July 2024

Economic Diversification of Coal Communities

Case Studies from the U.S. and India

Ian Barlow, Sandeep Pai, Rishi Kishore, Deeksha Pande

July 2024

Economic Diversification of Coal Communities

Case Studies from the U.S. and India

Ian Barlow, Sandeep Pai, Rishi Kishore, Deeksha Pande

SWANITI GLOBAL
THE GLOBAL CLIMATE AND DEVELOPMENT INSTITUTE

About Us

Swaniti Global, founded in 2012, is a social enterprise that provides development solutions and technical assistance to improve the delivery of public services by leveraging research, data, and on-ground expertise. Swaniti works in areas of climate, public health, and livelihood. Swaniti's theory of change is that if people are provided with access to quality healthcare, education, employment, and social welfare programs, then everyone shall have an equal opportunity to thrive. Swaniti has worked across five countries and 11 Indian states to enable administrators to effectively implement programs within communities. Swaniti works across South and East Asia with local teams present within communities. We have 150+ team members across geographies and work in a decentralized model.

The **Global Climate and Development Institute (GCDI)** is an initiative by Swaniti. It was established to tackle the most pressing challenges of climate change and harness opportunities for climate action. GCDI operates on a global scale, emphasizing high-quality research on climate and development issues. Additionally, it actively collaborates with policymakers, elected officials, and communities worldwide to address critical climate concerns.

SWANITI GLOBAL
THE GLOBAL CLIMATE AND
DEVELOPMENT INSTITUTE

Editor: Prashansa Taneja

Cover and design: Abhi Vaishnav

Citation: Barlow, I., Pai, S., Kishore, R. & Pande, D. *Economic Diversification of Coal Communities Case Studies from the U.S. and India*. (Swaniti Initiative, 2024).

Published by

Swaniti Global
Houston, Texas, United States
www.swaniti.com

Acknowledgements

The authors wish to acknowledge the support of the following individuals and organizations:

Reviewers: Rusty Bell (Gillette College Foundation), Samuel Workman (West Virginia University), Manish Kumar (Regenerative Environment and Development Foundation), Christine Risch (Marshall University), Matt Dalbey (Resources for the Future), Ezgi Canpolat (World Bank), and Ben Cahill (Center for Strategic and International Studies); Chinmayi Shalya and Joey James (Swaniti).

In addition, the authors would like to thank Shweta Srinivasan and Rupika Singh (India Climate Collaborative); Rusty Bell (Gillette College Foundation); Joey James, Kumar Satyendra Singh, Sai Chandra R, and Sriram Kolasani (Swaniti); Evan Hansen (Downstream Strategies); Ramendra Kumar (All India Trade Union Congress and former Member of Parliament), Vikas Kumar (United Coal Workers Union); Anand Prajapati (Zila Parishad); Riyaz Ahmed (Hind Mazdoor Sabha); Baba Saida and Lakhanlal Mahto (All India Trade Union Congress); and Arun Kumar (Centre of Indian Trade Unions) for their help in conducting this research. The authors also thank Arpita Kanjilal, Maitri Singh, Shehnaz Sharif, and Suresh Ram of the Digital Empowerment Foundation, and officials of Central Coalfields Limited, Singareni Collieries Company Limited, and the districts of Ramgarh, Peddapalli, and Bokaro for their help in data collection, surveying, and informing this report.

Table of Contents

Executive Summary

Coal production and consumption are under pressure worldwide. This pressure is largely due to the need to address climate change, or concerns about coal's economic viability, or both. In the United States, coal production has fallen by 47% since 2001 owing in large part to competition from natural gas and renewables.[1] In India, a commitment to coal phase-down has been made, but its production and consumption continue to grow rapidly to meet development needs—conservative estimates put annual coal production at 1.3 billion tons by 2030, i.e. a 300 million ton increase in current production levels.[2]

Addressing climate change successfully may require shuttering hundreds of coal mines and power plants globally, affecting coal-reliant communities on an unprecedented scale. For these communities, managing the sector's decline is an enormous—and often existential—undertaking.

To address this challenge, policymakers and scholars worldwide have proposed and enacted frameworks and mechanisms for a 'just transition' of coal-reliant communities, to mitigate the economic losses of coal decline. Diversification of coal-dependent economies is a goal often included in these just transition proposals meant to reduce coal dependencies and create more local economic resilience.

Economic diversification is generally enabled through economic development, which includes activities ranging from redeveloping legacy infrastructure for prospective investments to increasing literacy for local workforce readiness. These activities can both help attract new sectors to a community and expand smaller pre-existing ones.

Focusing on three local regions (counties/districts) each in the United States and India, we conducted a mixed-methods study to understand the scale and type of coal dependencies in these local regions, and economic diversification options for the future.

Based on the study, we have several recommendations for advancing just transition understanding and policy work:

1. **Governments, philanthropies, academia, international organizations, and civil society need to holistically consider coal dependencies when navigating just transition.** How the coal sector is integrated in communities varies substantially. These dependencies differ spatially, by degree, and by type. While all case studies show a dependence on the coal industry for employment and government revenues, the degree of dependence for either varies considerably. Other dependencies also vary; for example, in India informal coal jobs are prominent in some communities, but this is not the case in the United States. Holistic consideration of the coal industry's role in these communities can help foster more robust transition planning and management that account for essential, though perhaps less obvious, impacts.

2. **Governments, philanthropies, academia, international organizations, and civil society should support long-term economic diversification**

beyond the energy sector. Coal decline in coal-reliant communities is experienced acutely as an economic issue. Non-energy sector alternatives to coal may prove as or more beneficial to these communities, leading to a local economic future beyond or separate from energy. Funders should foster activities beyond greenhouse gas emissions mitigation in communities transitioning away from coal. Transition funding should support broader economic development activities that can help these communities diversify beyond clean energy deployment and repurposing of fossil fuel assets for alternative uses within the energy sector.

3. **Governments, philanthropies, IGOs, and other funders should increase longer-term funding opportunities for development activities that foster diversification.** Strategies can take a decade or more to bear fruit, thus making stable funding a huge boon to diversification efforts. Funding should not only be made available for clean energy projects. Our analysis shows that communities across the United States and India aspire to diversify into sectors ranging from tourism to food products. Activities destined to help coal-reliant communities should involve programming or funding that is guaranteed over longer periods, in order to help foster stability in the community's transition efforts.

4. **More research is needed by academia, state governments, IGOs, philanthropic organizations, and other stakeholders into finding suitable transition sectors for coal communities.** Interviewees and discussants identified sectors in each case study—from pisciculture to data centers—based on local assets, existing sectors, or government incentives; however, whether these sectors can fill the socio-economic gaps left by coal decline is not well understood. More research is needed to determine which sectors would be best suited for coal communities both in terms of filling the gaps left by coal decline, a community's unique characteristics, and its local assets. Additionally, research should be conducted into balancing sector-specific development efforts with broader economic development activities, given limited resources and to avoid risks of unduly targeting specific sectors.

5. **State and national governments should help localities holistically define, track, and assess economic diversification at the local level.** There is no universal definition for diversification at the local level. Providing a data-driven, multivariate definition and evaluation of diversification would help communities and external supporters chart a path toward economic diversification at the local level. ■

1.0 Introduction

For the first time, the world has seen record-high temperatures for 12 straight months.[3] This historic heat is a direct result of a decades-long lead-up to a 1.5-degree Celsius increase in global temperatures above pre-industrial levels. According to a survey by *The Guardian*, nearly 80% of top climate scientists consider global temperature rise likely to reach at least 2.5 degrees Celsius this century.[4] This continued rise will almost certainly worsen wildfires, droughts, floods, and other extreme weather events, and affect every region of the world.

Continued burning of fossil fuels, including coal, oil, and natural gas is the single most important reason behind this rise in global temperatures. While many countries are formulating policies to reduce their reliance on fossil fuels, the momentum towards a coal 'phase-down' or 'phase-out' is most visible.[5,6] Economically, low-carbon energy sources are increasingly competitive with coal—and are reducing coal's share in many electricity markets. As of writing this, 181 national governments, sub-national governments and prominent organizations including the United States have joined the Powering Past the Coal Alliance and committed to a complete phase-out of coal.[7] Although this is significant, notable exceptions include China and India, where coal use continues to thrive. Nevertheless, even these countries have committed to a coal phase-down in the long run.

While alternatives to coal are becoming increasingly commercially competitive, how local regions can successfully navigate coal phase-down is still not fully understood. Millions of workers and thousands of local communities around the world depend on coal for jobs, revenues, and social services. These economic benefits can be existentially important and difficult to replace both tangibly (e.g. with alternative sectors) and politically (e.g. public acceptance of coal decline). Coal mining as a way of life is often intergenerational and deeply embedded in local culture. The magnitude of these dependencies on coal make just transition—the varied, multi-dimensional efforts to mitigate negative impacts of energy transition on communities and people—not only an imperative from a justice point of view but also a key political and socio-economic consideration.

In the last few years, governments, academics, unions, philanthropists and multilateral organizations have strongly advocated for just transition for fossil fuel workers, their communities, and local regions.[8] On the other hand, from the United States to Australia, some mainstream politicians have instead supported continuation of coal industries to save local jobs and revenues.[9–11] This has in many instances delayed low-carbon transitions.

Earlier work on coal-related just transition globally has focused on three types of studies. First is a set of studies creating frameworks for just transition, quantifying coal dependency at the national or regional level, or understanding the role of solar jobs in replacing coal jobs.[6,12,13] The second set quantifies the cost of just transition using national averages, including the modeling of jobs lost versus gained in different climate scenarios.[14,15] These studies mainly emanate from the field of economics. Finally, some comparative work has been done at a state/provincial level comparing coal dependencies and economic diversification efforts.[16]

Although these are all useful studies, policymakers and scholars have advocat-

ed for a more systems-thinking approach and a clearer understanding of how local coal-dependent regions can diversify their economies. Economic diversification is meant to make the economy more resilient by reducing dependence on a single sector, such as coal. While economic diversification has gained traction as a key element of just transition, it is unclear how diversification may actually work in coal communities—despite the buzz, diversification is rarely studied at the local level.

We fill this knowledge gap by conducting a first-of-its-kind economic diversification study focusing on six local coal communities—three each in the United States and India—at different stages of transition. Focusing specifically on local regions, we investigate the scale and type of coal dependency at the local county (U.S.) or district (India) level. Then, based on interviews and other research, we identify new sectors for diversification and actions that may help advance these sectors within these communities.

We have chosen to focus on case studies from the United States and India because they are among the top producers and users of coal globally. Both countries have a long history of regional coal dependency, and coal is still an economic driver for many local regions in each country. While coal is on its way out in the United States—its production and use have declined by over 50% in recent years—coal use is still growing in India. This provides an interesting variation among case studies for this research.

Moreover, in both countries there is significant momentum for just transition. In the United States, the federal government and several coal-dependent state governments have made just transition a priority. With the passage of the Infrastructure Investment and Jobs Act, Inflation Reduction Act, and the CHIPS and Science Act, more than $100 billion have been allocated to just transition-related activities that could help transition coal communities. Similarly in India, the federal Ministry of Coal, states like Jharkhand, and federally owned coal companies like Coal India Limited have created their own task forces on just transition to gather evidence on how India's coal transition can be achieved while mitigating harm to their coal-dependent workers and communities.[17]

In 2022, these countries declared a joint U.S.–India Strategic Clean Energy Partnership that focuses, among other priorities, on just transition. Its preliminary report recommends "exploring regional collaboration and strategies, including sub-national engagements between coal-rich U.S. and Indian states to share best practices on how the states are dealing with decreasing dependence on coal."[18]

Analyzing and providing insights on coal dependency and economic diversification in different local communities in these countries would therefore be useful for the studied jurisdictions as well as for other coal-dependent economies in the United States, India, and beyond.

In the next section (2.0) we explain our objective and methods. In section 3.0 we share our case studies. Each study describes the nature of coal dependency in the locality, economic development in the area, and prospects for diversification. In section 4.0, we share our observations based on these case studies. In section 4.1 we discuss our work in the context of existing literature and consider the policy implications of our study. In the end (4.2), we provide recommendations for the United States, India, and more broadly for the field. ■

2.0 Objective, Research Questions, and Methodology

In this study we focus on the following research questions:

- **Q1:** What is the scale and type of local economic dependency on the fossil fuel industry?
- **Q2:** What are sectors for economic growth that local regions can diversify into, and the challenges and opportunities associated with them?

To answer these questions, we conducted mixed-methods case study research in six local regions. These consisted of field visits to mines and power plants, semi-structured interviews with local and regional community members, and focus group discussions involving key stakeholders like local governments, county and city governments, advocacy and environmental groups, unions, and workers. The first part of the interviews constituted open-ended questions; the second part involved direct questions about the scale and type of coal dependency and economic diversification options. Overall, we interviewed 25 and 44 experts in three U.S. and three Indian case study locations respectively. These interviews were semi-structured and recorded with written notes.

Apart from interviews with community members, we also collected secondary data on a number of socio-economic indicators, such as local revenues, local GDP, coal jobs, and community development spending. Very early on in the research it became clear that there was a lack of available basic datasets in the Indian context. Many scholars have reiterated that energy research in India has a data availability problem: "Lack of robust datasets has been a stumbling block for serious research and analysis on energy in India, evidenced, for instance, by limited data-driven analysis in top journals."[19] To counter this, we conducted primary data collection, including household surveys and enterprise surveys in all three case study locations in India. An upcoming complementary report will delve deeper into this massive data collection process and its associated analysis.

