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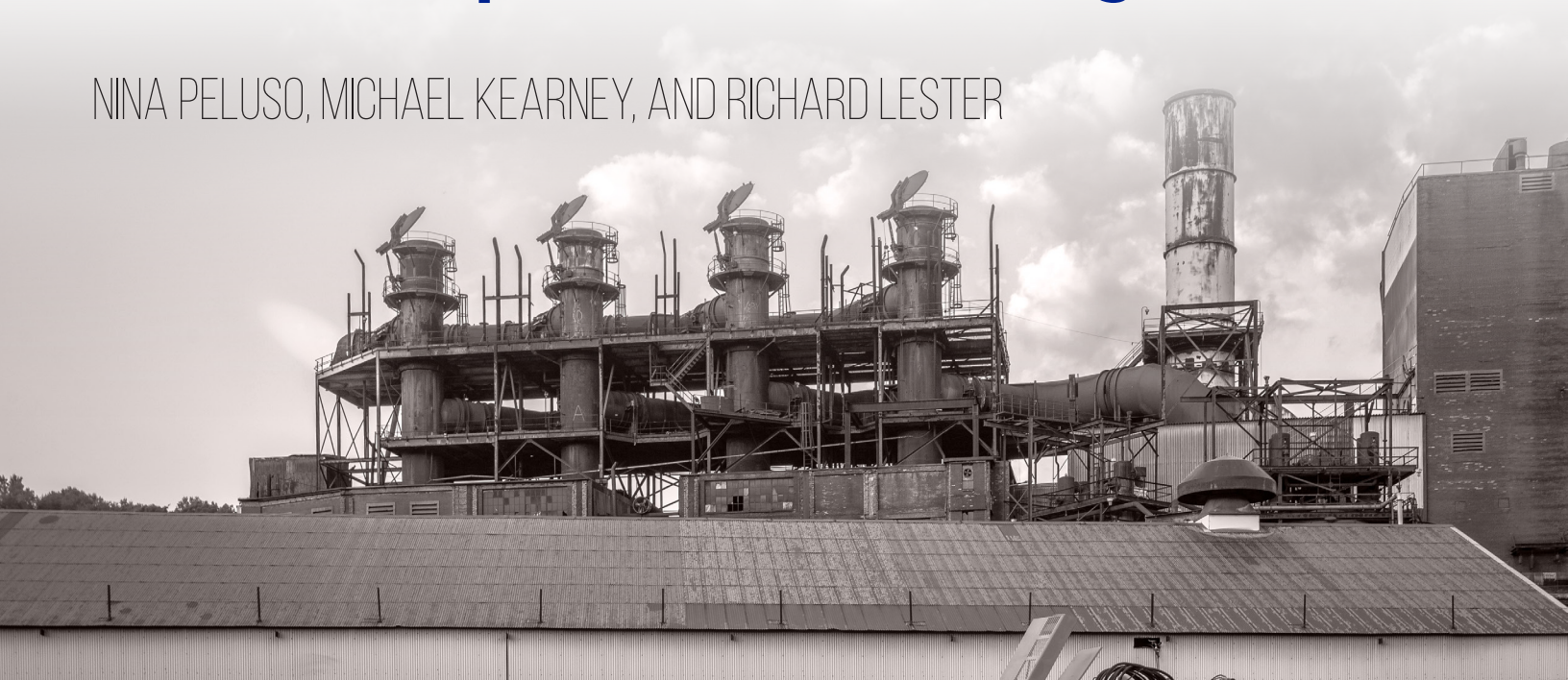
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# Assessing the Role of Public Policy in Industrial Transitions: How Distinct Regional Contexts Inform Comprehensive Planning

NINA PELUSO, MICHAEL KEARNEY, AND RICHARD LESTER





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# **Assessing the Role of Public Policy in Industrial Transitions: How Distinct Regional Contexts Inform Comprehensive Planning**

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## **Abstract**

Major industrial transitions in the United States led to highly divergent community outcomes. As the nation transitions to a deeply decarbonized economy, understanding the drivers of community success in the face of these historical transitions is crucial. We examine historical US transitions and corresponding policy via a series of literature reviews and case studies. First, we examine literature around four key domains governing community development. Then, we use historical transitions in Pittsburgh and the Pacific Northwest to interrogate markers for regional success and geographical disparities. Finally, we investigate the recent case of the US transition from incandescent to LED lighting to identify specific policy recommendations. Our findings suggest that, at a regional level, policymakers should identify drivers of community well-being, nurture strong ties between core institutions, carefully utilize economic development corporation structures, and use caution when considering private-led development initiatives.

## **1. Introduction**

As the threat of climate change looms, global policymakers and technologists have turned their attention to the vast array of measures to confront the challenge. As human-driven emissions rise, a large-scale rehaul of the global energy system, encompassing the electricity, transportation, industrial and buildings sectors seems imminent.

Within this global context, the United States must consider a major industrial transition on a scale and at a pace that it has never experienced. The transition will fundamentally reshape communities and individual livelihoods. The prosperity of the domestic and global communities alike relies on the policies adopted by federal, state, and local governments in the near term. Yet, policies that best spur positive environmental change can sit at cross purposes with the goals of the industries that have long supported U.S. working communities.

Consider the experience of Adams County, Ohio. Adams County, 70 miles from Cincinnati, experienced an economic boom in the 1970s and 1980s following the commissioning of two coal-fired power plants. At the time, coal-fired power plants delivered 80 percent of Ohio's electric power. Along with the plants came jobs, from handling heavy machinery in the yard, to operating boilers and turbines, to ensuring water quality and regulatory compliance. In recent years the availability of inexpensive natural gas and increased emissions reduction policies have combined to make traditional coal-fired power plants less economically viable. In 2017, AES, the owner of the Adams County coal plants, announced that they would shutter, leaving the roughly 500 employees at the two plants jobless. In addition to worker displacement, the plant closures created an acute budget crisis for Adams County – tax revenues from the plants made up 10 percent of the county budget – already under great stress as the criminal justice system was overwhelmed by the on-going opioid epidemic. In response to budgetary woes, the county was forced to cut spending on education, among other public services. (MacGillis 2018).

While the forthcoming energy transition is daunting, it is by no means the first large-scale industrial transition to occur with consequential distributive effects. Indeed, industrial transitions are deeply woven into the historical fabric of the United States. When these transitions “succeed” they are held up as evidence of the American Dream, but not all Americans have shared in their benefits.

Communities across the country have experienced widely varying outcomes during and in the aftermath of industrial transitions. A frequently-cited example, in both the popular media and academic inquiry, is the transition of the coal industry in West Virginia, which began experiencing employment volatility and decline with the Great Depression and the subsequent emergence of continuous mining machines and strip mining. The industrial fallout persists – at the beginning of the decline, Appalachian poverty was a “paradox, a disturbing contradiction of American prosperity” (Thomas 2010). Employment in coal is no longer a paradox, but rather a predetermined sentence. In a 2017 *Time* Magazine article, Ted Boettner, executive director of the West Virginia Center on Budget and Policy, said of coal industry employment, “There’s almost zero reason to be completely optimistic. It’s a disservice to coal-mining communities to tell them they will have a mighty comeback” (Worland 2017). In popular media, the Appalachian story lacks nuance and overshadows the experiences of many other U.S. regions that have successfully weathered industrial transitions (for example, post-textile New England). As regions across the country face the unique challenge of transitioning toward a decarbonized economy these historical experiences and their attendant outcomes should inform future policymaking.

