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Retraining investment for U.S. transition from coal to solar photovoltaic employment

Edward P. Louie [a], Joshua M. Pearce [b,c,*]

[a] School of Public Policy, Oregon State University, United States
[b] Department of Materials Science & Engineering, Michigan Technological University, United States
[c] Department of Electrical & Computer Engineering, Michigan Technological University, United States

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ABSTRACT

Although coal remains the largest source of electricity in the U.S., a combination of factors is driving a decrease in profitability and employment in the coal-sector. Meanwhile, the solar photovoltaic (PV) industry is growing rapidly in the U.S. and generating many jobs that represent employment opportunities for laid off coal workers. In order to determine the viability of a smooth transition from coal to PV-related employment, this paper provides an analysis of the cost to retrain current coal workers for solar photovoltaic industry employment in the U.S. The current coal industry positions are determined, the skill sets are evaluated and the salaries are tabulated. For each type of coal position, the closest equivalent PV position is determined and then the re-training time and investment are quantified. These values are applied on a state-by-state basis for coal producing states employing the bulk of coal workers as a function of time using a reverse seniority retirement program for the current American fleet of coal-powered plants. The results show that a relatively minor investment in retraining would allow the vast majority of coal workers to switch to PV-related positions even in the event of the elimination of the coal industry.

1. Introduction

Coal remains the largest source of electricity in the U.S. accounting for 39% of the electricity mix (U.S. EIA, 2014a). In addition, coal power and coal mining are tightly linked, with 93% of coal consumed used for electricity generation (U.S. EIA, 2014a). Despite the decline in coal jobs due to technological advancements, coal still provides many jobs with the U.S. Energy Information Administration (EIA) and the U.S. Bureau of Labor Statistics (BLS) finding 89,838 and 78,970 employees in coal mining in 2012 and 2013, respectively (U.S. EIA, 2013a; Bureau of Labor Statistics, 2014a. While there are no official published numbers on the employees working in coal power plants, studies found that coal-fired power plants employ around 0.18 people in operations and maintenance on a permanent basis per MW (Beamon and Leckey, 1999; Singh and Fehrs, 2001). Given there is 336,341 MW of coal generator capacity in the U.S. (U.S. EIA, 2013b), the number of people employed by coal-fired power plants is therefore around 60,541. Thus, coal mining and coal-fired power plants currently employ approximately 150,000 people in the U.S., although this is declining.

A combination of factors have and will continue to result in a decline in coal usage and production and the concomitant coal-related employment, which include: 1) price pressure from natural gas (U.S. EIA, 2014b) and renewable energy technologies such as wind (Wiser and Bolinger, 2013) and solar photovoltaic (PV) technology (Branker et al., 2011), 2) increasingly stringent environmental regulations such as the Mercury and Air Toxic Standards (MATS) (U.S. EIA, 2014b), Cross-State Air Pollution Rule (CSAPR) (U.S. EIA, 2014a; EPA, 2014) and the Clean Power Plan Proposed Rule (U.S. EIA, 2014a; Federal Register, 2014), 3) aging coal-fired power plants (U.S. EIA, 2013c; Mufson, 2014), 4) slow growth in electricity demand (U.S. EIA, 2014a), 5) rising mine-mouth prices due to decreasing productivity (U.S. EIA, 2014b), and 6) poor public perception of the coal industry (Jacobe, 2013). Finally, and perhaps most importantly, there is a growing threat of liability due to inherent greenhouse gas emissions that come from coal

* Corresponding author at: Michigan Technological University, 601 M&M Building, 1400 Townsend Drive, Houghton, MI 49931-1295, United States. Tel.: +1 906 487 1466.
E-mail address: pearce@mtu.edu (J.M. Pearce).

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combustion (Allen, 2003; Allen and Lord, 2004; Kunreuther and Michel-Kerjan, 2007; Stott et al., 2013). The potential liability is so large, this alone could threaten the existence of the coal industry in the U.S. as a whole (Heidari and Pearce, 2016).

These factors all contribute to a decline in profitability for continuing to operate coal-fired power plants in both the near and long term. This reduced profitably is driving a decline in coal plants in the U.S. For example, between 2010 and 2012, 14 GW of coal-fired capacity was retired and the EIA's *2014 Annual Energy Outlook* projects that a total of 60 GW will be retired by 2020 (U.S. EIA, 2014c). The coal mining industry has been weathering the decline in domestic demand by increasing export (with China and India being the primary importers). This method has been bottlenecked by the lack of export terminals resulting in a push to construct rail lines and export terminals on the coast of the Pacific Northwest. However, these plans have met resistance from the public, Native American tribes, environmental organizations, and now they are also threatened by falling coal prices in Asia and anti-pollution efforts in China (Davis, 2013; Roberts, 2013; Lynch, 2014). In short, the future of the U.S. domestic coal industry is not bright. Both from an economic and an environmental viewpoint, a reverse seniority phase-out model is recommended for coal-fired power plant retirement where the oldest plants (and often the least efficient and most polluting) are retired first.