Once the data collection was completed, we used deductive coding methods to generate details of each key theme.[20] This process began by carefully reading existing literature, public documentation, and relevant press reports. Themes and sector categories were then determined, to which details were added through interviews, surveys, and other data collection methods before analysis. Finally, patterns were identified across communities and sectors to assess commonalities and differences between communities.

2.1 Case Selection and Scoping

In this study, we focus on counties and districts as our unit of analysis.

In the United States, counties are the primary and largest subdivision of states (smaller subdivisions include municipalities, towns, and townships). Counties are responsible for various activities that involve diversification, including community

development, site development, zoning, and provision and maintenance of infrastructure. County revenues vary, but much of these are derived from locally levied property taxes. Other sources of revenue include various other local taxes, redistributed state revenue, and federal grants.

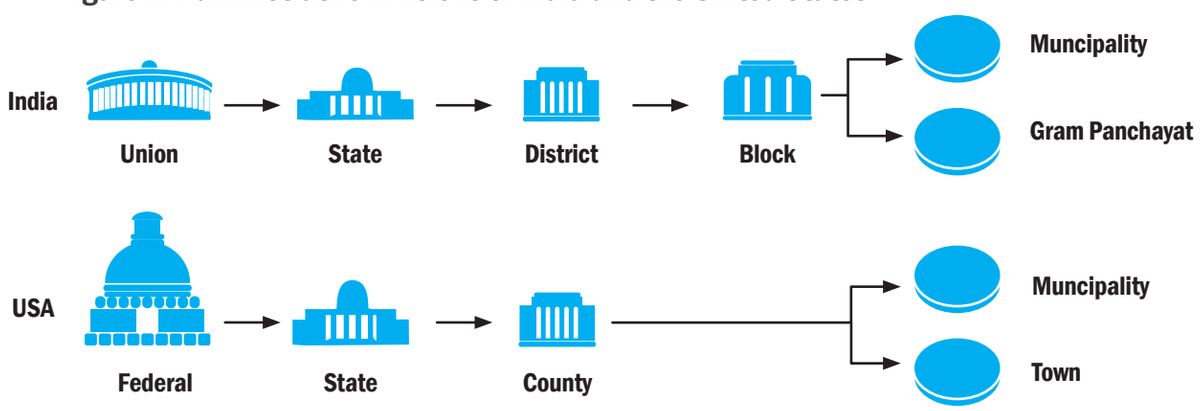
In India, districts are an important administrative subdivision of states. India's governance model is more centralized than that of the United States: generally, the national government sets priorities and distributes revenues, states then refine these priorities, and the districts implement. Districts are also responsible for the provision, permitting, and maintenance of infrastructure. Districts have no independent taxing authority; taxation and revenue distribution are decided at the national and state levels.

Districts and counties were selected as our unit of analysis for three primary reasons. First, the clustering of coal sector activity is generally more pronounced at the district and county levels due to concentration mining around coal seams, and the large local imprint power plants can have on local economies (e.g. through property taxation or high-paying jobs). Assessment at the state-level would have been too broad and obfuscated acute local dependencies; a scope more localized than counties and districts would have been too narrow jurisdictionally, geographically, and economically. Regional segments would have been inappropriate largely due to a lack of country-to-country equivalency and analytical difficulties stemming from analysis across multiple jurisdictions.

Second, districts and counties are the most comparable local administrative subdivisions between India and the United States in terms of geography, government revenue, and authority. Smaller Indian administrative units (i.e. blocks) in India have comparatively less authority than smaller U.S. units like municipalities.

Third and last, local data was most readily available at the county and district levels. In the United States, local-level data provided by state and federal government often stops at the county level, if available at all; collection or public provision of data by counties themselves varies widely and is often limited. In India, data is often diffuse, scarce, and not publicly available below the state level. Consistent data collection for administrative divisions lower than district would

Figure 1: Administrative Divisions of India and the United States



Note: This graphic is a simplification of organization for general guidance; variations exist in both countries. For example, some U.S. municipalities are merged with their respective counties. In India, some states have an additional level (divisions) in order to administer districts in clusters.

present immense challenges.

Among counties/districts, we chose Fayette, Person, and Campbell counties in the United States, and Ramgarh, Peddapalli, and Bokaro districts in India. We did this to capture the diversity of case studies: some that have largely transitioned away from coal, some that are actively seeing a coal decline, and others where coal transition is a few decades away. This is partially reflected in the case study titles, which identify their transition status relative to a >40% decline of coal or coal-fired power production over the last decade. We also focused on these localities as they represent communities that are variously dependent on coal mining or power generation,

Table 1: Case Study Counties and Districts, Select Characteristics

Case studies were selected based on diversity of geography, coal sector composition, economic state of coal sector, and other economic characteristics.

	Fayette	Person	Campbell	Ramgarh	Bokaro	Peddapalli
Coal sector composition	Mining	Power generation	Mining, Power generation	Mining	Mining, Power generation	Mining, Power generation
Current coal production million short tons	2.36 (2022)	n/a	216 (2022)	11.6 (2022–23)	16 (2023–24)	14.3 (2023)
Peak coal production* million short tons	7.05 (2008)	n/a	415 (2008)	38.7 (2040)	47 (2039–44)	33 (2036–40)
GDP per capita*	$28,000	$39,000	$121,000	$1,189	$801	$2,500
Population	40,000	39,000	47,000	1 million	2 million	795,332
Poverty rate**	20.2%	13.8%	8.6%	18.06%	15.28%	2.17%
Sex Ratio	102.4	94.2	104.5	108.6	109.2	100.8
Rural Population	57.9%	75.5%	29.1%	55.9%	52.3%	61.8%

a. Indian district peak production numbers are estimates.

b. Estimates in current U.S. dollars. Indian numbers are rough estimates based on the latest available population estimates (2011).

c. Poverty rate and rurality calculations vary by methodology and may not be directly comparable.

Source: U.S. Census Bureau[21–24], U.S. Bureau of Economic Analysis[25], U.S. Mine Safety and Health Administration[26], Singareni Collieries Company Limited[27,28], Central Coalfields Limited[29,30,] Census of India [31], Jharkhand Department of Planning[32], Telangana Directorate of Economics and Statistics[33], Peddapalli District Administration[34]

or both. Studying various types of case studies collectively helps us capture a whole host of coal dependencies and diversification options. Community buy-in was another important factor in the selection criteria for counties and districts; we chose these localities because we had historically engaged with some key stakeholders in these counties and districts. Previous engagement helped us access the expertise and data required to answer the research questions.

2.2 Limitations

This study is limited in several ways—one being that it does not directly address the political economy of transition, fossil fuels, diversification, and development. This is deeply interlinked with the systems and policies in place around diversification and development, which are not generally scrutinized at a fundamental level in this study. The political economy of these issues is considered by the authors and incorporated into this report (e.g. local acceptance of coal decline), but it is not deeply analyzed. Additionally, the socio-economic forces that have long supported coal in these communities have not been studied in this report or in the case studies; however, this is an important dimension to the prospects for new sectors in these communities and one that should be considered in future work. Given the highly political nature of economic diversification and coal transition, this is perhaps the most notable limitation of this study.

The potential impacts of diversification on different groups within these communities were also not assessed. Interviews were conducted with small cohorts of community leaders that may not reflect all groups within these communities. How diversification manifests in communities has significant and varied effects on different community members and should be considered in future research. For example, one interviewee noted the experience of coal decline can be heavily gendered; a household's loss of the salary of a coal miner may result in women taking on additional work in the form of wage labor to offset this loss.[35] Diversification into alternative sectors may affect these dynamics. Additionally, the views on diversification of these community groups may differ from those presented here and thus may affect how diversification should proceed locally.

Finally, this study's identification and analysis of prospective sectors is qualitive and based on interviews and research rather than on deeper economic analysis. Therefore, this study should be considered a first step toward identifying possible diversification pathways for communities instead of a comprehensive economic assessment of sector viability within these communities. ■

3.0 Case Studies from the Field

3.1 Transitioning: Fayette County, West Virginia, United States

Section 1: Background and Coal Sector

Fayette County is a rural Appalachian community of about 40,000 people in south-central West Virginia. The county's gender ratio is about 102.4 (nearly 1:1) and the population's two largest racial demographics are White (92.2%) and Black or African American (4%).[21,22] The median age is 44.7 years.[21] The county was once the largest coal producer in the state. Currently, the county has about ten active mines.[1] By some measures, Fayette County has already undergone a significant transition away from coal—both coal production and employment have declined over the last century due to coal resource depletion, competition from natural gas and low-sulfur coal, environmental regulations, and mine mechanization.[36,37] Between 2012 and 2022, direct mining employment in the county dropped by 35–40%.[26] Fayette County's coal production has declined about 67% since record production in 2008.[26]

Several interviewees said that the county is no longer considered coal-dependent economically.[36,38–40] Today, Fayette's top three sectors for employment are healthcare and social assistance; retail trade; and accommodation and food services.[41] However, coal remains a socio-economic force, and the sector remains embedded in the county economy in two primary ways:

1. **Employment:** Approximately 4% of total employment in Fayette County is directly related to coal production.[26,41] This share is above the U.S. average, but below average among coal-producing counties in West Virginia.[42] Given the industry's shift to contract labor in the last few decades, the total coal employment in the county could be over double this number.[43] Mining jobs are among the highest paid in the region, amplifying their importance. According to the National Mining Association, average annual coal mining wages in West Virginia were at $91,680, nearly double the state average for all other industries ($49,748).[44]

2. **Tax revenue:** Fayette County relies on the coal sector for about 4% of its revenues.[45–47] This number is speculative due to data availability and collection, a common challenge at the local level. Revenue comes to the county both directly (e.g. property taxes) and indirectly (e.g. coal severance taxes). Counties in West Virginia generally cannot levy income, sales, mineral, or gas/fuel taxes.[48] Fayette County receives roughly 3.4% of its revenue from severance taxes, a relatively modest portion.[45] A commanding majority of county revenue derives from property taxation (60%), typical among U.S. counties, but the share from the coal sector is roughly 1%, per the authors' calculation. The county has experienced significant fiscal turbulence because of coal decline; coal severance taxes, which fund prisons, staffing and other expenses for the county, peaked in 2011–12 at over $1 million, falling

Fayette County's Coal Sector

Composition

10
Mines (open cast and underground)

Production

7.05
million short tons (Peak; 2008)

2.36
million short tons (Current; 2022)

Employment

606
Total direct (2022)

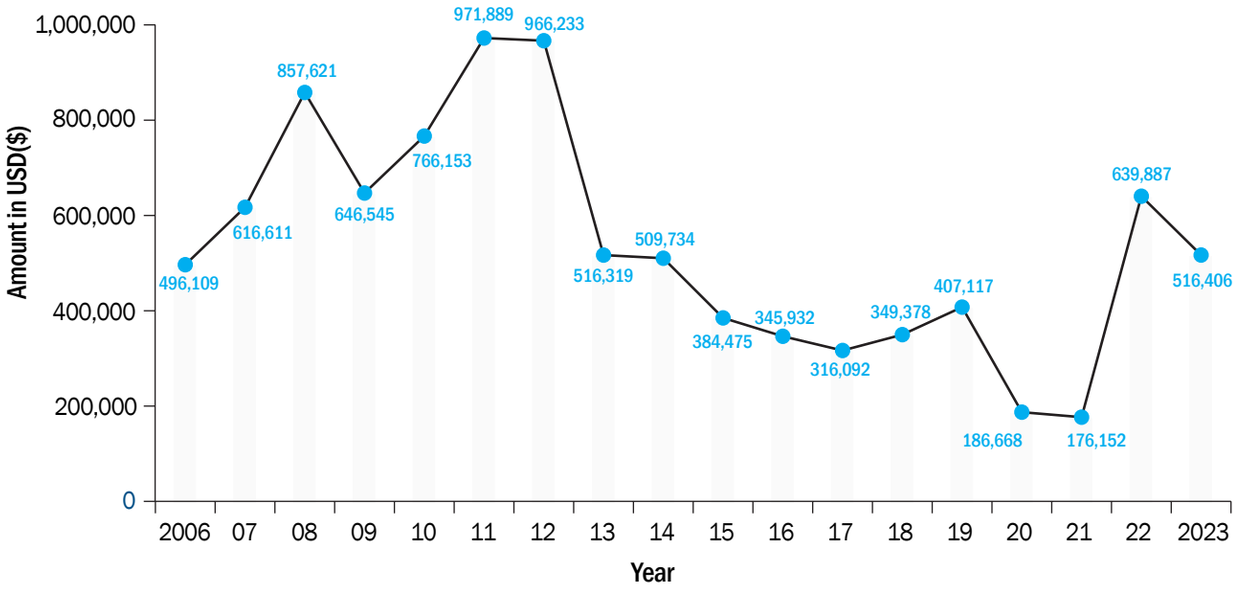
1,229
Recorded peak (2011)

4%
Current share of total county

Source: U.S. Energy Information Administration, U.S. Mine Safety and Health Administration, West Virginia Office of Miners' Health, Safety and Training, U.S. Census Bureau American Community Survey

Figure 2: Coal severance tax payments to Fayette County, 2006–2023

Severance tax payments to the county reduced by about 80% from 2012 to 2021. These payments surged in 2022 due to price spikes and temporary demand growth in 2021 due in part to economic recovery post Covid-19 lockdown. However, this resurgence has been considered only a temporary reprieve from decline.[49,50]



Source: West Virginia State Treasury[46]

dramatically in subsequent years (see Figure 2).[46]

The county also has two notable second- and third-order dependencies:

3. **Electricity supply:** Fayette County, like other West Virginia counties, primarily consumes coal-based electricity. Coal power accounts for about 90% of West Virginia's electricity production, of which roughly 40% is exported to other U.S. states.[51] As companies and states increasingly seek cheaper, lower-carbon electricity, Fayette County's increasingly expensive coal-fired power is a potential barrier to economic development and diversification.[52,53] This rise in cost has been partially due to competition from natural gas, which is not currently widely used in the state.[51,54] The county has limited means to alter the source(s) of its electricity in order to attract investment.[54,55]

4. **The broader economy:** West Virginia, and much of Appalachia, is as dependent on the coal sector as Fayette County itself, if not more so.[56] Spillover effects from the sector's decline in the region have been felt and may continue to affect the county's ability to grow and diversify its own economy. Additionally, businesses that play a supporting role for coal mining activities (services, manufacturing, etc.) also provide jobs and local government revenue to Fayette County.

