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Job creation and energy savings through a transition to modern off-grid lighting

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ABSTRACT

A market transformation from inefficient and polluting fuel-based lighting to solar-LED systems is well underway across the developing world, but the extent of net job creation has not previously been defined. This article finds that current employment associated with fuel-based lighting represents approximately 150,000 jobs. New jobs will accompany the replacement technologies. A survey of major solar-LED lighting companies finds that 38 such jobs are created for each 10,000 people living off-grid for whom stand-alone solar-LED lights are suitable. Applying this metric, the number of new jobs already created from the current uptake of solar-LED lighting has matched that of fuel-based lighting and foreshadows the potential creation of 2 million new jobs to fully serve the 112 million households globally that currently lack electricity access, are unlikely to be connected to the major grid, micro-grids, or are able to afford more extensive solar systems. A likely greater number of additional jobs and employment income will be indirectly created or preserved via indirect employment, re-spending of energy savings, conservation of foreign exchange, enhanced literacy, and improved working conditions. In contrast, central grid expansion is unlikely to provide any net increase in jobs. The case of solar-LED lighting demonstrates that policymakers have tools to increase the pace of in-country job creation in the context of sustainable development, while minimizing job displacement, and improving the quality of employment. These tools include stimuli for domestic manufacturing or assembly of products; supporting peripheral businesses and services, such as training, recycling, financing, and impact assessment; and removing market barriers that slow the uptake of emerging technologies.

Light and livelihood: a broad view

The challenge of providing high-quality and affordable illumination to the 1.2 billion people currently lacking access to electricity grids has long been recognized (Dutt, 1994), and solar-LED lanterns have emerged as a highly cost-effective means of achieving this goal (Mills, 2005). The global employment effects of a transition from kerosene and other lighting fuels and supplies to electric alternatives such as solar-LED lanterns have not previously been examined (IRENA, 2013). A methodology has recently been developed and applied in the 15-country ECOWAS region of West Africa (Mills, 2014). This article significantly expands that work to include all developing countries, and identifies the net effect of potential job losses and job gains.

In retrospect, few would regret the loss of employment among those who cared for horses following the advent of the car. However, such job displacement should be understood and mitigated to the full extent possible. When considering competing lighting alternatives it is important to assess not only direct employment outcomes, but also a host of indirect factors that influence livelihoods. For example, excessive expenditures for lighting divert incomes and diminish the value of wages. In addition to imposing higher operating costs, fuel-based illumination can create suboptimal and unsafe work conditions through effects on indoor air quality, fire safety, and visual performance (Mills, 2016a), thereby eroding the quality of livelihoods.

The patterns and demographics of employment are another consideration. While most manufacturing of solar-LED lighting components is focused in a small number of countries (often industrialized ones) and assembly takes place predominantly in China and India, this research focuses on the highly diversified in-country distribution and sale segments of the value chain, where the majority of jobs stand to be lost and gained. The quality and decency of employment must also be considered (ILO, 2012). For example, fuel-based lighting jobs, like other jobs in the fuel supply chain, may in some cases involve child labor, illicit activities such as smuggling and black-market pricing, undocumented migrant workers, or jobs based entirely outside of the country of concern. Emerging alternative technologies are not immune from these concerns, but stand to be less problematic in this regard.

Methods

This article develops model-based employment estimates—informed by field data—because no comprehensive survey data exist to enable

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tabulation of the numbers of direct, let alone indirect, jobs created by fuel-based lighting or alternative technologies. The approach utilizes two techniques for estimating baseline employment from the production and selling of lighting fuels and supplies and a third technique for estimating job creation from alternative solar-LED technologies.

1. Current-day upstream employment from lighting fuel production is estimated as the fraction of total petroleum-sector jobs corresponding to kerosene's share in total petroleum production.
2. Estimates of baseline downstream employment from selling lighting fuels and products are derived from "bottom-up" estimates of the revenues generated by kerosene sellers, converted to jobs assuming a standard working wage. These are validated against field observations of the ratio of kerosene sellers to a given population served. These job intensities are applied to other off-grid lighting inputs such as diesel fuel, batteries, and candles.
3. Estimates of job-creation by the emerging solar-LED lantern industry are developed based on a survey of solar-LED lantern companies operating across the developing world as of late 2013. Seventeen companies were contacted and invited to contribute data in a standardized format. Respondents included four of the larger manufacturers and four of the larger distributors representing the majority of global production of products quality assured by Lighting Global at the time. The countries/markets served by respondents included Ethiopia, Haiti, India, Kenya, Malawi, Tanzania, and Zambia. The primary countries of manufacture/assembly include China, India, and various points in Africa. The types and numbers of jobs were collected and normalized per million lanterns sold. A central value across the responses is then applied to the overall market size to derive estimates of current and potential job creation.