In this paper, we consider what we can learn from these historical transitions about the role of public policy. What policies have led to successful community evolution in the past, and what lessons do they teach for the forthcoming transition to a decarbonized economy? Of course, these historical transitions are not directly comparable to a projected decarbonized future. Rather, they provide a useful comparative baseline. We review the literature on industrial transitions, focusing in particular on case studies of the steel and timber industries, and identify key policy decisions affecting community outcomes. We also consider the case of the lighting industry and the shift from traditional lighting to LED technology. We discuss how major policy concerns in earlier transitions apply to the lighting sector, and how the lighting sector case can in turn inform the transition to a decarbonized future. We are primarily interested in identifying broad best practices for policymaking and corporate engagement that will have a positive impact on prosperity in those communities that are most at risk of economic dislocation in a decarbonized world. When it is apparent that those methods vary widely in different jurisdictions we provide guiding questions for policy development.

Section 2 summarizes the literature on industrial transitions, highlighting the broad domains studied in association with successful transitions. Section 3 explores two historical cases to examine the role of post-transition public policy: the post-steel reimagination of Pittsburgh, and the implementation of the Northwest Forest Plan in the Pacific Northwest. Section 4 presents a case study of the transition from traditional lighting to CFLs to LEDs and four affected communities. Section 5 concludes with findings and recommendations for policymakers.

## **2. Literature Review**

This section provides a broad overview of our literature review on previous industrial transitions, the processes that surrounded them, and resulting community outcomes. The literature highlights four key factors bearing on outcomes following industrial transition: social fabric, business landscape, human capital, and the policy environment.

### ***2.1 A Note on Successful Transitions***

A key challenge in reviewing this literature is determining what exactly constitutes a successful transition. When considering communities and regions that have experienced major industrial transitions it is easy to fall into the trap of relying on anecdotal evidence of failure or success. If success is not well-defined, policymakers risk designing policy predicated on past efforts that haven't led to substantive gains. For our purposes here, we rely on the vast literature highlighting the complexity of defining success and consider the following:

1. What represents success?
2. Who do we consider when we discuss success?
3. Are appropriate measures of success quantitative, qualitative, or both?
4. Have misapplications of success metrics led to worse outcomes for U.S. communities?

Some clear foundational metrics across policy and economic development literature are GDP, employment, and income per capita. The development literature tends to center on rising income as a metric that implies regional success. Beyond GDP and income, Malizia (1994) notes that the purpose of economic development “is to participate in the process of national wealth creation for the benefit of local consumers and producers by facilitating either the expansion of job opportunities and tax base or the redeployment of local resources.” Malizia’s frame of reference focuses on building societal wealth and income expressly for the purpose of increasing job opportunities and local resources.

Carley et. al.’s review of metrics for evaluating energy-based economic development programs highlights gaps in evaluation and suggests using non-economic evaluative metrics including qualitative measures of health, educational, cultural, political, and environmental outcomes (Carley 2014). Similarly, using internal migration and place-based social and

economic factors as metrics can demonstrate divergent outcomes in small communities facing transition (Harrison 2017).

## ***2.2 Key Domains and Capacities for Transition***

A broad literature investigates how communities experience industrial transitions. This literature reveals four general areas (or domains) that encompass markers of community health: human capital, business landscape, policy environment, and social fabric. Each domain includes multiple societal attributes that affect community outcomes and each may drive success in a way that is distinct from the others. Of course, these domains overlap, and entail many complementarities.

***Human Capital*** measures specific levels of knowledge or capability within a population and reflects how that knowledge enables action or the lack of it. The economic development literature emphasizes human capital as a foundational indicator of development outcomes.

Simon and Nardinelli's 2000 paper on human capital and urban growth shows that cities that begin with a more knowledgeable population tend to perform better economically in the long run. Notably, such "knowledge spillovers" are generally limited to a specific metropolitan area - knowledge is most productive in the region where it is acquired. Lester (2005) finds that local technical knowledge is often enhanced by universities, whose most important contribution, among an array of roles, is education.

Simon and Nardinelli point out that the importance of a knowledgeable population base is mutable in the short term - they use the 1920s automobile industrial boom as an example where explosive industry growth overwhelmed any regional benefits from a knowledgeable population base - but confirm that human capital drives economic growth in the long run. They also find that human capital is economically more consequential in manufacturing-based economies than non-manufacturing ones, though there may be reason to believe that this relationship may have evolved more recently, particularly when considering newer growth hubs such as Silicon Valley or Kendall Square, where technology and innovation serve as the backbone of the local economies. While Simon and Nardinelli deal primarily with knowledge attainment as a metric, a wide variety of other indicators also measure human



capital, including social insurance programs, union strength, apprenticeship training programs, and university presence.

***Business Landscape*** measures the strength of private actors, their ties to other regional players, and regional support for building and sustaining business. Among other elements, this domain includes public-private and private-private partnerships, industrial diversification, industry location, state and regional business incentives, union-private relationships, and the presence of foreign firms.

One example of a key factor driving industrial location is low cost energy. There is much evidence to suggest that low regional energy costs influence new industrial development. Carlton (1983) found that energy costs motivate business location. More recently, Kahn and Mansur (2013) found that energy-intensive industries (the backbone of a manufacturing-based economy) locate in counties with low energy prices. This trend continues, as large data centers routinely locate in counties with low electricity prices. The presence of new firms motivated by low energy costs can have substantial effect on local economic development, job opportunities, and the resulting business atmosphere for potential new entrants.

***Policy Environment.*** This domain encompasses past, present, and future government and industry initiatives at all levels: local, state, federal, and international. Importantly, in addition to covering the policy environment, concerned with tangible structures for policymaking, this category often overlaps with and informs the discussion of regional political environment.

Neumann (2018) describes the impact of urban branding campaigns on a city's public image, citing 1970s New York and 1980s Pittsburgh as two cities where public officials piloted programs to reimagine post-transition spaces. Neumann (2018) writes that "Pittsburgh's post-industrial rebranding was a triumph", and her story serves as an example of a policy environment that enabled successful post-industrial growth. Urban branding of this type represents one policy lever that leaders might use to target areas in need of revitalization.

Business tax incentives are another commonly-used policy tool for economic development, though evidence of their value remains ambiguous in the academic literature. Some studies show that state-level economic outcomes are not well-correlated with state business incentives (Bartik 2017). While perceived as well-targeted, tax incentives have seen

mixed results in terms of encouraging business relocation or incentivizing economic development (Button 2019). Moreover, Buss (2001) highlights a lack of consensus around the most effective implementation and incentive structures for such policies.

***Social Fabric.*** Finally, understanding the social fabric of a region is critical to structuring policy with respect to social and cultural context (Armstrong 2019). This domain includes the nature of actor networks, the magnitude of public-private partnerships, key demographic markers (racial, economic, religious, etc.), and historical union involvement.