These coal-sector dependencies and impacts have shaped—and continue to shape—the state of the county and its prospects for development and diversification.

Section 2: Diversification and Development

Economic diversification is a stated development strategy for Fayette County, and its economy can be considered diversified away from coal. As discussed earlier, under

5% of revenues and jobs in the county are directly related to coal.

As with most localities, the county's development priorities are generally broad-based and not sector-specific. Beyond tourism and agriculture, the Fayette County Comprehensive Plan (the county's primary development strategy) focuses on baseline challenges.[57] Historical coal busts and more recent coal production declines have created or exacerbated many of these issues, including via population decline, tax base erosion, and mine land abandonment.[36,38–40]

These challenges—noted by interviewees—include dilapidated and abandoned buildings, access to clean water and sanitation, broadband internet access, and population growth.[36,38,58] The county's population has been in decline since 1994, and some residents speculate that up to 40% of the population has limited to no internet access.[59,60] Availability of lodging (the county has approximately five hotels, excluding smaller motels), government capacity, workforce readiness, state law preemption (the state has prevented, through legislation or lawsuits, county zoning regulations, including for energy infrastructure and vacation rentals), and the decentralized nature of economic development are also known issue areas.[55] Affordability and availability of housing are also significant issues for the county; several interviewees noted that high interest rates, growth in vacation rentals, and a lack of new housing construction have driven prices higher.[36,39]

Legacy environmental and economic impacts from over 100 years of coal mining also affect Fayette County and its ability to develop and diversify. When asked about some of the significant challenges to attracting more businesses and sectors to Fayette County, interviewees noted the negative impacts of environmental degradation from abandoned and poorly remediated mines; poverty induced by multiple boom-bust cycles of coal; and geographic isolation due to founding communities near coal seams, away from major population centers.[36,40,61] Many counties in West Virginia share these challenges.[62] These issues are part of broader efforts to reevaluate the socio-economic role of local resources, including extractives, in the community, for alternative sectors like tourism.

These challenges and priorities often intersect with efforts to attract new sectors or to grow existing ones. Based on interviews and public records, we identify sectors with the potential to become anchors of economic diversification:

- **Tourism: Outdoor Recreation, Nature**

  Outdoor recreation and its associated tourism are now key pieces of the county's development strategy. Expanding roughly 125% since 2001 as a share of the county's GDP, it is one of the largest contributors to the county's GDP growth for the past 20 years.[63] The sector makes up about 7.4% of GDP and roughly 18% of all employment in Fayette County.[25,41] Whitewater rafting comprises a significant portion of tourism, having emerged organically in the 1960s, but the sector also includes recreational activities like hiking and rock climbing.[36,64] In addition to the county's existing natural resources, interviewees noted the sector's relatively lower upfront investment costs as a significant incentive.[38] State and federal support have also created significant incentives for this sector in Fayette County. Federal dollars via the National Park Service for the New River Gorge National Park help to preserve and maintain a significant tourist draw; in 2023 alone the park received 1.7 million visitors.[65] West Virginia provides several state tax incentives, such as West Virginia's Tourism Development Tax Credit, up to 25% of approved costs.[66]

Community appearance and availability of lodging are among the top development factors affecting the sector's growth, as cited by interviewees, official documents, and media reports.[36,38,57,67] The county has many abandoned and dilapidated buildings affecting the community's appearance and act as possible deterrents to visitors and investors alike. The county has only about five hotels; only one has conferencing capacity. Balancing this sector's needs with other areas of development is also a challenge; one interviewee noted a conflict between real estate developers and whitewater rafting companies who wanted homes set back farther away from the river to preserve the scenic view for customers.[40]

> "Community development is triage."
>
> Interview No. 2, comment on first-order development needs[38]

To address some of these challenges, the county is working with the New River Gorge Regional Development Authority to catalog abandoned and dilapidated buildings and address them systematically.[68] The county also has a public grant program to renovate or beautify qualifying dilapidated buildings.[69] Fayette County's current growth plan for the sector includes year-long tourism development that encompasses winter months, preservation of existing natural assets, and marketing.[57]

- **Real Estate: Residential and Commercial (e.g. lodging)**

  Real estate belongs to the biggest contributing sector group to Fayette County's GDP: the "Finance, Insurance, Real Estate, Rental and Leasing" segment comprises 17% of Fayette's GDP.[25] Residential and commercial real estate were listed as important sectors by several interviewees due to challenges related to the availability and affordability of both housing and lodging.[36,38] Interviewees considered real estate to be a key enabling sector for broader economic development and diversification, and connected constraints in this sector (particularly in housing) directly to the county's ability to attract or retain businesses, workforce, population, and tourists.

  There are several key challenges in growing this sector. High interest rates are one broad challenge; for example, home mortgage interest rates have risen from 3.99% to over 7% nationally in the last five years, making residential real estate more costly.[70] Growth in short-term rentals, which make up approximately 20% of vacant units in the county, has limited supply of long-term housing for local residents.[57] One interviewee noted that many available homes have degraded over time, requiring maintenance on top of already high prices.[39] For commercial real estate, challenges include location restrictions on commercial operations via zoning ordinances and balancing commercial real estate development with the character of the community (e.g. aesthetically).[57]

  Fayette's Comprehensive Plan outlines several suggestions for this sector moving forward, including conducting a Housing Needs Assessment, consulting relevant developers, and updating zoning ordinances to allow multiple commercial uses within a single district and more residential types.[57]

- **Manufacturing: Recreation Equipment and Associated Textiles**

  Interviewees highlighted opportunities for recreation-related manufacturing

(equipment and associated textiles) to leverage Fayette County's growing tourism sector for further diversification.[36,38] Manufacturing units can provide a significant number of higher-paying jobs in rural communities, where they can be among the largest employers due to their large size relative to the community. While manufacturing broadly contributes 4.7% and 6.7% to county employment and GDP respectively, the county does not yet have a recreation equipment manufacturer.[25] Important considerations moving forward include site availability for operations, market viability, and scalability (i.e. growth and export potential).[25,41] More generally, issues such as proximity to supply chains and other markets may also factor into establishing this sector.

A key first step for the sector would be consultation with relevant developers and a market study to assess (a) possible state and federal incentives and (b) demand, growth, and export potential. More broadly, prospective manufacturing sites can be identified, or local ordinances can be assessed, to determine ways to improve zoning in order to encourage manufacturing development. The county could also work with regional partners to procure and develop land for industrial operations, with a focus on recreation equipment manufacturing.

- **Power Generation: Solar, Hydroelectric**

  Power generation is currently limited in Fayette County, comprising less than 2% of county GDP.[25] Fayette County is home to two of the state's twelve hydroelectric dams, and solar installations greater than 1 MW have yet to be developed in the county.[71,72] One interviewee cited West Virginia's abundant water resources as an enabler for small-scale hydro plants, which may have significant employment potential relative to other low-carbon energies; several others cited solar installations while also noting the potential to reuse former mine sites.[36,38,39,73]

  Studies from the U.S. Department of Energy show significant potential for hydropower in West Virginia (a growth potential north of 340%) with much of this potential lying in small and micro hydropower in Fayette County.[74,75] For solar energy, Fayette County's former mine sites alone may have over 58 viable locations for large-scale solar farms.[76] Federal tax incentives from legislation such as the Inflation Reduction Act (IRA) may make sector development in Fayette County even more attractive, particularly given that certain clean energy investments in the county can qualify for up to an additional 10% in tax credits for IRA-related projects, thanks to the county's designation as an energy community under the legislation.[77]

  Solar projects in this sector face key challenges including from the state's regulatory environment, which for example requires commercial solar installations larger than 500 kW to have their power purchase agreements regulated as utilities.[78] Larger scale solar farms in the state cannot exceed 50 MW.[79] For hydroelectricity, there are no existing state-level incentives, its regulatory requirements can be arduous, and its economic prospects in the county have not yet been studied.[80,81] Higher upfront capital costs may also deter expansion of small-scale hydroelectric power.[82] Consulting relevant developers, assessing the county's existing ordinances (to ease regulatory burdens or unnecessary zoning restrictions), and determining market viability may help this sector's expansion in the county.

- **Agriculture: Crops and Niche Crops**

  Agriculture comprises less than 0.26% of county GDP; though only a small portion, the sector is historically and culturally significant for Fayette County.[25] The county's top crops include tomatoes, green beans, lettuce, and potatoes.[83] The sector has not seen much growth in the last ten years, but it is a targeted sector in the county's Comprehensive Plan.[57] Based on interviews and county records, the sector is seen as culturally significant, and a 2015 Downstream Strategies report noted strong interest among farmers in the region (70%) to expand operations.[36,57,83,84]

> "In West Virginia, you need a side hustle."
>
> Interview No. 4, comment on community members needing multiple jobs to make ends meet

  Key challenges include low profit margins in the sector (which declined nationally for small farms by 50% from 2012–20) and workforce availability: for example, U.S. citizens are less likely to work in agriculture, where the workforce was over 70% foreign-born in 2020 nationally.[85,86] By contrast, Fayette County's foreign-born population is at 0.3%.[22] Farmland availability may also present a challenge for growth, as agricultural land makes up only 10% of the county's total area.[57] Finally, county documents highlight aggregation and distribution of produce for larger buyers as significant challenges for small farmers who may lack the capacity to produce, package, or transport larger orders.[84]

  In the county's Comprehensive Plan, recommendations for fostering and growing the sector include (a) creating opportunities for farmers within the tourism sector (through marketing and new avenues for their products, such as restaurants and festivals) and (b) the creation of an agriculture land trust to fund the acquisition and protection of farmlands. Other efforts are also underway like the New Roots Community Farm, a county-initiated (now independent), non-profit organization that provides local produce and serves as an agriculture education resource on techniques relevant for Central Appalachian farming.[39,87]

As demonstrated for each sector, development requisites—infrastructure, workforce, site development, etc.—have direct impacts on a sector's potential, and thereby on its diversification prospects.

Alongside community and local government efforts, regional organizations like the Region 4 Planning and Development Council, the New River Gorge Regional Development Authority, and the Appalachian Regional Commission are finding new ways to bring to the county resources and infrastructure meant to attract new sectors and grow economic activity, in order to support economic diversification.[38,58] With recent federal legislation, such as the 2022 Inflation Reduction Act and the 2021 Infrastructure Investment and Jobs Act, there is an unprecedented amount of funding available to counties like Fayette County to incentivize new infrastructure projects and private investment, which could in turn help further diversify the local economy. The county and its municipalities are undertaking creative initiatives and creating innovative alliances to develop and diversify the local economy by tapping into this newly available funding.[88,89]

Fayette County's economy can be considered diversified, but it has not fully recovered in economic strength (e.g. employment) or population since the decline of the coal sector—a trend which is expected to continue.[36,90] To continue diversification, the county will need to ensure that no single sector becomes supercritical for county revenue, employment, or the local economy. Emergence of new sectors has happened in part organically, built upon the natural resources of the community; to grow existing sectors and attract new ones, meeting Fayette County's more baseline needs will continue to be a critical necessity. ■

Table 2: Fayette County – Identified Sectors
Rationale, key factors and challenges, and current or possible next steps for relevant institutions

Sector	Opportunities	Challenges	Current or possible next steps
Tourism Outdoor Recreation, Nature	**Natural resources** There are several natural features, including the New River Gorge, a well-known national park, naturally occurring rock walls, and hiking terrain. **Low barrier to entry** Upfront capital costs are relatively low; workforce skill set is generally broader; entrepreneurs see nature tourism as high in potential. **Federal- and state-level support** Tax incentives, such as West Virginia's Tourism Development Tax Credit, and funding and technical support from the National Park Service for the New River Gorge National Park, which now helps conserve nature in large parts of the county.	**Lodging availability** The county has limited indoor lodging options, with about only five hotels in the county. **Community appearance** The county is dotted with abandoned and dilapidated buildings, which may deter tourists or tourism-related business development. **Environmental conservation** Outdoor recreation is dependent on a safe, clean, and attractive natural environment—a priority that can be at odds with the requirements of other economic sectors, like real estate development which for example can obstruct the vistas or cause environmental pollution.	**Catalog abandoned, dilapidated buildings*** County Commission and the New River Gorge Regional Development Authority (NRGRDA) are in the process of cataloging abandoned, dilapidated buildings in order to address them systematically. The County also has a grant program for building remediation and beautification. **Seek relevant developers** The NRGRDA, Municipal governments, County Commission, and WV Department of Economic Development can continue to seek out developers for both tourism and lodging to attract investment or identify necessary steps to attract businesses. **Balance the zoning code** The County Commission can continue to ensure that the zoning code finds an equilibrium between nature preservation to foster tourism and the needs of private developers.
Real Estate Residential and Commercial (e.g. lodging)	**Enabling the sector for broader diversification and development** Current supply constraints on housing for residents and lodging for visitors has a negative effect on the county's ability to attract or retain businesses, workforce, population, and tourists.	**High interest rates** High interest rates are making real estate purchases particularly residential property, much more expensive. Nationally, rates have risen over 3% in the last five years. **Short-term rentals** Short-term rentals are growing in the county and now make up approximately 20% of its vacant units, reducing supply for longer-term residents.	**Update zoning codes** The County Commission and municipal governments within the county could assess existing zoning codes to provide more flexibility for commercial and real estate development, such as mixed-use buildings (e.g. office, retail, and residential). **Conduct needs assessment** Per the county's Comprehensive Plan, the County—in coordinating with other partners like municipal governments or housing-focused civil society organizations—could commission a Housing Needs Assessment to understand how to spur residential real estate development.

