, largely because of reclassifying employees as contractors. According to the U.S. Department of Labor, this practice is often an act of misclassification that is particularly prevalent in hydraulic fracturing.[17]

The frequency of contracting is correlated with low union membership in the oil and gas industry and may be even further undermining the role of unions—no other industry saw a bigger drop in union membership between 2004 and 2014.[18] And even when union members are available to perform work in states such as Ohio and Pennsylvania, fracking companies have frequently imported workers from states with lower union memberships.[19]

Finally, wide variations in reserve estimates raise questions as to how long fracking can continue to create jobs. When first developed, it was often reported the Marcellus Shale belt across New York, Pennsylvania, and Ohio contained a 100-

year supply of natural gas, but more recent estimates suggest the actual amount may be considerably lower.[20]

Fracking also appears to come at considerable cost to community life. Its local environmental impacts are heavily contested, to say the least. It is beyond the scope of this document to analyze these debates, but it is clear that the increase in fracking is generating considerable conflicts in communities with shale resources. In farming communities, neighbors have been pitted against neighbors, while in boomtowns in North Dakota, the growth of shale oil has come with many of the negative hallmarks of boomtowns in the past: skyrocketing rents, high rates of liquor consumption, growth of prostitution, and a population dominated by males.

The traditional oil and gas industry has always created a handful of well-paying jobs that are accompanied by unsafe conditions and environmental damage. Fracking appears poised to continue these trends, though with the notable exception that there are a greater number of employees in fracking development who work in unskilled and semiskilled positions earning less lucrative wages. Whether the financial benefits offset the personal health risks, volatility, and community tensions is a matter for public debate.

Solar energy

Solar panels installed on the roofs of homes and businesses represent one of the largest growth areas in renewable energy. The solar energy industry as a whole employed nearly 175,000 workers as of November 2014, and has seen 15 percent to 20 percent annual growth rates over the previous several years. The majority of solar jobs can be found in installation (55.8 percent) or manufacturing of solar equipment (18.7 percent); sales and distribution (11.6 percent), project developers (8.7 percent), and other employees (5.2 percent) make up the balance. Compensation for the roughly one-quarter of workers in these latter categories appears strong, with sales personnel averaging wages of $44 an hour and project managers averaging between $30 to $40 an hour; "other" employees includes many well-paid executives, research scientists, and other professional occupations.[21]

As installers and manufacturers of solar equipment make up the large majority of solar workers, understanding their opportunities and risks should be the focus of determining whether these green jobs also provide a pathway to middle-class stability. Some of the numbers are encouraging: The Solar Foundation finds aver-

age wages of $20 to $24 an hour for installers and $18 an hour for assemblers. Considering that most employees in these jobs do not have associate's or bachelor's degrees, this is promising.

Yet other sources are more critical of what is hidden within these averages. The category of installers includes several different groups, from construction workers and roofers to plumbers and electricians. Plumbers and electricians who have gained professional training and obtained certificates typically earn more than roofers or construction laborers, driving up these averages. The Bureau of Labor Statistics reports that in 2014, electricians had median hourly wages of $23.73 while construction laborers averaged $15.12.[22] Much of the work of solar installation is performed by construction workers or roofers with little specialized training, and the pay is considerably lower. Researchers at the University of California, Berkeley Labor Center report average wages of $14.42 an hour (most positions offered between $10 and $17 an hour) for solar installers according to an analysis of job postings.[23]

Three other factors suggest skepticism about entry-level solar installation jobs. First, it is a dangerous occupation. Though we do not yet have reliable data on accidents in the solar energy industry, it combines three positions that have historically had high accident rates: roofing, construction, and electrical work. OSHA reports that 20 percent of American job fatalities in 2014 occurred in the construction industry, with falls and electrocution being the top two dangers.[24] There is little reason to assume solar installers would not be regularly subject to these risks.

Second, unionization rates are low in the solar industry, with less than 10 percent of employees being members of unions.[25] Third, contract labor appears to be a regular feature of solar installation work. More than half of solar installation firms have less than 10 employees, which bodes well for sharing the economic benefits of the industry with local entrepreneurs.[26] But such firms often rely on contract labor when sales increase and are quick to let workers go during slack times. Therefore, such employees are not likely to have an optimal level of job security.

A more optimistic picture emerges when we look at solar installations built by utility companies. While about 75 percent of solar energy is built on the rooftops of residences and commercial entities, some utilities oversee the construction of large solar arrays typically located in desert areas. As opposed to homes and businesses, utilities are more likely to hire firms with more experience and a greater number of unionized employees, resulting in wages that are roughly 20 percent higher for utility-scale solar than rooftop solar.[27]

These findings suggest some of the difficulties in balancing the environmental, economic, and sustainable jobs goals of solar energy. Solar jobs provide an example of a "wicked" problem in which optimizing one aspect appears to come at the expense of another. It is socially desirable to support a decentralized solar energy industry in which local entrepreneurs can create companies rather than having the industry managed by a few oligopolistic corporations. At the same time, small enterprises typically rely more heavily on contract labor because of their lower levels of capital.

Similarly, utility-level solar energy creates better jobs for workers, but environmentalists have often critiqued utilities for dragging their feet and even actively resisting renewable energy developments or conversely creating large-scale desert solar utility installations that disrupt local environments. The burdens of these solar plants are often borne by Native American groups who see little benefit from the projects.[28] Therefore, it is a challenge to balance the competing ambitions in solar energy between environmental health, local economic sustainability, and quality jobs.

Conclusion

Analyzing the history of energy reveals that the sector creates a great number of jobs, though not all of these positions have offered a reliable path to secure membership in the middle class. By looking at past and present patterns in energy jobs, we can identify several trends for policymakers to consider when pursuing measures to increase opportunities for American workers.

Unionization correlates with higher pay, better benefits, and improved safety outcomes for workers in energy jobs

Coal unions are one of history's clearest examples of groups of workers combining to achieve a host of benefits that transformed one of the world's most dangerous and undesirable occupations into a pathway into the middle class. This historical pattern is reflected in electric utilities as well, suggesting that it is important to develop policies that assist today's energy workers in creating unions if and where they desire.

New energy jobs bear many similarities with construction

For both unconventional oil and natural gas fracking as well as solar energy, many of the jobs share a good deal in common with the construction industry. This is for better and for worse. The higher-up positions within construction are quite good, but entry positions raise many concerns as they are associated with low wages, high accident rates, and unreliable contract work. Policies to improve energy jobs, therefore, may achieve broader social benefit if they also seek to enhance the prospects for construction workers more generally.

Several other policy options should be considered

Clearly, no government agency or think tank is in a position to mandate unionization, but there are a number of other policy measures that could be taken to help ensure that new energy jobs achieve clear benefits for their workers. These include:

- Adopting stricter safety regulations for the energy trades to lower accident rates
- Supporting training opportunities that allow workers to learn skills and obtain certifications that will give them chances to climb the ranks and obtain better positions within the energy trades
- Providing incentives for companies hiring permanent workforces rather than contract labor to improve employment stability for those in emerging energy jobs

These three steps could well ensure current and future jobs in the energy sector lead to solid, middle-class jobs.

About the author

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