Social fabric indicators are useful when studying the interactions between diverse actor groups, as evidenced in the literature on public-private partnerships. In the context of Pittsburgh steel, Giarratani and Houston (1989) wrote that while public-private partnerships can be a useful tool for spurring economic growth, they divert attention from efforts to shape targeted government-led development policy. In Pittsburgh, public-private partnerships drove growth when measured by traditional quantitative indicators, but it is unclear if they improved livelihoods on a more qualitative scale (e.g., happiness, perception of mobility), and whether those mixed outcomes were a result of a lack of attention to the existing social fabric.

Armstrong (2019) reinforces the importance of government attention to social fabric – asserting that industrial policy is most successful when state governments work to convene and monitor local actor coalitions. To develop this argument, he compares the trajectories of Pittsburgh, PA and Cleveland, OH following industrial decline. Armstrong (2019) argues that Pittsburgh flourished due to an intentional effort by the Pennsylvania state government to convene and monitor a coalition of empowered research universities to design a detailed local economic development strategy. In contrast, the Ohio state government put policies in place that were ripe for capture. A group of strong private incumbent firms in Cleveland exploited state attempts at development policy and obstructed multi-tiered change.

When considering the energy transition, it is crucial to remember that the nuanced set of community features does not lend itself to a clear mapping of inputs and outputs. The 2005 report from the MIT Industrial Performance Center on universities and innovation argues that ‘one-size-fits-all’ approaches to economic development fail to recognize the diversity of needs in industrial communities (Lester 2005). Indeed, in this context, where the assets on the ground in any given community are highly specific, there is no one-size-fits-all solution,

even within the same sector. We might expect that a successful energy transition in New Mexico will look very different from energy transitions in Michigan, Wyoming or Louisiana. For this reason, a regional approach is essential to managing future transitions.

### **3. Industrial Decline & Economic Recovery: Two Historical Cases**

In this section, we assess industrial transitions in Pittsburgh and the Pacific Northwest and the policy responses aimed at reshaping affected communities. Both cases reinforce key points from the literature review and simultaneously highlight complex regional dynamics outside of broad understanding.

#### ***3.1 The Role of State and Local Policy in Pittsburgh's Steel Transition***

Our first case of industrial transition outlines the downfall of the U.S. steel industry, its impact on the Pittsburgh metropolitan area in the 1970s and 80s, and the area's subsequent policy efforts. U.S. steel production hit its peak in 1973, producing a total of 137 million metric tons annually. Less than a decade later, globalization and advancements in production technology led to an industry-wide restructuring and production dropped to a low of 67.7 million metric tons (Haller 2005). The collapse of the steel industry in the Mon Valley was occasioned by a broad set of intersecting industry interests, labor clashes, and, ultimately, full-scale industrial collapse (Hoerr 1988).<sup>1</sup>

Between 1980 and 1986, regional manufacturing employment dropped by 42.6 percent, with nearly half of the drop attributed to steel production. Broader regional employment, on the other hand, only declined by seven percent, buoyed by existing economic development efforts to motivate growth in the service and financial sectors (Detrick 1999). This shift happened across Allegheny County, as steel producers disinvested and laid off vast swaths of their workforces (Giarratani 1989). The state of Pennsylvania and the Pittsburgh city government faced a crisis that was both social and economic. Before the decline, Pittsburgh relied heavily on a traditional model of public-private partnerships to drive economic development. In the face of industrial collapse, city and state leaders leveraged and adapted this structure to better incorporate new stakeholders, primarily research universities, and were hailed for leading the city through the storm (Detrick 1999). Forty years after the initial

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<sup>1</sup> Similarly, Sherry Lee Linkon and John Russo's 2002 book *Steeltown, U.S.A.* paints a picture of the devastation Youngstown, Ohio faced in the fallout of the steel industry (Linkon 2002).

decline, the question remains whether this reshaped public-private partnership model adequately supported both human and industrial interests in Pittsburgh's subsequent growth.

Prior to the collapse of the steel industry, Pittsburgh long relied on a set of economic development policies spearheaded by the Allegheny Conference on Community Development started in the 1940s, a program eventually termed Renaissance I. This business growth coalition focused primarily on real estate development projects and environmental improvements in downtown Pittsburgh (Detrick 1999). As the decline of the steel industry became apparent in 1977, leaders reorganized that same group for Renaissance II, a new effort involving local nonprofit organizations in continued downtown development and community renewal. Renaissance II sought to empower community organizations as liaisons and collaborators, but ultimately failed to change the underlying power structures in the city and its outlying regions (Detrick). Still, redevelopment in the city core flourished.

In 1982, Pennsylvania's Governor Richard Thornburgh introduced the Ben Franklin Partnership, a state initiative designed to create links between universities and private institutions. It provided funding for advanced technology programs, including an Advanced Technology Center led jointly by the University of Pittsburgh (Pitt) and Carnegie Mellon University (CMU). Armstrong (2019) argues that the Ben Franklin Partnership and its related state programs assisted Pitt and CMU in overcoming deep institutional differences which allowed them to form a partnership for broad expansion of university research infrastructure.

The leaders of Pitt and CMU were central to a 1985 coalition that included the mayor and three county commissioners and drafted Strategy 21, a long-term strategic plan comprised of eighteen infrastructure and real estate development projects across the region. The strategy required more than \$400 million in state funding to supplement billions in private investment. Strategy 21 projects encompassed airport renovation and technology parks, and capitalized on Governor Thornburgh's goal to spur statewide investment in advanced technologies. The effort further empowered the city's universities as local leaders driven by a reimagining of the city's future as a technology center.

In the ensuing years, economic development efforts were continually aimed toward this reimagined future. The Working Together Consortium charged the city with creating

100,000 new jobs by 2000 via infrastructure grants (Detrick 1999). Pittsburgh public schools saw substantial investment and became a paragon of public elementary education (Treadwell 1990). The guiding principle across the history of these programs was that Pittsburgh sought to reimagine itself as a center for advanced technology and research (Neumann 2018). Rather than shore up futures for the legacy steel mills and workers, state leaders promoted a new set of community leaders – the research universities.

While this strategy saw success in image and by some metrics, the social support resources for former steel workers and those in related industries were not often bundled into those grand economic plans (Neumann 2018). Graham (2002) writes that, in the wake of job losses, unemployment insurance and social benefits were provided solely by grass roots and religious organizations in Pittsburgh. The community was forced to step up to provide services that were not embodied in Pittsburgh’s plan for future growth. State and city efforts focused on impacted industries rather than blanket economic incentives, identified by Treado (2008) as fundamental to the Pittsburgh story. As the city’s service and technology economy grew and state-wide productivity flourished, median income stagnated and poverty rates outside the city limits rose, particularly for Black Americans (Neumann 2016). Pittsburgh went through a grand reimagining following the collapse of the steel industry, but it remains unclear whether state and local leaders were successful in enriching the lives of the existing population, or whether that was even a central motivation.