Manufacturing Recreation Equipment and Associated Textiles	**Sector synergies** Manufacturing of this equipment could feed into the county's existing tourism sector, which utilizes outdoor recreation equipment for activities including rock climbing and whitewater rafting.	**Market viability** As the sector does not currently exist in the county, its viability is relatively unknown beyond notional connections with the county's existing tourism sector. **Zoning** Land must be authorized by the proper authority (county, municipality, etc.) for certain activities. Sites are not always appropriately zoned in advance; and rezoning can be controversial. **Site availability** Fayette currently has few sites available for large-scale manufacturing; "shovel-ready" site development is complex and can take 10 or more years. **Lower-carbon power access** The carbon-intensity of West Virginia's electricity is a growing challenge to attracting businesses to communities in the state. **Connectivity** A dearth of major roadways in the county may limit growth opportunities in this sector.	**Market viability study** The County Commission, alongside partners like the NRGRDA, could commission a study to assess the viability of the sector in Fayette County and factors affecting its development in the county. **Update zoning codes** The County Commission and municipal governments within the county could assess existing zoning codes to ease regulatory challenges in siting manufacturing operations. **Seek relevant developers** The County Commission, alongside partners such as the NRGRDA and the WV Department of Economic Development, could consult existing businesses to gauge interest, attract investment, and assess needs in the sector. **Industrial site development** The County Commission could work with regional partners to procure and develop land for manufacturing oper ations, with the production of recreation equipment in mind.
Power Generation Solar, Hydroelectric	**Natural resources** For hydroelectricity, much of West Virginia's growth potential (380% by U.S. Department of Energy estimates) lies in Fayette County. For solar, former mine sites alone may have over 58 viable locations for large-scale solar farms. **Federal tax incentives** As a designated energy community under the federal Inflation Reduction Act, the county may qualify for an additional 10% in tax credits on top of existing credits offered by the legislation.	**Regulatory environment** Solar projects in the state are currently limited to 50MW, and commercial scale installations larger than 500kW are regulated as utilities. For hydropower, there are no existing state-level incentives, and obtaining permits is very arduous. **High upfront capital costs** Hydroelectric power comes with relatively high upfront investment costs, which may deter investment, particularly without state or local financial incentives.	**Assess zoning codes** To ease the regulatory burden of deploying hydropower and solar energy, the County Commission and municipal governments in the county may consider identifying improvements in zoning codes to better facilitate solar and hydropower development. **Tax incentives** The state legislature and the County Commission could consider offering tax breaks to financially incentivize the sector. **Market viability study** The County Commission, alongside partners like the NRGRDA, could commission a study to assess the viability of the sector in Fayette County and factors affecting its development in the county.

		Unclear market viability in the county The economic viability of solar and hydropower in the county has not yet been assessed.	**Seek relevant developers** The County Commission, alongside partners such as the NRGRDA and the WV Department of Economic Development, could consult existing businesses to gauge interest, attract investment, and assess the sector's requirements.
Agriculture Crops and Niche Crops	**Farmer interest in expansion** Per a 2015 report by Downstream Strategies, there was statistically high interest in expansion (70%) among farmers in the region.	**Workforce availability** Statistically, much of the U.S. agriculture workforce is foreign-born (70%). By contrast, Fayette County's foreign-born population is at 0.3%, which may present workforce challenges in growing the sector. **Low profit margins** Tight margins and low capacity are hurdles for smaller agribusinesses to compete in the market; margins declined for small farms by 50% during 2012–20. **Market access** Aggregation and distribution of produce for larger buyers may be a significant challenge for small farmers, which may in turn limit growth potential. **Farmland availability** Fayette has limited available farmland, which comprises only 10% of the county's total area. This issue is exacerbated by abandoned and poorly remediated mineland.	**Technical support*** Various institutions, including the WVSU Extension and New Roots Community Farm, are working to promote best practices in Central Appalachian farming, both in farming and getting products to market. **Farmland preservation*** Through the Fayette County Farmland Protection Board (under the County Commission) and the WV Department of Agriculture, financial and policy incentives are being created and offered to pro mote preservation of farming and agricultural land. **Financial support for farmers*** Government agencies, such as the WV Department of Agriculture, and other institutions, like the Appalachian Regional Commission, provide grants to farmers to begin, enhance, or expand operations.

*Action underway

Source: This table is a summary of the sector write-ups in this case study. Please see main text for citations.

3.2 Transitioning: Person County, North Carolina, United States

Person County's Coal Sector

Composition

Roxboro Power Plant

2.5GW

Mayo Power Plant

0.7GW

Production*

Roxboro Power Plant

~70%
(Peak; 2000)

~28%
(Recent; 2017)

Mayo Power Plant

~70%
(Peak; 2000)

~22%
(Recent; 2017)

Employment

328-524
Total Direct

2-3%
Share of total county

*Production of electricity as a percentage of theoretical maximum

Sources: U.S. Department of Energy[93], U.S. Census Bureau[21], Duke Energy[94,95], Institute for Energy Economics and Financial Analysis[96]

Section 1: Background and Coal Sector

Person County is a rural community of about 39,000 people in north-central North Carolina.[21] The county's gender ratio is approximately 94.2, with a slightly higher female population; the population's two largest racial demographics are White (64.5%) and Black or African American (26.4%).[21,24] The median age is 43.7 years.[21] Person County has one municipality, the city of Roxboro, and is home to two coal-fired power plants (Roxboro and Mayo) and no mines; the Roxboro Plant is the largest plant in the state by capacity.[91] These plants are owned and operated by Duke Energy, which serves 2.8 million customers in the broader region.[92]

Currently, Person County is coal-dependent in terms of government revenue, GDP share, and to a lesser extent employment. The utility sector, largely coal-oriented due to the size of the county's two power plants, constitutes roughly 25% of the county's GDP and provides vital revenue and valuable jobs to the county.[25,41,93,97]

Person County's economy is now managing a transition away from coal following North Carolina's climate mandates and the changing economics of coal-fired power. In 2021, the state of North Carolina passed House Bill 951, mandating the North Carolina Utility Commission (NCUC) to find and pursue the least-cost pathway to reducing the state's emissions from electricity generation by 70%.[98] Subsequently, NCUC adopted a plan requiring Duke Energy and Duke Energy to reduce their (as owner or operator) plant emissions, resulting in expedited retirement dates for the Roxboro and Mayo plants.[99] While Mayo's original retirement date of 2035 was later restored, the Roxboro plant's units 1–2 are slated now for a 2028 closure (up from 2032) and units 3–4 are slated for a retirement no later than 2033 (up from 2035).[100,101]

Person County's coal-fired thermal plants are not the county's only major economic drivers. Manufacturing is the largest sector in the county by GDP, and the county is more reliant on manufacturing than coal for employment.[25,41] Person County's top three sectors for employment are: manufacturing; retail trade; and healthcare and social assistance.[41] While Duke Energy Progress (owner of both plants) is a large employer in the county, Polywood—an outdoor furniture manufacturer—is currently Person County's largest.[102,103]

Nevertheless, the coal sector remains embedded in the county economy in two primary ways:

1. **Tax revenue:** Government revenues from the coal sector comprise over 18.5% of the county's total revenue.[97] This revenue comes to the county primarily from property taxes and sales taxes, totaling approximately $7 million annually.[104] Counties in North Carolina may only levy property, sales, animal, and room occupancy taxes.[105]

2. **Employment:** Direct jobs from both coal plants are roughly between

328 (as per Person County) and 524 (as per the U.S. Department of Energy), comprising about 2–3% of total employment.[21,93,102,106] Person County has the second highest coal-related employment in the state, according to U.S. Department of Energy data.[93] While total sector employment is still far below the top three sectors in the county, it has an outsized economic impact relative to other jobs in the county—owing to higher wages.[107,108] In May 2023, the median hourly wage in the region was $28.12 USD; by contrast, power plant operators earned $50.62, nearly double the regional median.[109]

The county also has several notable second- and third-order dependencies:

1. **Induced economy:** Plant support services and other induced businesses provide Person County other major sources of jobs and revenues. In a 2022 North Carolina Utilities Commission (NCUC) filing, the county noted the negative impacts on small businesses and contract service providers in the community that support the power plants should they cease operation.[97] CertainTeed, the second-highest property tax payer in the county, was until recently an off-taker of the Roxboro and Mayo plants' desulfurized gypsum, which it used in the manufacturing of wallboard—a relationship that has been complicated by coal decline.[110]

> "If the plants close, rail [which now also carries coal] could hike transport costs for [grain and fertilizer] by 20%.
>
> Interview No. 14, commenting on the possible costs of plant repurposing on other local industries

Some businesses otherwise unrelated to coal (e.g. grain, fertilizer) rely on rail infrastructure on which coal is brought to the plants.[111] Rail transport is made affordable by the volume of coal delivered to the plant.[111] Furthermore, the county touts its proximity to the plants' large power supply as an attractive asset for prospective industrial development (e.g. manufacturing).[112] The proximity may help ease utility installation, possibly expediting a process that could otherwise take two to three years.[113] A location near the plants may also allow for cheaper electricity due to shorter transmission distances, a factor that may grow in importance as U.S. electricity costs rise.[113–115]

2. **Real estate:** Residential development opportunities have also been fostered by the plants. Hyco and Mayo lakes, the reservoirs created to facilitate cooling at the plants, have become home to some of the most expensive real estate in the county and created local recreation opportunities.[116] Studies have demonstrated contamination of the lakes with selenium, arsenic, and other chemicals, primarily from the plants' coal ash pits, but they purportedly remain safe for recreation.[117,118] If the plants were to go away entirely, the future of these reservoirs is unclear, as Duke Energy owns both the land under the lakes and the dams that divert the rivers to sustain the reservoirs. As of 2021, Duke Energy has stated it has no intention to drain the lakes.[119]

3. **Community development:** The employees at Roxboro and Hyco plants are often community leaders, and Duke Energy frequently sponsors community events

and provides donations to the community, as noted by interviewees and press releases from Duke. The company claims over $600,000 in donations to government and community non-profits, including for parks, veteran support, and support services for domestic and sexual violence survivors.[104,120,121]

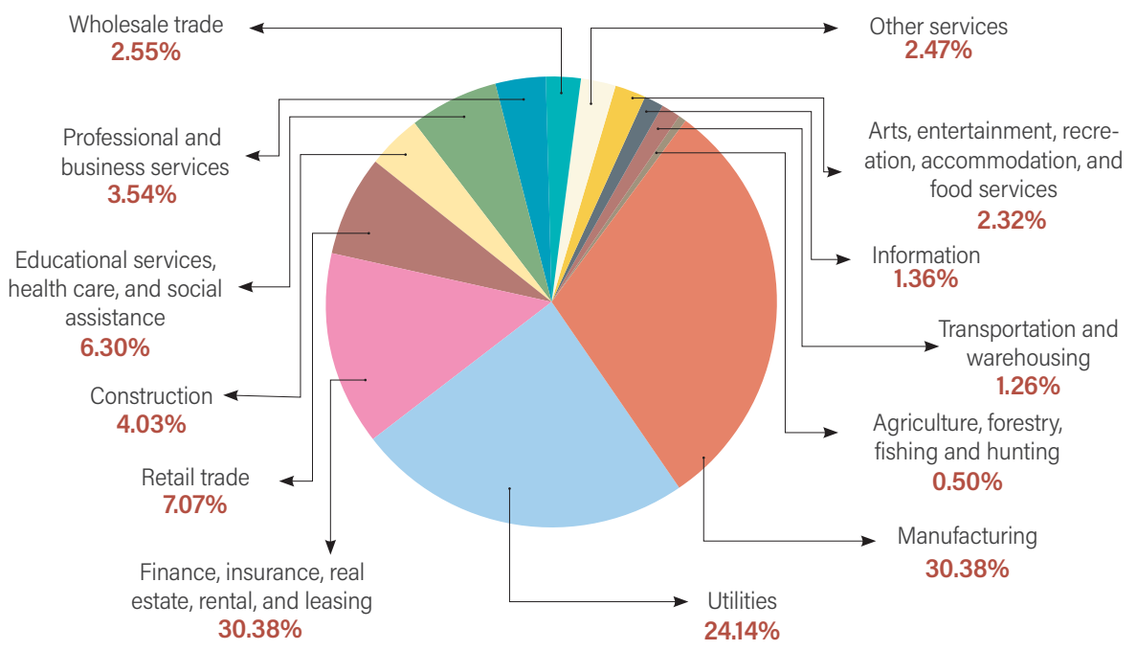
These coal-sector dependencies have shaped Person County's community and economy and therefore have implications for its economic development and diversification.