A global estimate by the International Finance Corporation (IFC) concludes that approximately 274 million households are without modern lighting and electricity (IFC, 2012), of which 112 million can afford or best be served by individual solar-LED lanterns. The remaining segments can afford more extensive upgrades, such as complete solar home systems or access to the central grid or micro-grids. Moreover, there are an estimated 1 billion people with intermittent access to electricity grids who utilize fuel-based lighting during power outages (Bloomberg New Energy Finance, 2016). While these secondary and tertiary segments can utilize solar-LED lighting, the associated employment is not estimated here.

Various types of indirect jobs were also not estimated, including production of the raw materials and components (e.g. batteries, LEDs, PV panels, switches, housings) comprising the lighting products, contract manufacturers' employees who are not employees of the downstream branding and distribution companies, entities involved in shipping and customs, independent system re-charging enterprises, and third-party entities involved in financing. As a proxy for contract manufacturing, an estimated 105 manufacturers and 127 suppliers are producing and distributing these products at the wholesale level (Bloomberg New Energy Finance, 2016), but their employee base is not known. Emerging jobs in areas such as training and recycling were also not quantified. Secondary income provided by solar-LED lanterns that also enable phone charging would create additional jobs but is not evaluated here. Ultimate job creation would thus be even greater than estimated here. IRENA (2013) estimates that direct jobs associated with renewable energy represent one-third of total jobs in the off-grid solar sector.

The practical distinction between having any (even part-time) employment versus none at all is central to an individual or family's economic viability, so this study focuses primarily on the presence or absence of employment rather than the number of hours or level of income. Many people in off-grid communities are underemployed. Similarly, many people maintain multiple modes of obtaining income. For example, SunnyMoney, which by mid-2015 had sold 1.7 million solar-LED lights across five East African countries, has augmented the incomes of 600 sales agents by approximately 30% (SolarAid, 2015).

Given the lack of comprehensive survey data, the estimates presented here are largely model-based and thus embody uncertainties. Results are presented as highly rounded values to avoid over-precision. The scaled-up estimates of livelihoods provided by kerosene selling are cautious insofar as they assume that every market has vendors dedicated solely to kerosene.

Current employment situation

The lighting energy upstream

Energy supply has a very low "job intensity" compared to alternate activities that provide energy efficiency services (in this case illumination). This is particularly so for the primary lighting fuel, kerosene, given that it represents a minor sub-component of the overall petroleum-sector value chain. As of 2015, only 26 out of 146 developing countries produced kerosene domestically and thus the vast majority did not host any related upstream jobs (USEIA, 2016).[1]

The job-intensity of oil refining is approximately 392 barrels per worker per day (Kojima et al., 2010). If kerosene-related jobs are also created at this level of job-intensity, the global kerosene output in the peak year of the past decade (1.1 million barrels of kerosene per day globally) (USEIA, 2016) would be equivalent to only 2800 jobs. Approximately 80% of this kerosene is destined for end-uses other than lighting (e.g., cooking, heating) (Mills, 2016b), so the lighting-related value could be substantially lower. Moreover, it could be argued that crude oil no longer needed for kerosene will be produced and used instead for the production of other petroleum products, without a net reduction of labor input.

Candles are a more important lighting fuel than kerosene in many countries (Wei, 2012). Within the developing world, only Brazil, China, South Africa, and Venezuela are among the major wax manufacturers (approximately half of which is used for candle production). Regionally, only China and Europe are net exporters of wax. Most developing countries are thus net importers the raw material for making candles and thus do not enjoy the jobs created by its production. Employment data are not available on in-country candle manufacture.

The lighting energy downstream

The energy downstream is far more job-intensive than the upstream, particularly in the developing world where distribution and retail sales are not highly mechanized. It is important to identify the downstream points where employment could be most at risk as kerosene is displaced by alternatives. At the wholesale level, and at almost every subsequent node, kerosene is one of many petroleum products being moved or sold. Similarly, lighting equipment is almost always sold with other goods, even by informal vendors (Fig. 1).

A diverse product offering is thus the norm at the retail level, for example, within petrol stations that derive the vast majority of their income from transportation fuels and who have no employees that deal exclusively with kerosene. Petrol stations also have far lower rates of employment per unit of fuel sold than do micro-enterprises. This also applies within shops where kerosene is commonly only one of a large variety of commodities sold. Moreover, the emerging solar-LED lighting alternatives are being sold through many of these same outlets, and thus the revenue can remain within that sector even as technology/fuel choices evolve.

In many developing countries, the informal sector represents the vast majority of employment (Cohen et al., 2000). No statistical information exists on the extent of employment among informal lighting fuel and supply sellers. The International Labor Organization offers technical guidelines for this purpose (ILO, 2013), and has a specific statistical

[1] This value includes countries producing less than 500 barrels per day of the fuel.