### ***3.2 The Role of Federal and Regional Policy in the Northwest Timber Transition***

The second example we highlight is the transition of the Pacific Northwest economy away from timber harvest. The Northwest Forest Plan (NWFP) encompassed a set of federal policies adopted in 1994 to regulate resource management for 24.5 million acres of forest in Oregon, Washington, and northern California (“Northwest Forest Plan” 2019) and aimed to both staunch the flow of timber job losses and protect the endangered Northern Spotted Owl. This example is particularly appropriate for comparative analysis in the context of deep decarbonization, because both this historical transition and the impending clean energy future will be simultaneously driven and affected by large-scale policy.

From the 1950s through the 1980s, timber was seen as the foundational industry for rural communities in the Pacific Northwest – in some regions (such as southwestern Oregon), timber jobs represented as much as 30 percent of total employment. Timber employment began to decline throughout the 1980s, due in part to mechanization, reduced capital investment, legacy mill closure, regional recessions, and lessening demand for wood products. In 1990, to further jolt the industry, the Northern Spotted Owl received a threatened characterization under the U.S. Endangered Species Act which led to a slew of court injunctions on timber harvest within the owl's habitat. In 1994, the Clinton Administration developed the NWFP, a two-pronged policy package to minimize impacts on owl habitat and stabilize the flow of regional timber sales. Whether caused by the initial threatened characterization of the Northern Spotted Owl or the later implementation of the NWFP the region continued to see steady declines in timber employment throughout the 1990s, endangering a core source of regional prosperity.

In considering this transition, Carroll et. al (2000) emphasize the complex social context that surrounded timber workers in the Pacific Northwest, and note that the “dynamics of attachment to place, to rurality, and to occupation” in the region were difficult to disentangle. The timber industry was only one of several factors tying people to the region. Further, Goodstein (1999) discusses the importance of a diverse market economy outside of timber, its own type of safety net – as timber employment declined, regional employment opportunities grew. This finding is mirrored in Charnley's work, which shows that the most severe effects of the transition were felt by communities located within five miles of federal forest (i.e., in rural, less diverse labor markets). In contrast, many communities in the region saw increased prosperity based on their proximity to major metropolitan areas, transportation routes, or natural amenities that spurred tourism (Charnley 2008). The region as a whole was buoyed by new employment opportunities while a small portion of timber-dependent communities were left behind.

Simultaneous interventions by the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) offer a convenient comparison of divergent outcomes based on regional context. Both land management agencies were required to oversee the planned transition from a timber-based economy to a new ecosystem management paradigm. USFS budget allocations were determined in large part by timber sales, and as harvests continued

to decline the agency saw an unexpected deep cut in funding. This budget reduction severely limited the ability of USFS to provide goods and services to the communities it serves (Charnley 2008). From 1993 to 2002, USFS lost 36 percent of its workforce (3,006 positions) and closed or downsized 23 percent of its regional offices. As timber jobs disappeared, so too did agency jobs within USFS. Paired with the declining workforce was declining funding for procurement contract spending, a key pathway for employing local workers. In 1991 USFS spent \$103 million annually on contract work. By 2002, only \$33 million. What USFS did spend was not targeted toward impacted communities (Charnley 2006). The Bureau of Land Management saw losses as well, but the bulk of their funding was not tied to timber receipts, and the agency started with a smaller mandate. BLM lost only 13 percent of its regional workforce in the same time period (166 positions) and agency contract spending stayed constant at \$20 million annually. Agency offices remained open, and BLM increased the funding allocated to the plan area which allowed local and state managers to appropriately distribute funds to affected communities (Charnley 2008).

Thomas Michael Power (2006) argues that the Pacific Northwest communities most in need, those that were strongly “timber dependent”, were seeing employment declines well before the implementation of the NWFP, and that the Plan actually “eroded the effectiveness” of the regional services (e.g. USFS) that could help them most by maintaining what little forest was left available to harvest. The responsibility of forest management and revitalization was increasingly placed in the hands of nonprofit or industrial actors, who had relatively less experience in the domain. While the core economic assumptions of the NWFP were flawed, and federal efforts to stabilize regional communities failed to materialize, entrepreneurial residents took the helm, and created their own economic opportunities within the region (Power 2006). Communities most negatively impacted by the Plan, particularly those in close proximity to forests, already experienced larger barriers to upward economic mobility. Charnley (2008) found that the most resilient communities were



those with close proximity to metropolitan or tourism areas or those with substantial alternative agricultural industry.<sup>2</sup>

In their 2006 review, Charnley et. al compile conclusions about the success of the NWFP across four goals related to socioeconomic success: (1) to produce a predictable level of timber sales, (2) to maintain the stability of local and regional economies, (3) to assist with long-term economic development and diversification, and (4) to promote agency and citizen collaboration in forest management.

The first goal, regarding predictable timber sales, was not fully met by Charnley's 2006 paper, nor by the publishing of a 25-year multi-author report outlining the plan's success (Spies 2019). The second goal, to maintain economic stability, was more nebulous and also not explicitly met. In 2006, Charnley found that an agency's ability to provide local stability was only as valuable as that agency's funding. In essence, USFS programs lacked the funding to provide community support, while BLS managed to achieve preliminary success. By 2019, the NWFP area saw diversification in forest-related jobs stemming from tourism and related ecosystem management (Spies 2019).

The Northwest Economic Adjustment Initiative (NEAI), also discussed in Gallagher and Glasmeier (2020), was designed to meet the third goal of long-term economic development. Unfortunately, NEAI was broadly considered 'too little, too late' to help displaced timber workers. Similarly, job retraining programs were limited to such small populations that the muted positive effects did not produce broad impacts (Daniels 1998).

The Northwest Forest Plan did achieve its fourth goal to some extent, to promote collaboration in forest management. Public support for forest management and strong relationships between local community members and agencies have been valuable, if community-dependent. Going forward, more attention will be paid to a growing minority population in the region and aligning tribal interests to ecological goals (Spies 2019).

One of the key findings of the 25-year assessment report is that the large-scale NWFP monitoring program has been vital to the success of the program, in meeting both its

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<sup>2</sup> Charnley notes that, while the nontimber forest products industry remained stable, employment was dominated by immigrant and mobile labor and didn't provide comparable family-wage jobs for displaced timber workers or former agency employees.

ecological and socioeconomic goals (Spies 2019). Some monitoring programs have been left aside, and uncertainty persists, but the commitment to monitoring has allowed policymakers, community leaders, and researchers to understand the complex regional dynamics affecting such a broad-scale program.

### ***3.3 Central Questions Raised by the Transition Cases***

Generally, policy initiatives in the context of industrial transitions are not embodied by one governmental or community effort, but rather by patchwork approaches to addressing major economic change. Resulting divergent outcomes are clear in both the cases of Pittsburgh's post-steel transformation and the Northwest Forest Plan. Each point to well-known policymaking tactics as leading to "success" but may also conflict with some guiding principles. In most cases, these conflicts arise based on differing regional characteristics. Below, we raise several questions brought forward by the above cases.