Section 2: Diversification and Development

The coal sectors' contribution to government revenues and high-paying jobs in Person County complicates any transition away from coal. However, the county has made economic diversification a stated development strategy for the county, which may be helping to ease this transition.[103]

The county's economic development priorities, opportunities, and strategies are central to any efforts to attract new sectors or to grow existing ones. A key piece of Person County's broader economic development and diversification efforts is industrial site development and reuse.[116] Developed industrial sites such as the Business and Industrial Center, Mega Park, and North Park are considered by county leaders as essential to attracting bigger industry players, both within North Carolina and nationally. The county's economic director, as quoted in the Triangle Business Journal, has stated: "[I]f you don't have a [site]...you can't even be competitive."[122] The county's Business and Industrial Center is currently home to manufacturing facilities and a solar energy installation, and the county is still fielding proposals for North Park and the Mega Park. The Mega Park has been developed with semiconductor manufacturing in mind, competing by offering technical specifications (e.g.

Figure 3: Person County Gross Domestic Product by Sector, 2022



Note: Sectors are organized per the 2017 North American Industry Classification System (NAICS)

Source: U.S. Bureau of Economic Analysis[25]

power, water, space) at a scale that is becoming harder to find.[113] Other industries also have inquired about the Mega Park; should the site become occupied, the new employer could be large enough to increase the county's employment and GDP substantially.[123] The county has seen success in industrial site reuse, which has fostered some of the county's largest private employers, including Polywood and Spuntech.[102]

Beyond industrial site development, the county is also working to invest in local education and skilling. Much of this is through the local Piedmont Community College, which helps address workforce needs through programs like customized professional training funded annually by the state.[116] The county has also made it a priority to improve internet access in order to attract more residents and businesses, as internet services are relatively poor for a significant portion of the county.[124] Additionally, Person County works closely with Roxboro, its sole city, and other organizations to facilitate an attractive central business node as well as local cultural events to attract and maintain investments and residents.[125] Other priorities include population growth and expansion of the county's airport.[126]

Barriers to development, and thus diversification, include limited commercial and industrial sites and public acceptance of projects. County documents note limited stock of available, suitable sites for prospective businesses, which may result in missed business opportunities.[126] Public acceptance—a common issue in economic development—has presented challenges for new businesses, as community members may be unpleasantly surprised due to the private nature of investment decisions and short notice.[127] For example, a recently approved natural gas storage project has drawn public concern and legal action from the community.[103,116,127] The county's proximity to the Raleigh–Durham area was another challenge noted by one interviewee: the county is close enough to benefit (through available workforce, proximity to larger businesses and universities, etc.) but far away enough that standard business site suitability assessments often capture a narrower view of Person County's workforce potential, which can result in the county being needlessly overlooked for investments.[108]

These priorities, challenges, and activities directly intersect with the attraction of new sectors or growth of existing ones. Through local interviews and public records, the authors have identified the following sectors:

- **Power generation**

  Currently, power generation makes up around 2–3% of Person County's employment, about 20% of its revenues, and much of the 24% of county GDP from the broader utilities sector.[21,25,93] As its power generation sector is almost entirely concentrated in two power plants, coal asset repurposing is an essential piece of Person County's strategy to mitigate job and revenue losses from the impending closures of the Roxboro and Mayo power plants.

  Person County has applied pressure and support to keep the business of Duke Energy, whose current proposal is to replace the coal generation assets of the Roxboro Plant with natural gas assets that can also burn hydrogen. (Other options like nuclear and battery storage were also considered before Duke's hydrogen-capable natural gas proposal.) This plan would require an entirely new facility but would repurpose transmission infrastructure, buildings, and possibly existing equipment.[128,129] A fuel shift at the Roxboro plant would help maintain the

county's power generation sector while moving away from the coal sector toward natural gas, a sector whose footprint in the county has been growing.[130] The future of the Mayo plant—whose anticipated 2035 closure date has fluctuated—is uncertain.[131]

Many of the challenges for this sector's future lie outside of the county's control, as Duke Energy is regulated by the state of North Carolina. Noted above, Person County has submitted legal filings to Duke's regulator (NCUC) to communicate the criticality of the Roxboro Plant to its local economy, and the county continues to engage in processes as and when it is able. Should the repurposing plans be completed successfully, it is uncertain how many jobs and government revenues would be maintained. Further, public acceptance of more natural gas infrastructure may also present hurdles, as evidenced by recent concerns within the community.

Should the Roxboro plant close without being repurposed, the county would have few avenues for attracting power generation investments of similar scale and socio-economic impact. Other options for power generation in the county are currently limited. While Person County has some local solar generation, the county currently limits the size of solar installations to 100 acres.[132] Hydroelectric potential exists but is small (~0.02 GW) relative to the existing coal plants (3.2 GW), and wind potential is low.[133,134]

- **Manufacturing: Semiconductors and microelectronics**

  Manufacturing is the largest segment of Person County's economy by both GDP (30%) and employment (24%); however, semiconductor and other microelectronic manufacturing operations do not currently exist in the county.[25,41] Person County is working to diversify its manufacturing sector by attracting these types of advanced manufacturing businesses. Semiconductor manufacturing facilities are often large, potentially providing the county with significant amounts of revenue (through property taxes on land, structures, and equipment) and jobs.

  Challenges for manufacturing in Person County are primarily related to perceptions of workforce availability. Site selector and private developer assessments may not capture in their standard assessments the region's true labor potential (e.g. in neighboring Durham) for medium-to-large scale manufacturing facilities.[108] Additionally, the high electricity demand of these manufacturing units, the equivalent of thousands of residential homes, may prove to be a barrier as Duke proceeds with closures or repurposing of the Roxboro, Mayo, and other regional coal-fired power plants.[113,135,136]

  The state's and county's previous experiences in attracting manufacturing investment is a significant boon for the rural community. As noted above, the county has substantial experience with industrial site development for businesses to lease or purchase, and it has developed its Mega Park in part to court this sector.[137] North Carolina is commonly ranked nationally among the top three states for manufacturing development. A general national shortage of large industrial sites may also help the county capitalize on these opportunities.[113] Finally, the county's proximity to the region's Research Triangle—a major academic and business hub—may prove useful in attracting the semiconductor industry, as 22.72% of the industry's workforce is reliant on engineering and architecture occupations.[138]

- **Manufacturing: Non-woven textiles**

  Non-woven textiles (e.g. chemically bonded materials) are an additional sector that Person County is interested in expanding in order to diversify within its manufacturing base. Currently, Spuntech Industries is the only non-woven textiles manufacturer in the county; however, it is a significant employer (209 jobs, or 1% of total employment).[21,106]

  In addition to the broader challenges that may affect sector growth (noted under Manufacturing: Semiconductors), a limited supply of small to medium industrial sites in the county may prove to be a challenge in siting more non-woven textile manufacturing units. A lack of local suppliers of input materials such as polyester and viscose may also limit sector growth; though cotton is also sometimes used in non-woven manufacturing, Person County no longer grows cotton.[139]

  Person County cites workforce potential as a boon for potential businesses due to its proximity to the North Carolina State University's Wilson College of Textiles, the only U.S. college dedicated exclusively to the study of textiles, and its fabrics engineering program.[137] Similar to semiconductor manufacturing, the county's experience with attracting manufacturers, specifically in non-woven textiles, may help the county tailor their efforts to draw related investments. Next steps for the sector by the county could include seeking expert consultation on how to attract industry raw material suppliers (e.g. producers of viscose) as well as the development of shovel-ready, small-to-medium-size industrial sites for prospective non-woven textile manufacturers.

- **Agriculture**

  Agriculture contributes a modest amount to Person County's GDP (0.5%) and employment (0.32%).[25] Total cropland in the county is around 33,600 acres, or about 13% of the county's total area.[137] Tobacco remains its most valuable crop; however, the county also grows soybeans, wheat, corn, and vegetables, among other produce.[139] The county's interest in the sector is two-fold: expansion of supply chains for its existing agriculture products (e.g. finding more processing or manufacturing opportunities for existing crops) as well as preserving the rural character of the county.[137,140] Aside from state and federal programs, the community currently has several local government programs, boards, and organizations offering technical and financial support to farmers, including the county's Agricultural Advisory Board and the local office of the North Carolina Cooperative Extension.[103]

  Lower profit margins, also noted in the Fayette County case study, may present challenges for small to medium size farms. Per the U.S. Department of Agriculture, net cash farm income decreased 9% in the county between 2012 and 2017.[139] The county's aspirations for population growth may also adversely affect agriculture employment opportunities.[141]

  To grow this sector and help diversify the economy further, the county—or community organizations within it—may consider a local assessment of the economic viability of alternative crops in order to diversify within the sector. Currently, most market value derives from growing tobacco and soybeans.[139]

Each of these sectors are affected by the county's development in the county—of infrastructure, workforce, site development, etc.—which in turn affects the

county's prospects for further diversification.

Doubling down on the utility and manufacturing sectors may result in the persistence of some of Person County's existing dependencies, but the story is complex. A large manufacturing facility at its Mega Park site would greatly increase the county's dependence on manufacturing, but it could also vertically diversify large-scale manufacturing in Person County beyond textiles, furniture, and building materials. Repurposing the power plants would move Person County away from coal dependence, but the value of the future plant may result in continued, if diminished, revenue dependence on the utility sector. The county will continue to manage these trade-offs as it seeks new sectors to further diversify its economy in the wake of local coal decline. ■

Table 3: Person County – Identified Sectors
Rationale, key factors and challenges, and current or possible next steps for relevant institutions

Sector	Opportunities	Challenges	Current or possible next steps
Power Generation Natural gas, Solar	**Repurposing existing plants** Duke Energy is currently planning on repurposing the Roxboro Power Plant into a natural gas plant also capable of utilizing hydrogen. **Modest solar potential** Interviewees noted potential for solar energy expansion, pointing to existing solar farms in the county. **Federal incentives** As a designated energy community under the federal Inflation Reduction Act, the county may qualify for an additional 10% in tax credits on top of existing credits offered by the legislation.	**Limited jurisdiction** The future of the repurposing of the plants is largely in the hands of the utility (Duke Energy) and its regulator, the North Carolina Utilities Commission (NCUC). **Environmental concerns** Recent natural gas infrastructure in the county has faced local resistance at public hearings. Repurposing the Roxboro plant may face similar challenges from environmental groups and the community. **Regulatory restrictions** Attracting solar energy at a large scale is currently ham pered by county regulations which restrict solar farms to 100 acres.	**Monitoring of and intervention into repurposing process*** The County Commission is currently monitoring and supporting Duke Energy's repurposing plans, making interventions (e.g. filings to the NCUC) when legally permitted. **Regulatory changes (e.g. solar farm limits)** The County Commission may consider lifting or changing restrictions to solar farm development in the county to encourage its development.
Manufacturing Semiconductors and micro-electronics	**Experience in manufacturing** The county has extensive experience in attracting and maintaining manufacturing operations. Broadly, manufacturing comprises 30% of Person County's GDP. **Megasite availability** The county has one of the nation's few currently available mega sites, for semiconductor or any other manufacturers.	**Perceptions of workforce availability** Site selector and private developer assessments may not capture the region's true labor potential (e.g. in neighboring Durham) for manufacturing facilities, potentially curbing sector development. **High electricity demand** Sector operations' electricity requirements can be equivalent to that of several thousand homes; as local power plants are closed or repurposed, meeting this power demand may prove challenging.	**Developer and site selector outreach*** By seeking out related developers and sector-focused site selectors, the County Commission and the county's Economic Development Commission may be able to break through standard assumptions about labor force availability. **Utility consultation*** The County Commission, which is already monitoring the future of the county's power plants, may consult with Duke Energy to understand the power supply implications of repurposing the Roxboro Power Plant.

	Proximity to Research Triangle Research Triangle—a major academic and business hub—may prove useful in attracting the semiconductor industry, as 22.72% of the industry's workforce is reliant on engineering and architecture occupations.		
Manufacturing Non-woven textiles	**Proximity to North Carolina State University (NCSU)** NCSU has a textiles engineering program and has the only college in the United States dedicated exclusively to the study of textiles.	**Limited site supply** Person County has a limited stock of small to medium industrial sites, which may prove to be a challenge in attracting more investment to the sector. **Limited local suppliers** Limited local suppliers of input materials like polyester and viscose may limit sector growth. (Cotton is occasionally used in non-woven textile manufacturing but is no longer grown in Person County.)	**Industrial site development*** The County Commission and the county's Economic Development Commission are working with regional partners to procure land and develop it for manufacturing, including for non-woven textiles. **Supply chain consultation** The County Commission and the county's Economic Development Commission could seek professional consultation on attracting raw material suppliers for non-woven manufacturing (e.g. viscose producers).
Agriculture	**Supply chain expansion** According to the county's economic development website and interviews, the county is interested in establishing higher-value supply chain segments for its agriculture products.	**Low profit margins** Tight margins and low capacity are hurdles for smaller agribusinesses to compete in the market; net cash farm income decreased 9% in Person County from 2012 to 2017. **Population growth** Population growth is an existing priority of Person County. Some studies have shown that population growth can dampen prospects for agriculture's development and expansion.	**Crop economic assessment** Various institutions, including the North Carolina Cooperative Extension or the county's Agricultural Advisory Board, may consider a study into the economic viability of alternative crops for diversifying the sector, which is currently focused on tobacco and soybean cultivation.