There is a concern in the public and in particular in regions heavily dependent on coal employment that policy should be developed to ensure a smooth transition to other employment for coal workers whose jobs will be eliminated. The decline in employment in the coal industry is not a new problem and thus the industry has not been attracting many young workers. This is somewhat fortunate, as now the average age of the coal-fired power plant worker is 48 years, the reduction in number of coal-fired power plants is timely with personnel approaching retirement age (Krishnan and Associates, 2007). In the short term, the remaining workforce can then be shifted to younger generating units minimizing the retraining and layoffs needed for coal power plant workers. This would incur moving and relocation costs for workers. However, in the medium and long term, the eventual phase-out of coal-fired power plants means there will be a need to find employment for coal workers outside of the coal industry (Elliott, 2015). Fortunately, there is one energy industry sector growing at an incredible rate — solar photovoltaic technology that converts sunlight directly into electricity. As solar can be implemented everywhere in the U.S. the need for relocation would be minimized. PV technology has both the scalability, high employment potential and long-term environmental impact to provide a sustainable source of electricity to meet humanity's present and future needs (Pearce, 2002). Since the rapid decrease in the costs of solar PV (Branker et al., 2011) deployment is rising rapidly and generating a large number of jobs (Gordon et al., 2007; Wei et al., 2010). The U.S. solar industry already employs 209,000 and is creating jobs 12 times higher than employment growth in the overall economy (Solar Foundation, 2016). In addition, solar employment is projected to grow to over 239,000 jobs in 2016 (Solar Foundation, 2016). The BLS's more conservative projection for solar photovoltaic installers forecast employment to grow by 24% from 2012 to 2022 which is still much faster growth than the projected occupational average of 11% (Bureau of Labor Statistics, 2014a, 2014b, 2014c). It thus appears possible for the growth of solar PV-related employment to absorb the layoffs in the coal industry in the next 15 years. It should be pointed out that the solar PV was chosen over the other top renewable energy technologies for the following reasons: wind energy has already expanded to a large fraction of its potential in the U.S. and it is geographically limited (De Vries et al., 2007), hydro electricity has also been largely developed in the U.S. and further hydro-development continues to be restricted by extensive and complex regulatory procedures, and environmental opposition (Bartle, 2002) and biomass on the large scale needed to replace coal would compete with food production further expanding world hunger and any bioenergy related crops would be cultivated by existing agricultural workers thus restricting the influx of coal workers (Azar et al., 2005; Senauer, 2008). PV is the only technology growing rapidly enough in the U.S. with appropriate employment modalities to absorb the potential coal employment declines.

In order to determine the viability of smooth transition from coal to PV-related employment, this paper provides an analysis of the cost to retrain current coal workers for solar photovoltaic industry employment in the U.S. The current coal industry positions are determined, the skill set evaluated and the salaries tabulated. For each type of coal position, the closest equivalent PV position will be determined and then the re-training time and investment will be quantified. These values will then be applied on a state-by-state basis for coal producing states employing the bulk of coal workers as a function of time using a reverse seniority retirement program for the current American fleet of coal-powered plants. The results will be discussed and policies outlined to provide a smooth transition from coal to solar energy employment in the U.S.

2. Methods

The BLS releases an annual national industry specific occupational employment and wage estimates every year (Bureau of Labor Statistics, 2014a, 2014b, 2014c). This estimate provides a detailed view of the current coal industry positions and information on the skills, education, and salaries of each position. The U.S. Department of Energy's SunShot Initiative (U.S. DOE, 2014) has assembled a solar career map which details jobs across the PV industry, the education, training, and skill requirements of each position, as well as possible pathways to advancement in the PV industry. This information was used to assign an equivalent PV position for each coal position, by matching existing skills, salary and educational attainment (e.g. an engineer in the coal industry matched with an engineering position in the PV industry and an office administrative position in the coal industry would be assigned a similar job in marketing, sales, and permitting in the PV industry). The amount of training needed to equip each coal worker for success in the closest matching PV job was determined based on the educational requirements detailed by the career map versus preexisting skills and knowledge. The time and cost of the required training was determined from trade schools, community colleges, license and certification requirements, and universities as detailed in the sources in the results.

The investment necessary to retrain coal workers for the PV industry is quantified for two scenarios. In the best case scenario (least expensive to retrain) all employees who work non-coal specific positions such as secretary and electrician are able to find a job outside of the PV industry, thus only those working coal specific positions such as roof bolter needs to be retrained for a position in the PV industry. In the worst case scenario (most expensive to retrain), all employees in coal mining will be absorbed into the PV industry. The number of employees by state working in coal mining (U.S. EIA, 2013a) is used with the assumption that the occupational mix and wage are the same in coal mines across states, the weighted average cost of retraining was multiplied by the number of coal employees in each state and multiplied by the fraction of the jobs that need retraining based on the scenario, the result is the investment each state would need to make in order to retrain its coal workers for jobs in the PV industry. To determine, the weighted average retraining cost per coal worker (C_{av}) the following terms are defined. First, E_c is the total number of coal jobs and can be given by:

$$E_c = E_r + E_{nr} \tag{1}$$

where E_r is the total number of employees that need retraining and E_{nr} is the total number of employees that need no additional training. Eq. (1) can be applied for all coal workers in any given region of study (e.g. a state). As E_{nr} will have no costs for retraining they will not be