In both Pennsylvania and the Pacific Northwest, the largest policy programs were centered around the existing business landscape. In Pittsburgh, the Allegheny Conference on Community Development convened major research universities to lead the charge on public-private partnerships and strategic regional plans. These plans stimulated specific infrastructure development to enable the growth of the finance and service sectors within the city, leading to a more diversified economy. In the Pacific Northwest, rather than attempt to transition the region away from timber harvest, the Clinton Administration sought to stabilize the flow of timber products produced and sold in the region. However, by the implementation date, timber sales had already declined substantially. The Pacific Northwest later reimagined the role of its forests as the center of a local economy dominated by ecosystem services and tourism.

Both transitions might be considered successful based on the economic diversification that resulted, but it is unclear whether either slate of policies achieved the goal of mitigating poor outcomes for impacted workers. In Pittsburgh, integrating steel workers into a city actively reimagined as an advanced research economy inherently conflicted. The city relied heavily on public-private partnerships that did little to assist displaced steel workers. In the Northwest Forest Plan, timber workers were not visibly reskilled or put back to work within

their communities. Rather, the region saw uplift from other external industries. How then does this inform thinking around industrial transitions in the energy space? The regional vision for the future seems paramount, whether in advanced technologies or ecosystem services. As the United States transitions away from traditional fossil fuels, how must regional leaders envision their future industry? Economic diversification appears important for regional stability in these two cases, along with an eventual understanding that legacy workforces may fade entirely. How can policymakers structure clean energy legislation and regulation with respect both to the existing business landscape and also the imagined future?

Another key theme underlying these two cases is the existence of long-term convening and monitoring programs as a precedent to success. As Armstrong (2019) outlines, convening local actors to collaborate with state government agencies, monitoring the outcomes of any implemented policies, and adapting based on observation is vital to ensuring strong policy outcomes. In the case of Pittsburgh, the state government successfully convened and nurtured relationships between local actors. Further, they monitored the progress of university-led development issues over a series of decades, allowing the institutions to act as effective network liaisons. The Northwest Forest Plan initially saw unintended outcomes, as the initial premise that timber harvest was the only important link between rural communities and local forests proved false. This overlooked the significance of natural resources in influencing both tourism and local economic well-being. However, the NWFP was developed with long-term monitoring in mind and, 25 years hence, local and regional leaders continue to adjust forest management policies with respect to an evolving social fabric.

A decarbonized energy future, as envisioned, is sure to involve broad and diffuse policy programs. These two cases point to the deep importance of effectively convening and monitoring local actors and promptly adapting policy to reflect current status. How might Pittsburgh look if the State of Pennsylvania had funded Pittsburgh's research universities without oversight? Would the Pacific Northwest have weathered the decline of timber without careful and persistent attention to Plan outcomes?

With these questions in mind, we turn to the case of the U.S. lighting industry over the past several decades – to investigate how one portion of the energy industry has responded to declining domestic demand and subsequent productivity.

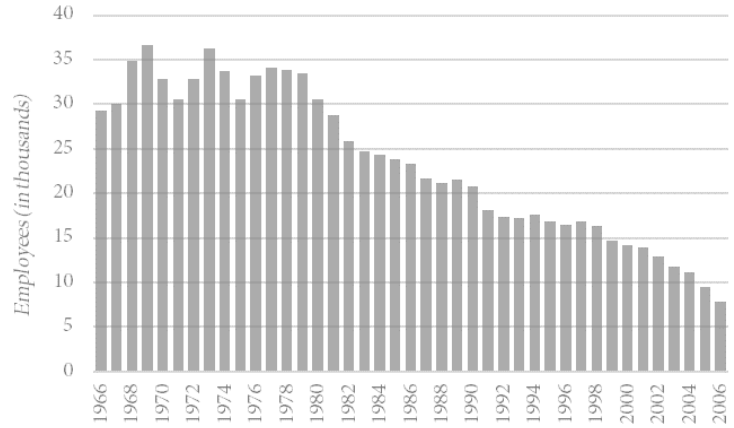
#### **4. The U.S. Lighting Industry: A Case Study**

Industrial transitions occur within a wide array of geographic, political, and temporal settings that are deeply influenced by macroeconomic and microeconomic activity and technological developments. These variations complicate the task of evaluating the effects of public policies on the outcomes of transitions. For this reason, studying the transition of the lighting industry from incandescent bulbs to LEDs is particularly informative. The lighting transition occurred nationally within a relatively short timeframe (starting around 2012), across disparate geographies, and involving many different firms. We are able to select specific cases that isolate these exogenous factors (time, geography, and politics), allowing us to isolate the relevant regional policy activity that we want to study. The case is particularly relevant to a study of future decarbonization because it was spurred by public policy, specifically the development of U.S. national lighting standards. It also occurred within a globalizing economic context, with intense pressures on the domestic lighting industry coming from abroad. The transition therefore required multi-levered responsive policy action, as will the transition to a decarbonized future.

##### ***4.1 History of the LED transition***

Light bulb production in the United States has declined steadily over the past several decades (See Figure 1). The last U.S. factory producing incandescent light bulbs, in Winchester, Virginia, closed in 2010. The few factories that have transitioned to specialty lighting or LED bulb production are struggling, and Sylvania's LEDVANCE facility, north of Pittsburgh, announced its impending closure in April 2019 (Brady 2019). Two key forces have driven the decline of U.S. light bulb manufacturing: increased international production and lighting efficiency regulations.

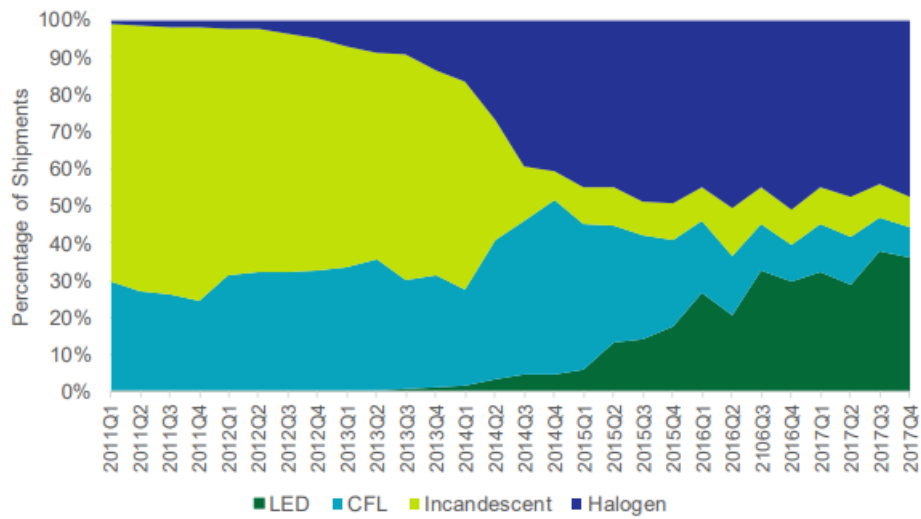
Figure 1. U.S. Lamp Bulb Production Employment, 1966-2006



Source: U.S. Bureau of Labor Statistics

Lighting standards were first implemented at the state level in the early 2000s. Following patchwork state-level enactment, bulb manufacturers and advocates worked together to drive federal action on lighting standards. In 2007, Congress passed the Energy Independence and Security Act (EISA), which required increased bulb efficiency of 25 percent by 2014, effectively shuttering remaining incandescent bulb manufacturers (Ungar 2015). This spurred a rapid transition away from incandescent bulbs, first to compact fluorescents (CFLs), then to halogen bulbs and, beginning in 2015, to LEDs (NMR Group 2018).