*Action underway

Source: This table is a summary of the sector write-ups in this case study. Please see main text for citations.

3.3 Transitioning: Campbell County, Wyoming, United States

Campbell County's Coal Sector

Composition

11
Mines
(open cast)

6
Power Plants
(1.3GW capacity)

Production

415
million short tons
(Peak; 2008)

216
million short tons
(Recent; 2022)

Employment

5,246
Mining & power generation
(Total direct; 2022)

28%
Share of total
county employment

4,995
Mining
(Total direct; 2022)

5,552
Mining
(Peak direct; 2011)

Source: U.S. Energy Information Administration[1], U.S. Mine Safety and Health Administration[26], U.S. Department of Energy[93], U.S. Census Bureau American Community Survey[21]

Section 1: Background and Coal Sector

Campbell County is a rural community of about 47,000 people in northeast Wyoming.[21] The county has two municipalities: the city of Gillette, and the town of Wright. Campbell County's gender ratio is nearly 1:1, and the population's two largest racial demographics are White (94.3%) and Hispanic or Latino (9.9%).[23] The median age is about 35.5 years.[21] The county hosts six coal-fired power plants and eleven open-pit mines; the North Antelope Rochelle and Black Thunder mines are the two largest coal mines in the United States.[26,142] 30% of U.S. coal is mined in Campbell County—making up approximately 3% of global production.[143] In addition to coal mining, oil and natural gas extraction is also prominent in the county, contributing roughly 30% assessed property value in the county.[144]

Presently, Campbell County is heavily coal dependent. Mineral extraction constitutes nearly 40% of the county's GDP, and a large segment derives from coal, providing vital revenue and jobs to the county.[25] Coal-fired power generation is a smaller but significant share of GDP and employment; the plants serve as an important demand source for the area's coal, and their proximity to mines enables price-competitive power generation.[25,93] Most of the coal mined and coal-fired electricity produced are exported to other U.S. states.[142,145]

The coal sector is embedded in the local economy in two primary ways:

1. **Government revenue** from the coal sector comprises over 36% of the county's total direct revenue.[144,146] This revenue primarily derives from property taxes (over $21 million) and a sales and use tax (over $6 million) as of 2023.[144,146]

   Additional tax revenue comes to Campbell County from the state of Wyoming in various ways. Coal severance taxes, federal mineral royalties, and property taxes comprise the bulk of Wyoming's coal-derived tax revenue.[147,148] Portions of this revenue return to the counties in various forms, including school district funding, infrastructure repair, and direct transfers back to the counties.[147] The complexity of the state's tax redistribution makes the exact coal-related benefit to Campbell County extremely difficult to determine; however, this redistribution likely pushes coal's share of the county's total tax revenue closer to 50%.

2. **Employment:** Direct employment by coal plants and mining in Campbell County is approximately 5,000, or 28% of total jobs.[21,93] Electric utility employment in the county is approximately 364 (or 2%), roughly 70% of which derives from coal-fired power plants.[21,93] The sector also generates secondary employment from companies that service the local coal industry. After mining, these ancillary ser-

vice jobs offer some of the highest wages in the community.[149]

The county also has several notable second- and third-order dependencies:

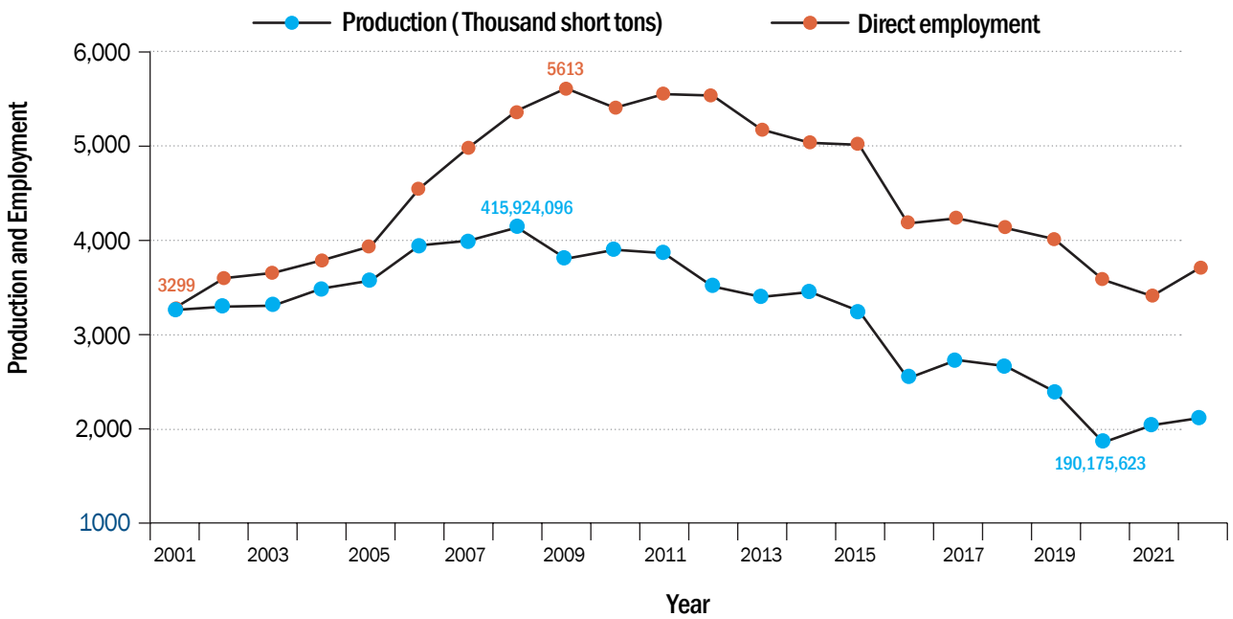
1. **Induced economy**: Secondary and support businesses, mentioned above, provide Campbell County other major sources of jobs and revenues. Engineering, construction, machinist, and other services are provided locally by many businesses for both coal-mining operations and the county's coal-fired power plants. This group of businesses includes large firms like Wyoming Machinery Co. and L&H Industrial.

2. **Electricity generation:** Coal-fired power is a major component of the county's coal sector. Around 70% of electricity generated in Wyoming is coal derived, and electricity is a major export of Wyoming, which sends nearly 60% of its generated electricity to other states.[142] Of the power consumed in Campbell County, much is consumed by mining operations.[150] Concerns have been voiced around the viability of Wyoming's generation mix as natural gas and renewables gain market share.[151] These gains in market share are spurred in part by nearby states' and other electric utilities' adoption of increasingly stringent requirements to lower power-sector emissions (e.g. Renewable Portfolio Standards).[148]

   The local power supply is also touted as a boon for economic development, as the proximity to the community makes interconnection easier and can enable higher power consumption.[152]

3. **Community development** is also substantially related to the coal sector. Many community leaders are directly or indirectly affiliated with the coal mining industry, and coal (or coal-adjacent) companies often sponsor community organizations, scholarships, and other community development activities.[153–156]

Figure 4: Coal Production and Direct Mining Employment in Campbell County, 2001–22



Source: U.S. Mining Safety and Health Administration[26]

Coal production in the county has been in decline since it peaked in 2008. Production has fallen by nearly 50%, while mining employment has fallen by roughly 30% in the same period.[26] The county's cheaper-to-mine surface mine coal, relatively stable prices, and cost-competitive mine mouth operations (i.e. power plants next to coal mines) have blunted the effects of coal decline; however, many in the county acknowledge the downward trend and believe coal production has likely peaked in the county.[37,157,158]

Section 2: Diversification and Development

Campbell County can be considered a relatively undiversified economy, both generally and vis-a-vis the coal sector. However, as noted in Section 1, oil and natural gas also comprise a significant portion of the county's economy; this fact is often effaced by these sectors' consolidation with coal in public data.[25,41] The county's second largest sectors are Transportation and Warehousing (23% by GDP) and Retail Trade (14% by employment).[25] Economic diversification is a stated development strategy for the county.[159]

Though there is some debate around the pace and severity of coal decline in Campbell County (where the last ton of U.S. coal will be mined, according to several interviewees), many community leaders are working to head off coal decline projections.[157,158,160]

Transition efforts in the community have been building momentum for years, focusing on ways to evolve the local economy. This work has recently produced the Office of Economic Transformation (OET), funded in part by the U.S. Economic Development Administration.[160] Broadly, the office is working with other local economic development entities—such as the community's non-profit corporation, Energy Capital Economic Development (ECED)—to chart a path toward economic diversification. Specific initiatives from the office include strategic planning, building awareness of the community, business recruitment, creating pipelines for local entrepreneurs (e.g. with facilities, seed funding, etc.), and exploration and facilitation of coal asset repurposing.[157,159–161] Beyond the OET, Campbell is now home to the Integrated Test Center (ITC) (focused on carbon capture, utilization, and storage technologies) and the Wyoming Innovation Center (WyIC) (focused primarily, but not exclusively, on coal-to-products research and development).[162,163]

Broader economic development efforts are focused on workforce development (including population growth, job creation and diversification), industrial site development, and community development. Gillette Community College is a focal point of local workforce development, which has included increasing local control over higher education (to meet local and market needs) and creation of community facilities for skill development and capacity offset (e.g. Area 59).[164,165] For industrial development, the county has created a pipeline for "shovel-ready" industrial sites for prospective manufacturers or other industrial businesses.[157] In community development, Campbell County is at a higher baseline than many of its fellow rural communities: the county has for example successfully used its mineral wealth for community investments like the county recreation center and CAM-PLEX conference center.[166,167]

Campbell County is a relatively well-resourced rural community but not without

socio-economic challenges. Coal bias, housing availability, and mismatches with federal priorities and programs were cited as general issues by interviewees and local leaders.[157,160,168] Interviewees noted that many visit Campbell County incorrectly assuming the community is struggling, a presumption that could deter investment. In the community itself, interviewees noted that some harbor biases in the opposite direction, either toward coal's fortitude or toward activities seen as pro-coal, or not anti-coal.[160,169] The federal mismatch with state and local priorities in Campbell County exacerbates project financing, which is already a significant challenge at the local level. Interviewees noted the federal government's lack of focus on alternative uses for fossil fuels like coal, and the Wyoming Energy Authority (a state-level funder for many energy-related economic development projects in the state) has noted it does not see recent federal funding opportunities (e.g. from recent legislation like the Inflation Reduction Act and the Infrastructure Investment and Jobs Act) as good fits for Wyoming.[157,168]

> "It's hard to find sustainable funding if people don't think you're working."
>
> Energy Capital Economic Development board meeting, February 2024; comment on impacts of inaccurate external assumptions that the community is now struggling due to coal production decline[157]

The mechanics of economic development in the county also present hurdles. Non-local land ownership, local politics, and debates around how the county manages and sells land (including the extent of the county's role and what constitutes "fair value" for the land it sells and leases) are other issues of focus for local leaders.[157] Additionally, low unemployment in the county is ironically a challenge, as local businesses can hesitate to support development projects that pull from a relatively tight labor market.[157]

These priorities, opportunities, and strategies intersect with efforts required to attract new sectors or to grow existing ones. In interviews and public records, community leaders have expressed interest in the following sectors:

- **Manufacturing: Coal-to-products**

  Manufacturing in Campbell County comprises 3% of employment and 1.4% of GDP.[25,41] Many companies (e.g. Komatsu, L&H Industrial, AKJ Chemicals) partially or fully support local mining, and the county is interested in diversifying its manufacturing base into sectors that use coal as a low-carbon feedstock. By fostering coal-to-products, the county's primary goal is to create more demand for coal in low-carbon processes. This in turn will help develop economic pathways for its plentiful coal resources in a future, lower-carbon economy as U.S. demand for thermal coal wanes.

  The novelty and niche nature of this sector may pose a challenge to its growth in the county. At present, the coal-to-products sector is a small segment of Campbell County's economy: Atlas Carbon, which produces activated carbon products, is currently the only coal-to-products manufacturer in the county. In the United States, coal-to-products accounts for less than 3% of total coal consumption.[170] Additionally, a lack of interest in coal-to-products at the federal level was a challenge noted by interviewees and could potentially reduce government funding opportunities to develop the sector.[160,168]

As noted, the county's enormous coal reserves (1.15 trillion short tons) are a significant enabling factor for coal-to-products manufacturing.[171] The county's recently constructed WyIC is meant to bridge the gap between R&D and commercialization for these products, including for coal-derived construction materials.[172] The WyIC was developed with external partners like the University of Wyoming School of Energy Resources, which is also a tenant at the facility alongside the U.S. National Engineering and Technology Laboratory (NETL).[163,172] Additional steps for the county could include building out a pipeline for commercialized operations to remain in Campbell County. This may include industrial site development for prospective businesses, targeted policy or tax incentives, or working with Gillette Community College to foster relevant education and skilling among the local workforce.