Figure 2. A-line Bulb Shipment U.S. Market Share, 2011-2017



Source: NMR Group, Inc. 2018, NEMA Lamp Indices

These lighting standards shook the international bulb manufacturing status quo. When the standards came into effect, China was the only producer of CFL bulbs. While U.S. manufacturers eventually began to produce LED bulbs, they remain costlier to produce domestically (Whoriskey 2010). The traditional lighting and bulb manufacturing industry is projected to decline “at an annualized rate of 9.8 percent” over five years and international imports, led by Chinese manufacturers, satisfy approximately 63 percent of domestic U.S. demand. On the other hand, the LED industry is projected to see 4.2 percent growth in 2019 alone (Holcomb 2019). Halogen bulbs continue to be shipped in regions that have lower efficiency standards as a marginally cheaper and more efficient replacement to incandescent bulbs (NMR Group 2018).

While jobs in energy efficiency soar across the United States, and in the efficient lighting sector as a whole (2020 U.S. Energy), futures for communities with existing lighting manufacturers are uncertain. Jennifer Dolan, the head of government affairs for LEDVANCE spoke to industry ambiguity in the context of the Pittsburgh plant closure, saying “There’s a lot of uncertainty in policy. There’s a lot of uncertainty in the marketplace. Everything is just converging to make it very difficult in lighting.” (Brady 2019) In the following pages, we examine the impact of policy, from the federal down to the community level, on groups affected by the decline of traditional lighting manufacturing and the ascent of efficient lighting.

#### ***4.2 Case Studies***

We selected four U.S. lighting manufacturing sites that represent different outcomes in the face of the bulb transition. The first, GE’s Ohio Lamp Plant, in Warren, Ohio, was one of the oldest lighting factories in the U.S. and was shuttered in 2014 after a long history of declining demand and a controversial union vote. The second, GE’s Circleville Plant, in Circleville, Ohio, was retrofitted to produce halogen bulbs in response to increasing national efficiency standards, but ultimately closed in 2016. The closure of each of these plants tells a distinct story about worker and union participation, as well as local and regional response to declining manufacturing. Our third case study considers Cree’s LED lighting plant based in Sturtevant, Wisconsin. Based in the smallest community we studied, the Sturtevant plant

represents the continued but tenuous success of Made-in-USA LED lighting. Cree's other key plant, in Durham, North Carolina is covered by our fourth case study. This plant, which has already transitioned away from lighting to semiconductors, sits in a different geographical and business landscape than the other three factories, and benefits from its close proximity to a strong research infrastructure.

As outlined above, these cases serve as a tool for isolating some of the exogenous factors that make studying industrial transitions so challenging. We examine two plants owned by both GE and Cree, which allows us to compare outcomes separate from and influenced by firm ownership. The two GE plants also allow us to examine divergent outcomes within the same geographical region (Ohio). Finally, among the many lighting plants that we studied, these four cases happen within the same timeframe. We are thus able to investigate the specific driving factors at both federal and regional levels across this period. Our careful case selection strengthens the comparative nature of our analysis by aiming to isolate similar cases.

### ***GE's Ohio Lamp Plant, Warren, OH***

One of the oldest traditional lighting factories, the Ohio Lamp Plant was founded in 1880 by the Packard Brothers and acquired by General Electric (GE) in 1903. In its hey-day in the 1970s, the plant employed 1200 workers, and maintained a strong workforce through the national decline of lighting, still employing 600 workers in 2000. However, by 2010, with an accelerating decline in demand, the plant employed only 240 workers (21 WFMJ 2013).

In 2013, as demand for traditional lighting dropped across the U.S., due in part to the EISA standards, GE threatened to shut down the plant (Tribune 2013). Threatened with losing their jobs, some plant operators developed a plan to convert the existing production lines to manufacture halogen lamps. In one of the few such events recorded, GE approved their proposal and agreed to reverse plans to close the plant. The local union (IUE-CWA Local 722) negotiated an offer that included 15 percent wage concessions, wage freezes, and personnel reductions, but ultimately kept the plant open in line with the worker proposal.

In a surprising turn of events, the factory workers ultimately voted the proposal down by a narrow margin of six votes. Older workers had the opportunity to cash in on strong

retirement benefits, and they narrowly outweighed the younger, more enthusiastic workers. The union and younger workers expressed disappointment, but legacy plant workers ultimately saw the GE deal as a band-aid – only pushing out plant closure by a couple of years. Carol Hoffman, a longtime Lamp Plant mechanic observed, "You are going to have young people losing their jobs. They think they are saving their jobs, but they will be laid off. People in the middle will go down to lower pay grade. It's not about seniority anymore." (Tribune 2013)

Bulb production at the Ohio Lamp Plant ended in January 2014, and the factory was demolished several months later. It was the last of six GE plants in the area to close (WFMJ 2014). The plant closure attracted both local and state attention, and Congressman Tim Ryan shared his support of the initial plan to keep the plant operational and subsequent disappointment at its closure. Warren, Ohio city officials estimated that the closure would result in an estimated loss of \$280,000 in income taxes (WKBN27 2014). The largest remaining employers in Warren are the Trumbull County Government, ValleyCare Health, AVI Food Systems (food service), Ohio Security Systems, and Warren City Schools (Regional 2019). Accordingly, the city turned to economic development options aimed at attracting new business via tax abatement incentives (WKBN27 2014).

In 2017, it seemed that some of those dreams had come to fruition when Chris Allen, a Warren native and the CEO of AutoParkIt, an automated parking solutions company, announced an expansion in the city. Allen bought both the Ohio Lamp Plant plot and an adjacent shuttered auto parts factory. His plan for the facility was multi-use, with some manufacturing functions (Nelson 2017). As of September 2019, AutoParkIt had invested four million dollars into facility improvements, had undergone a full locational environmental study, hired 40-60 employees, and had a reported monthly payroll of \$250,000. Allen took advantage of the tax incentives offered by the city, and was reimbursed for the environmental study by JobsOhio, a state-run public-private economic development agency (21 WFMJ 2019).

The response to the closure of Ohio Lamp Plant in Warren, Ohio was a one-dimensional push to incentivize new manufacturing in the same location. Warren's economic development materials trumpet the city as sitting at the "crossroads of America", within reasonable distance of ten major U.S. metropolitan markets. While the city hasn't seen major



success in the manufacturing arena, it hasn't seen unprecedented decline either. Population has been declining from its 2010 level of around 41,500, but slowly. Warren's median household income sits at \$29,241, substantially lower than the national average of \$63,179, and the poverty rate is 34.6 percent (American FactFinder). The city's identity revolves around its manufacturing workforce and has suffered from the decades-long decline in industry, driven initially by the fall of steel. The closure of the Ohio Lamp Plant follows that pattern, though it didn't dramatically worsen community livelihoods.

### ***GE's Circleville Plant, Circleville, OH***

The Circleville Plant was founded in 1948, and by its 50<sup>th</sup> anniversary employed more than 600 line workers. The Circleville Plant, owned by GE, manufactured primarily fluorescent lamps, and specialized in producing a wide variety of sizes and shapes that couldn't be manufactured elsewhere in the United States (GE Circleville 1998). The Circleville Plant experienced declines that mirrored those across the country in the early 2010s. In 2013, following the failed conversion proposal at the Ohio Lamp Plant, GE committed to a \$30 million investment in increasing production of soft white halogen light bulbs. Halogen bulbs had the advantage of being marginally more energy efficient, and GE planned increased production at their Circleville, Bucyrus and Mattoon plants. Across the three plants, GE projected an additional 150 jobs, 100 of which would be located at Circleville (GE to Invest 2013).

The halogen upgrade was motivated by increased lighting efficiency standards and also by a new agreement between GE and Walmart. Under the agreement, GE would provide soft white halogen bulbs to be sold in 3,400 Walmart stores across the country (GE to Invest 2013). In 2013 and 2014, the county also saw a resurgence of onshore manufacturing. Scott Paul, the president of the Alliance for American Manufacturing, said that manufacturing in the U.S. just seemed to "make economic sense". Jobs at the Circleville Plant climbed back up that year, and some line workers were even featured in a Made-in-USA ad campaign by Walmart (Gearino 2014).

As lighting standards pushed CFL and LED sales higher and international bulb production proliferated around 2014, the price of halogen bulbs dropped and GE's Circleville operations

became uneconomic. By 2016, the Circleville Plant was operating at 90 percent below capacity, and GE announced its closure. Workers were offered severance, a benefits package, and preferential treatment for employment at other GE plants. Approximately half of Circleville's workers were eligible to collect retirement benefits (Gearino 2017).

The City of Circleville had a relatively new, but strong economic development corporation, the Pickaway Progress Partnership, or P3, which covers Pickaway Country, stretching from Appalachia to the Columbus Metro Area. In Circleville, P3 partnered with the city government to provide income and net profit tax incentives through the City of Circleville Economic Growth Initiative. Their tax incentive package appears to mirror those in other Ohio cities (Business Programs). By 2017, P3 credited itself with creating 1,700 jobs and spurring one billion dollars in capital investment and had received over \$49 million in grant funding (Collins 2017).

The City of Circleville's Safety Committee was actively looking for a new user for the Circleville Plant site, but in the meantime focused on other avenues for attracting new manufacturing jobs (Collins 2019). In October 2018, Sofidel, a leading Italian sanitary tissue manufacturer announced a \$400 million investment in a new manufacturing plant in Circleville. The new plant comprises both a paper mill and a tissue conversion process. Sofidel employed 300 jobs at the plant's initiation and projected an eventual 700 positions. Sofidel took advantage of the local tax incentives and also benefitted from the SelectUSA project, designed to promote foreign investments in the United States (Sofidel 2018). Additionally, in March 2019, DuPont announced a \$200 million investment to expand their existing Circleville operation and add 50 more positions on top of the existing 500, allaying community concerns around the future of the plant in the face of the Dow Chemical/DuPont merger (Williams 2019).

Circleville followed a similar strategy of economic development and business incentive structures as Warren, but saw more success, likely due to the existing growth of regional actor networks. Circleville's population rose 3.4 percent from 2010 to 2019, to 13,965. Educational attainment is similar in both cities, but the median household income in Circleville is substantially higher at \$41,660, and its poverty rate is much lower at 23.1 percent (American FactFinder).

### ***Cree Wisconsin, Sturtevant, WI***

In August 2011, Cree, an American LED manufacturer, acquired Ruud Lighting and its manufacturing facility in Sturtevant, Wisconsin. Cree paid \$525 million to acquire Ruud, which manufactured LEDs and had a strong niche in the outdoor lighting market. In Sturtevant, Cree planned to expand Ruud's manufacturing facility by 280,000 square feet, costing approximately \$24.5 million and projected to bring 469 new jobs to the town over four years. For this proposed expansion, Cree received incentives totaling \$8 million from the Wisconsin Economic Development Corporation, Racine County, the Racine County Economic Development corporation, and the Village of Sturtevant (LEDs Magazine 2011). Further, the US Department of Energy provided a show of support to Cree in 2013, when it designated a \$30 million grant to expand the firm's manufacturing footprint in both Wisconsin and North Carolina (JournalTimes 2013).

On the surface, it appears that Cree's investment paid off for the village of Sturtevant. As of 2019, they employed approximately one thousand workers (JournalTimes 2019) and were one of the three largest employers in the village, all of which are manufacturing firms (including BRP US, a powersports company, and Andis Company, an electric clippers and trimmers manufacturer) (Leading Employers).

However, Cree has been volatile in recent years, and it is unclear whether stress on the company will translate to lost jobs in Sturtevant. In 2016, Cree saw corporate-wide layoffs, though they were limited in the Sturtevant area (Patch). In 2018, the Trump Administration announced tariffs on LEDs that threatened Cree's international supply chain, in the face of already declining gross margins – down to 26.4 percent in 2018 from 34.7 percent in 2016 (WSJ). Finally, in 2019, Cree announced that it would sell off its entire lighting business for \$310 million to Ideal Industries and would transition its focus to semiconductors. As of March 2019, there was no announcement regarding the impact on employees at the Sturtevant location (JournalTimes 2019).

Sturtevant is stable right now with a population around 6,600, educational attainment and median income high (\$67,212), and the poverty rate around 8.9 percent (American FactFinder). Yet, its future remains unclear, as the LED lighting plant faces an uncertain future.

### ***Cree North Carolina, Durham, NC***

Meanwhile, Cree's other central factory, located in Durham, North Carolina, a much larger city, though touched by the rapid shift away from lighting, may not see negative consequences for workers or the community. In 2015, Cree announced that it would consolidate its two Durham factories into one. Much of Cree's lighting business was already centered in Wisconsin, but Durham continued to be the central hub of Cree's manufacturing operations, internationally and domestically (Ohnesorge 2015).

Following the sale of its lighting business, Cree doubled down on chip fabrication. In 2019, Cree announced a \$1 billion investment in expanding its silicon carbide wafer manufacturing capacity in Durham (Area Development 2019). This plan included a partnership structure with state and local community and four-year colleges to implement training programs aimed at preparing a workforce for long-term, high quality employment. Further, Cree is investing in Utica, New York via a public-private partnership with the state that will comprise a \$1 billion investment and create 600 local full-time positions at a new silicon carbide wafer factory (Business Facilities 2019). Similar to Cree's efforts in Durham, the Utica facility will implement a talent development program in partnership with the State University of New York (SUNY) system.

Durham is a major city with a population of approximately 274,000, with an extremely high educational attainment rate (around 49 percent of the population has a bachelor's degree) and a median household income of \$55,851 (American FactFinder). Cree's individual success as a firm likely will not impact the overall health of the city, but the city of Durham does provide Cree with a strong set of resources and a fertile testing ground for the expansion of its semiconductor manufacturing.