- **Carbon Capture, Utilization, and Storage (CCUS)**

  Campbell County (and the state of Wyoming) is formulating policies and dedicating resources toward the development of CCUS technologies. Similarly to coal-to-products manufacturing, CCUS development is meant to create low-carbon economic pathways for the county's coal resources and existing power plants. Its interest is also driven in part by the state of Wyoming, which has taken steps to grow the sector, such as mandating electric utilities to study and, if viable, adopt CCUS retrofits onto coal-fired power plants.[173]

  High costs and water usage are among the existing challenges to this sector's growth. CCUS is currently cost-prohibitive for power plants: the county's Dry Fork power plant—the only U.S. coal-fired power plant producing cheaper electricity than solar or wind—could see the cost of its electricity double with the use of existing CCUS technologies.[174,175] CCUS technologies require large quantities of water, and many of Campbell County's and the region's aquifers are currently under moderate to high stress.[176]

  Currently, most of the county's activities around CCUS are centered around state-led research and development for use at coal-fired power plants in collaboration with private businesses. The ITC, integrated with the county's Dry Fork Power Station, hosts companies and other organizations to test CCUS technologies in a real world environment at various scales.[177,178] The county may consider conducting a study into economic prospects in other segments of CCUS supply chains beyond R&D, particularly those less exposed to technology evolutions, such as storage and injection or production of related minerals.[176,179]

- **Tourism: Sports, Conferencing**

  Tourism in Campbell County comprises around 11% of employment and 6% of GDP.[25,41] Interviewees underscored strong community support for sports tourism, which anecdotal evidence shows to make up a significant amount of tourism dollars to the county.[160] Sports facilities that Campbell County has invested in allow the county to host games with teams across the region, including basketball, rodeo, and hockey. The county has also been working to leverage its facilities for larger conferences, including the 50,000-person International Pathfinder Camporee.[180]

  Challenges include capacity (e.g. limited lodging and airport capacity) and competition from other, wider-known parts of the state like Yellowstone National

Park. Interviewees noted that tourism, while important to local diversification, would likely not become a new economic bedrock.[35,160]

In 2022, Campbell County produced a master plan for development of the tourism sector, which focuses on sports, public attractions, amenities, transportation, and other travel infrastructure. Activities outlined in the plan include creation of a formal sports commission and continued development and enhancement of the county's downtown for businesses and events like concerts and festivals.[181] Additional next steps may also include studies into hotel development and expansion of the regional airport to draw in and accommodate more tourists.

- **Data Centers**

  The information sector comprises roughly 1.5% of employment and 2.5% of GDP.[21,25] Campbell County has sought to establish data centers in the past, but a major center has yet to emerge.[182] Wyoming generally has the tax exemptions, geography, climate, and electricity infrastructure to attract power-hungry data centers which, as they are erected, create construction jobs thought to be related to mining skills.[183,184] Once established, the limited but high-wage employment is seen as a boon for communities with tight labor markets like Campbell County, whose current unemployment rate is 2.8%.[23]

  Challenges for data centers in the county include the carbon intensity of electricity (as tech companies seek lower-emission energy sources) and the county's proximity to long-haul fiber optic cables.[185] Next steps may include consultations with data center developers by Campbell County and Energy Capital Economic Development to attract business or to better understand local opportunities and barriers to data center development in the county.

In pursuing these sectors and other development activities, Campbell County's leaders are proactively seeking alternative economic pathways for their community. The county has historically seen success in utilizing its mineral wealth for community development, offering many public amenities unseen (or limited) in most rural communities. But this mineral wealth may diminish as domestic coal demand declines.[160,186] While the wealth is there, the county is making inroads—supporting local entrepreneurs, engaging the existing coal sector, and imagining new industries—toward a more diversified economic, and energy, future. ■

Table 4: Campbell County – Identified Sectors

Rationale, key factors and challenges, and current or possible next steps for relevant institutions

Sector	Opportunities	Challenges	Current or possible next steps
Manufacturing Coal-to-products	**Natural resources** Campbell County has enormous coal resources (1.15 trillion short tons) that will remain plentiful for the very long term for any coal-derived products. Additionally, coal-to-products manufacturing can create new economic avenues for coal utilization in a lower-carbon economy. **Diversification** Much of the county's manufacturing is focused on supporting the coal industry through chemicals and machinery. Coal-to-products manufacturing will diversify the broader manufacturing sector. **State support** The state of Wyoming, which is also deeply reliant on coal, has supported the county's efforts, for example through the University of Wyoming's School of Energy Resources, which has helped the county develop local operations to facilitate R&D and commercialization.	**Sector novelty** Growth prospects are uncertain for the relatively small sector. Presently, Campbell County's economy has only one coal-to-products manufacturer, Atlas Carbon, and coal-to-products accounts for less than 3% of total coal consumption nationally. **Lack of federal support** Lack of incentives at the federal level for coal-to-products—including funding for research, development, and commercialization—may act as a dampener for the sector's growth prospects.	**Measures to encourage local siting of fostered coal-to-products businesses** The County Commission, the city of Gillette, and Energy Capital Economic Development could consider industrial site development for prospective manufacturers. The County Commission and the city of Gillette may consider tax or policy incentives for commercialized "graduates" of the WyIC. Gillette Community College may consider program development for related skilling in coal-to-products manufacturing, in collaboration with the University of Wyoming's School of Energy Resources.
Carbon Capture, Utilization, and Storage (CCUS)	**New life for power plants** Much of coal-based emissions derive from burning coal at power plants. In a low-carbon future economy, CCUS may extend the life of coal-fired power plants, which are a significant source of high-wage employment in Campbell County. Coal-fired power's share has declined from 48% of U.S. electricity to just 20% since 2008, in part due to efforts by other states to reduce the carbon intensity of their electricity. **Low-carbon coal consumption** In a low-carbon future, CCUS-retrofitted power plants may help maintain demand for coal, thereby mitigating the negative economic impacts.	**Cost** CCUS is currently cost-prohibitive for power plants. For some plants, CCUS could double the cost of electricity produced. **Water intensity** CCUS requires large amounts of water; adopting the technology at scale may be limited in Campbell County, whose aquifers are currently under moderate-to-high stress.	**Development and demonstration*** The county is currently home to the Integrated Test Center (ITC), a testing and demonstration facility integrated with the Dry Fork Power Station. The ITC is facilitating some of the necessary steps toward development and commercialization of CCUS technologies. **Viability studies*** The state of Wyoming has mandated power plants in the state to assess the technical and economic viability of CCUS retrofits. **Market study of CCUS supply chain segments** Campbell County, the city of Gillette, and Energy Capital Economic Development may consider commissioning studies with consultants or the University of Wyoming to better understand local opportunities in other segments of CCUS supply chains (e.g. production of related minerals or storage and injection).

Tourism Sports, Conferencing	**Existing sector** Tourism comprises approximately 6% of county GDP; the county has significant tourism infrastructure, including its CAMPLEX conference center and the Campbell County Recreation Center. **Demand** Interviews with local leaders highlighted strong local and regional demand for regional sports tourism, particularly for college athletics. Additionally, the county will be hosting the 50,000-person International Pathfinder Camporee.	**Capacity** As a relatively small rural community, interviewees noted limited lodging availability and the limited capacity of the local airport, which runs only three roundtrip flights daily. **Competition** At the national level, Campbell County may find itself competing with other, better-known parts of the state, such as Yellowstone National Park, for tourism dollars.	**Market study for lodging** Campbell County, the city of Gillette, and Energy Capital Economic Development may consider commissioning a study to assess growth potential for local hotels to increase tourist capacity. **Airport expansion** Campbell County and the Brookneal–Campbell County Airport Authority may consider feasibility studies for airport expansion to help increase traffic into the community. **Continue downtown development*** he City of Gillette and Campbell County are continuing to enhance downtown Gillette to create more opportunities for events like festivals and concerts.
Data Centers	**State incentives** Wyoming has tax exemptions for data centers, which includes a sales and use tax exemption up to $2 million for qualifying purchases. **Existing assets and climate** The county's abundant energy resources are a boon for energy-intensive data centers, as is its relatively cool climate, which helps with facility cooling. **Economic footprint** An established data center produces property tax revenue and a modest demand for high-wage labor, which may help in labor-constrained communities like Campbell County. The current unemployment rate in the county is 2.8%, well below the national rate of 3.9%. .	**Carbon intensity of electricity** As tech companies continue to lower their emissions, the carbon intensity of Wyoming's grid may prove to be a barrier in attracting data centers in the future. In 2022, 71% of Wyoming's electricity was coal derived. . **Proximity to long-haul fiber optic cables** Campbell is relatively far from the long-haul fiber optic cables that run through the state, which may present a challenge for siting data centers in the county.	**Seek relevant developers*** Campbell County, the city of Gillette, and Energy Capital Economic Development may seek expert consultations with data center developers to attract more business and better understand the local opportunities and obstacles in data center development in the county.

*Action underway

Source: This table is a summary of the sector write-ups in this case study. Please see main text for citations.

3.4 Pre-transition: Ramgarh District, Jharkhand, India

Ramgarh District's Coal Sector

Composition

16
Mines (open cast and underground)

4GW
1 Power Plant (Planned)

Production

11.6
million tons
(Recent; 2022-23)

38.7
million tons
(Expected peak; 2040)

Employment

+10,968
Mining
(Total Direct; 2024)

Note: Coal employment as a share of district total not shown due to lack of current census data.

Source: Central Coalfields Limited[29,30], PVUNL[190], Tata Steel[189]

Section 1: Background and Coal Sector

Ramgarh is one of twelve coal-producing districts in the state of Jharkhand.[187] Ramgarh has a population of approximately 1 million, spread over six administrative blocks.[31] The population has a per capita income of $1,189 (₹99,168) (2021–22), two-thirds of the national per capita.[188] The district's gender ratio is 108.6, with a notably higher male population, and its two most prominent religions are Hinduism (81.6%) and Islam (13.6%).[31] Ramgarh has 16 active mines scattered over the district: 15 of these are operated by state-owned company Coal India Limited (CIL)'s subsidiary Central Coalfields Limited (CCL), and one by the privately owned Tata Steel.[30,189] A joint venture between the nationally owned NTPC Ltd. and Jharkhand's state electricity board is slated to commission a new supercritical 4GW coal-fired power plant in the district, located in the district's Patratu administrative block.[190]

Ramgarh District is highly coal dependent, which manifests in two key ways:

1. **Employment:** Focus group discussions, interviews, and secondary data analysis show that people are dependent for employment in different activities related to coal mining in this district.[191,192] Over 10,968 workers are directly employed in the mines.[29] Apart from these direct jobs, about 4,000 workers are involved with companies providing services to coal companies, such as cleaning and sprinkler systems.[193,194] At least 100,000 workers and residents support the coal-induced economy, including coal transport workers, maintenance workers, and local vendors (e.g. grocers) near the mines.[191] Like many old coal mining areas in India, hundreds of thousands of people in Ramgarh are involved in illegal or informal coal mining and scavenging.[191] This is largely due to many underprivileged people selling the coal in local markets, which is technically illegal but a mainstreamed livelihood in the district.[191]

2. **District Mineral Funds (DMF) and government revenue:** The district government is responsible for federally mandated DMF payments by coal and other mineral producers. Since its inception in 2015, the DMF of Ramgarh has collected $144 million (₹11.95 billion).[195] Over 95% of the fund is contributed by coal companies (the remaining 20% derives from production by other mines.[196] Nearly 1,210 projects have been started using DMF funds and benefit most of the district's population.[31,197] Total DMF expenditures have reached $127 million (₹10.58 billion) since 2016.[197] Additionally, a significant but undetermined amount of district revenue derives from coal royalties and taxation. Other coal-related government revenues are generally not reported at the district level, but CCL alone contributes over 15% of Jharkhand's non-tax revenues through royalties.[198–200] Non-DMF revenues, which include these royalties and a significant Goods and Services Tax on coal, are aggregated at the state and national levels before being redistributed by Jharkhand to its districts, including Ramgarh.[201,202]

The district also has several notable second- and third-order dependencies:

1. **Infrastructure:** Coal companies provide all basic and social infrastructure in the area near the coal mines.[191,193,203] This infrastructure is supported by companies within 25 kilometers of each mine through formal and informal arrangements

with the district via corporate social responsibility spending and direct access to company infrastructure (e.g. power lines and water supply).[194,203] Anecdotal evidence based on the interviews and focus group discussions conducted by the authors in the district suggests that much of Ramgarh's population is dependent on coal companies for this infrastructure, as mines are located throughout the district.[193] In addition to physical infrastructure in the form of roads, electricity, and water supply, the coal companies also support social infrastructure like healthcare and educational facilities, including six hospitals and one primary school.[204,205]

2. **Induced Economy:** The coal sector enables much of Ramgarh's economy in two key ways:

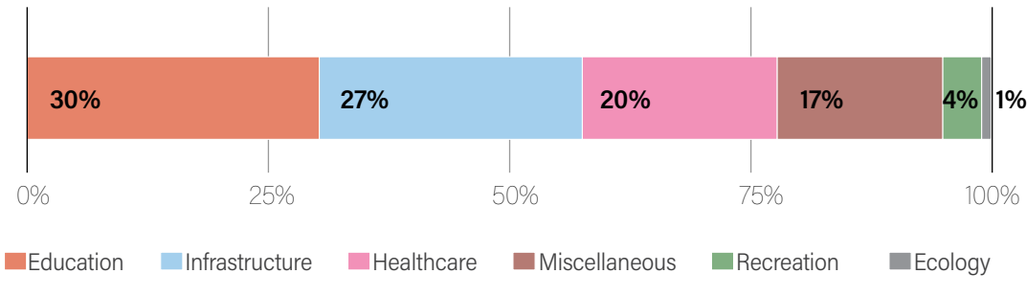
    a. **Coal worker spending:** Coal sector employees in Ramgarh are among the highest paid workers in the district and in the country.[206] The 2023–24 National Coal Wage Agreement places most of Coal India Ltd.'s workers in the highest income tax brackets nationally (20–30%).[207,208] Throughout Ramgarh, small businesses such as grocery shops and retail cloth stores depend on coal workers spending their income locally, fostering marketplaces and the broader local economy. Anecdotal evidence suggests that up to 60% of customers in these marketplaces get their income directly or indirectly from the coal mining industry.[192,209]

    b. **Fueling local industry:** Metallurgical, hard coke, and some red brick manufacturing outfits have been established in the district owing to its proximity to coal production. These industries all use coal as fuel, which is essential to their operations.[210,211]

3. **Energy supply:** Locally supplied coal also serves as a major cooking fuel for many in Ramgarh. Over 67% of households within 5 kilometers of a mine use coal as a primary cooking fuel, as gleaned from interviews and the surveys conducted for this report.[192,193] Separately, the district is also heavily dependent on coal for electricity supply, as over 90% of electricity in the state derives from

Figure 5: CCL Corporate Social Responsibility Spending in Ramgarh District, Jharkhand, FY 2022–23

Shares of funding allocation by project type. In FY22–23, most of the CSR spending in the district was allocated to education, healthcare, and other infrastructure.