### ***4.3 Central Findings from the Lighting Cases***

Based on our examination of these four case studies, we have identified four central conclusions regarding post-transition stability.

**Union involvement.** As with many traditional manufacturing operations, unions play a central role in the livelihoods of workers employed at lighting plants. In these scenarios, union involvement appears to consistently improve worker outcomes, even when plants

close. In the Warren and Circleville cases, the unions were central to managing the relationship with GE. In Warren, GE allowed a 60-day period following the initial plant closure announcement for unions and employees to submit ideas to make the plant more competitive. The workers developed a plan so attractive that GE reversed its decision to close, an unprecedented move. In parallel the IUE-CWA Local 722 in Warren had successfully negotiated strong wages – GE’s CEO had once called workers the highest-paid lightbulb workers in the world, and they earned \$27 per hour (Ohio Lamp Plant). However, high historical wages and strong benefits, negotiated by the same union that supported the plant conversion project, ultimately contributed to the plant’s closure.

The Warren and Circleville plants are both based in Ohio, both owned by GE, and were both faced with the same federal lighting policies. While workers at both plants were represented by a union, the Warren plant saw stronger action by local leaders while the Circleville workers were left with base level support. Ultimately, the Warren workers were able to exercise more agency and benefited from a stronger set of negotiated protections, while the Circleville community faced a slow and uncertain decline.

**Regional economic development corporations & business incentives.** In all four of the cases we studied, economic development corporations were heavily involved in spurring local investment. These organizations serve primarily to incentivize the development of income and profit tax incentives, and in some cases partner with manufacturers to find sources of initial capital. At the local level, both the City of Circleville Economic Growth Initiative and the Village of Sturtevant provided tax incentives for local manufacturing development. Regional economic development corporations, such as the Pickaway Progress Partnership in Circleville and the Racine County Economic Development Corporation, credit themselves with effectively marketing their respective regions and creating beneficial connections between industry and local government to fund expanded manufacturing. Further, firms pursuing new manufacturing in the place of traditional lighting leveraged state-level programs (e.g., the JobsOhio funding of site environmental studies in Warren Ohio and the State of New York partnership with Cree to fund the new Utica facility). In each of these communities, regardless of ownership, geography, or population, economic development corporations served as a mechanism to drive policies that promoted business incentives and sought to create a business-friendly environment.

**Detrimental effects of private-private partnerships.** Circleville's story is a reminder that private-private partnerships, while beneficial for the participating firms, may also discount community longevity. The initial Made-in-USA partnership between GE and Walmart led to a brief increase in employment, but ultimately failed to recognize the impending decline of domestic lighting manufacturing. Sturtevant, Wisconsin is a small town that is highly reliant on a few key manufacturers. Throughout Ruud's, Cree's, and now Ideal Industries' tenures, the future of the Sturtevant plant has been opaque and provides little long-term assurance to workers. Both communities, previously reliant on these private actors for support, anticipate future reliance on similar industry partnerships.

**The effectiveness of retraining or career support programs.** In every case, in every geography and every community size, retraining and career support is placed in the hands of the corporations, which makes the process opaque at best. There is very little evidence concerning what, if anything, these programs have added for displaced workers. Facilities with proximity to strong research hubs can lessen corporate reliance by partnering with universities to develop a more highly-skilled manufacturing line. For example, as Cree transitioned its Durham facility to semiconductors it utilized the nearby network of colleges and universities and looks to be pursuing the same approach for its new facility in Utica.

## 5. Conclusions and Policy Recommendations

The transition from incandescent to LED lighting may seem at first like yet another story of traditional industrial demise in the United States. Yet our four case studies suggest a somewhat rosier picture. In the least fruitful transition, approximately half of the employees at the Ohio Lamp Plant entered retirement upon plant closure, while the rest found other manufacturing jobs within a close radius. In a more positive transition, Cree leveraged its early success in LED lighting into semiconductor manufacturing within the U.S., leading to the growth of more accessible and more highly-skilled jobs. The presence of strong local unions and regional economic development corporations have shepherded the growth of new business, though private-private partnerships demonstrated little recognition of community development and the impact of retraining programs remains hidden. Beyond these policy considerations, lighting communities have consistently benefitted from their geographic proximity to other manufacturing jobs or metropolitan centers.

### *5.1 Recommendations*

Between our literature review and industrial transition and lighting case studies we conclude that policy packages are strongest when they acknowledge distinct regional social fabric and human capital, carefully structure policy to encourage cross-community collaboration, and design policy with the particular business landscape in mind, while avoiding overreliance on private firms. Accordingly, we have developed a set of three high-level recommendations for policymakers to keep in mind when responding to the impending energy transition.

**Understand local competitive advantage. Knowledge of a community's specific skillsets and an understanding of the importance of geography is paramount to managing a transition.** Each community has its own characteristics, and policymakers should be fully aware of these. In our research, we found that knowledge of a community's specific skillsets and an understanding of driving geographical factors is paramount. For example, line workers in communities dominated by lighting manufacturing have been able to step from traditional bulb manufacturing to employment in advanced bulb or other forms of production and manufacturing. In contrast, select rural timber communities in the Pacific

Northwest faced severe challenges in changing occupations and saw little assistance from the regional market-based policy effort.

Additionally, while geographic proximity to major metropolitan areas has been a boon to displaced lighting and steel workers, less obvious place-based social and economic factors drove success in some transitions. Take, for example, the many moderately remote communities in the Pacific Northwest who were able to leverage the natural beauty of their locations to advance tourism. Geography, existing skillsets, and other underlying indicators of regional social fabric should be considered and interrogated ahead of policy creation.

**Build ties between core institutions.** Nearly every example of industrial transition we investigated benefitted from a robust structure of communication and trust between local actors. The absence of any particular group or dominance of one strong firm can lead to policy capture and emerge into unintended consequences. Take the case of Cleveland, Ohio, where an existing network of private actors monopolized on attempts at economic development and failed to include community organizations (Safford 2009) versus Pittsburgh which successfully leveraged a network of private actors, research universities and community organizations to reimagine the city.

Similarly, in Sturtevant, the reliance on a few major private firms and relative lack of social or educational assets makes the community's future uncertain whereas in Durham and Utica, Cree is partnering with state government and local universities to provide a multi-organizational robust safety net. Policymakers should prioritize the creation and maintenance of stakeholder networks ahead, during, and following the implementation of economic development efforts.

**Leverage economic development corporations and public-private partnerships with caution. Beware the creation of private-private partnerships or private initiatives that do not consider long-term community benefits.** Economic development corporations feature heavily in the current steady or positive progress during the lighting transition. They can provide useful hubs for facilitating strong networks and maintaining the prominence of regional knowledge. However, the work of economic development corporations must be



monitored, as the business tax incentives they promote are highly susceptible to policy capture and misuse.

The story of the Circleville lamp plant, and its overreliance on a private-private partnership between GE and Walmart serves as a warning against trusting siloed firm-led policies. While often well-intentioned, private deals can be blind to community futures. Across our literature review and case studies, public involvement was key to building beneficial outcomes. While private initiatives may play a central role in some post-industrial transitions, it is important that policymakers structure plans that do not rely too heavily on them.

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