Note: Categories based on authors' interpretation. Included under 'Education' are technical skilling, education-related infrastructure (e.g. libraries and water purifiers for schools), and student supplies (e.g. bookbags). Most (85%) of 'Miscellaneous' spending is for the Har Ghar Tiranga Campaign 2022.

Source: Central Coalfields Limited[183]

coal-fired power.[212] The forthcoming coal-fired power plant will theoretically add to the district's electricity supply, as 85% of the power generated will be allocated to Jharkhand.[190]

The district has yet to reach peak coal production. However, according to our data analysis of 2022–23 mining company data, coal production is anticipated to peak within the next 15 years at approximately 38.7 million tons.[214] In the interim, smaller mines with low production may close due to consolidation within the industry, and others may reach the end of their natural productive life.[194] Of the 15 mines currently in operation, at least four will close in the next decade or shortly thereafter because of reserve depletion.[215]

> "If the mines shut down, then we'll have nothing left."
>
> Comment from focus group with locally elected representatives[216]

In the medium-to-long term, coal mining and the upcoming power plant will play a major role in Ramgarh's economy. But surveys and interviews show mine closures are seen as a significant concern for Ramgarh that would lead to job scarcity and reduced infrastructure access.[192,216] At the same time, coal decline is not expected for more than a decade, making it a relatively distant problem in a district with other urgent, immediate needs. Currently all economic development plans are in line with general development priorities of the national and state governments, and these plans do not yet anticipate widespread mine closures or a broader energy system transition away from coal.

Section 2: Diversification and Development

Ramgarh's economy primarily consists of coal mining, coal-based industries, and agriculture. The district's GDP broadly comprises raw materials, manufacturing, and services (or, primary, secondary and tertiary sectors) in nearly equal parts (between 30% and 36%).[217] Most of the raw materials segment (e.g. coal production) comprises coal mining and agriculture. Ramgarh's agricultural sector centers largely around paddy and vegetable production (e.g. leafy vegetables, eggplants/brinjals, potatoes), which contribute significantly to Jharkhand's crop production.[218]

Ramgarh's economic activities are largely planned around, and dependent upon, the coal sector owing to a long history of mining. The district is traditionally industrial, its coal production and organized mining since 1947; Tata Steel's coal mines were in operation before India's independence. Ramgarh's major industries have developed primarily around coal, including small scale metallurgy and hard coke.[210,219,220]

Ramgarh's development priorities—like most districts in the state—are to improve socio-economic parameters, promote investment, and improve infrastructure. Nutrition and limited public health resources are among Ramgarh's top social development priorities.[221] For example, Ramgarh has the lowest number of hospital beds (157 for a population of nearly 1 million) in the state.[222] Ramgarh's literacy rate (73.17%) is above the state's (66.4%) and almost equal to the national literacy rate (72.98%), but closing the large gender gap (19%) in literacy remains a development

priority.[223] Social infrastructure improvements are needed primarily in the interior part of the district.[210,220] Survey respondents and interviewees consistently listed law and order as an important challenge, for the purposes of both diversification and community welfare more broadly.[193,211,224] Though not heavily discussed in interviews and focus group discussions, land is also a significant challenge in both Ramgarh and in the state of Jharkhand more broadly. Complex regulatory frameworks, uncertainties around ownership, and the resulting litigiousness can create barriers to the acquisition, use, and availability of land, which may in turn discourage private investment in the district.[225]

Development efforts are largely concentrated within local (and state) governments and coal companies, which are responsible for the bulk of development activities and often work in tandem. To diversify, Ramgarh's Industrial Development Office (alongside the state's Department of Industry) is establishing a District Industrial Centre, a dedicated industrial area in Ramgarh's Patratu administrative block meant to attract industrial firms in general, though manufacturing is broadly a sector of interest for the project.[219] The district administration also has other subdivisions dedicated to various development priorities, including the District Development Officer (for community development and welfare program implementation), the District Welfare Officer (to support vulnerable populations, e.g. scheduled castes and tribes), and the District Rural Development Authority (for implementation of rural government programs).

Industry associations and district authorities agree that the district needs more socio-economic development for attracting new industries.[211,216] Community leaders also noted in interviews and discussions that new industries need to be established concurrently with the growth of existing sectors.[210,216,226] The following sectors were identified as promising in interviews, surveys, and other research:

- **Pisciculture**

  Pisciculture is currently not a major economic sector in the district. Ramgarh contributes less than 6% of the state's total fish production.[222] However, its open-cast mines present opportunities for growth in pisciculture development. According to local leaders, local market potential for this sector is high.[227] Ramgarh is now largely dependent on fish from other states (i.e. the southern state of Andhra Pradesh), and the district could tap into larger markets in Jharkhand (e.g. Ranchi, Dhanbad, Bokaro). This sector aligns with Jharkhand's Food Processing Policy of 2015, which provides subsidies including a 35–50% subsidy for fisheries in cold chain, value addition and preservation infrastructure).[228] The Department of Fisheries, along with the Ramgarh District Collector's Office, has also promoted pisciculture in these mines by providing relevant technical and financial support to locals. This initiative has helped locals affected by mine closure. For example, a 57-member fishing cooperative has been formed as a result of pisciculture development in the Saunda open-cast mines.[227]

  The major challenge for this sector is scaling production and integration within the broader market, for which infrastructure development is required but currently missing or limited. For example, storage and processing facilities for the fish are currently of poor quality or limited.[227] Establishing this infrastructure near mine sites, closer to areas that would be most affected by coal decline, is also a significant hurdle: mine closures are infrequent, and getting the relevant permits

and authorizations is a complex process.[229] In addition to these infrastructure challenges, prospective local entrepreneurs face a relatively shallow pool of potential investors and poor law and order.[230,231]

To move this sector forward, skill development, infrastructure buildout, and regulatory changes may be considered. For skilling, the District Collector's Office, the Regional Directorate of Skill Development and Entrepreneurship, and civil society organizations may consider further streamlining training opportunities for processing, packaging, and cage culture techniques. For building better infrastructure, the district administration (including the District Collector and the Development Commissioner), Jharkhand Road Construction Department's Chief Engineer, and the Jharkhand Department of Food Processing may collectively develop a systematic road map to develop and establish facilities for farming, storage, and processing in Ramgarh. To foster pisciculture infrastructure near mines (e.g. repurposing mine voids for raising fish) the relevant authorities—including the District Mining Officer, the Department of Fisheries, coal company officials, the District Collector, and the District Forest Officer—could work together to streamline authorizations and lay out assessment requirements for pisciculture viability under the formal mine closure process. At the federal level, the Ministry of Coal announced new guidelines to introduce reforms to this system in June 2024.[232]

- **Manufacturing: Sand**

  Sand manufacturing from coal overburden (i.e. soil or rock overtop coal deposits) was also highlighted by survey respondents, who pointed to CIL's experiments with this in its other subsidiaries (e.g. Western Coalfields Limited and Northern Coalfields Limited).[224] Nationally, demand for sand is high and growing, in part due to strong economic growth. According to media reports in Jharkhand, construction projects amounting to half a billion U.S. dollars in value were halted following a recent sand supply crisis.[233] Currently, no overburden sand is being produced in Ramgarh, but the overburden-to-coal ratio (1.6–3.1 cubic meter per ton) of the district's mines indicates that sand mining could be profitable for CCL.[218] In addition to repurposing existing coal value chains, overburden-to-sand manufacturing could mitigate excess sand mining near riverbanks, thereby helping related ecosystems.[206,234] Sand manufacturing could also generate revenue for the district through production royalties from producers.[193] Finally, this sector would create jobs near the mine sites, where coal decline is often felt most acutely.

  Major challenges to sand manufacturing include market access, establishing formal supply chains, labor expertise, and law and order. As for market access, the Indian construction sector having traditionally used natural sand can be biased against artificial sand.[206,235] Manufactured sand would need to overcome this hurdle for greater market access and economic viability. Formal supply chains need readily available infrastructure (e.g. overburden supply), much of which is currently concentrated among coal companies.[193] For labor, whether the existing workforce has the skills required is unknown; and they would likely need to be trained in stone crushing to particular grades as these skills are uncommon and the sector is relatively new.[193] Law and order present significant challenges for growth in this sector, as the pervasiveness of organized crime in the sector was noted by multiple interviewees.[193,194,211] Additionally, determining royalties is a challenge, as lower royalties relative to natural sand may help consumer adoption while higher may depress its acceptance and use.

To begin fostering this sector in Ramgarh, the Superintendent of Police and civil society may consider efforts to further reduce organized crime, which is pervasive in the local sand sector as per interviews and focus group discussions. To overcome bias against manufactured sand and encourage its adoption, the federal government could consider lower royalties (relative to natural sand). For workforce skilling, the National Skill Development Commission may consider a study into this sector's skill requirements and gaps, particularly among existing coal workers. CCL may also help provide training to the local workforce using their corporate social responsibility funds. To build out supply chains, CCL may coordinate with the relevant departments, including the District Development Commissioner, to build infrastructure like crushers and roads to transport sand.

- **Manufacturing: Food Processing**

  The food processing sector is nearly non-existent in Ramgarh today. Though Ramgarh's Gola and Chitarpur blocks are known for vegetable and maize production with a cropping intensity of 260%, it has limited production of high-value crops like strawberries and green leafy vegetables.[218] Most crops produced in the district are sold directly to the market without any processing or value addition.[218,236] Processing these crops could locally capture higher-value parts of the producer's supply chain, create new employment opportunities, and increase the incomes of farmers and local businesses. Additionally, the food processing industry could generate more income for the district, diversifying its revenue sources.[210,211] These manufacturing units could also help small entrepreneurs by providing new business opportunities with higher-value produce and products. The development of this sector aligns with the state's food processing policy meant to position the state as one of India's major food processors and suppliers.[228] This policy provides sector-enabling subsidies including a 50%–70% subsidy for processing and distribution centers in rural areas.[228]

  Major challenges for food processing include supply chain development, including skill gaps within the existing workforce and poor storage and processing facilities.[237] Breaking of law and order (e.g. local crime or rent-seeking by organized groups) presents significant challenges for smooth operations and may deter the establishment of businesses in this sector.[224]

  To begin growing this sector, the government may consider skilling and buildout of supporting infrastructure. The National Skill Development Commission, Regional Directorate of Skill Development and Entrepreneurship, district administration (district collector), civil society, and the Agriculture Technology Management Agency (ATMA), Ramgarh may consider creating tailored skill development programs for the sector, e.g. in food safety and packaging. Moreover, the district administration—in coordination with other stakeholders like the Jharkhand Department of Food and ATMA Ramgarh—may consider developing a strategy to build processing units, cold storage units, and other infrastructure essential to the sector's growth. Finally, the district may consider increasing patrolling by law enforcement and allocating more resources to address the issue of organized crime.

- **Tourism: Nature, Religious, Mining**

  Ramgarh's tourism industry is relatively small, but many locals aspire to work in the sector.[192,216] The sector primarily consists of outdoor recreation at its Patratu Dam, nature tourism around Patratu Lake, and pilgrimages to the Chhinnamasta

Temple at Rajrappa, which is visited by thousands of devotees every month.[238] Additionally, one coal company official spoke of plans to repurpose a mine site into a tourism site, which would involve the district administration and coal companies repurposing an old mining area (the Rajrappa mines) into an ecopark.[194,206] Development of lodging, restaurants, and more recreational sites could enable Ramgarh to capitalize on its existing tourist assets, considering the district has the advantages of connectivity to the state capital and relatively good road infrastructure.

Major challenges for tourism include inadequate infrastructure: the district only has two mid-range hotels, app-based taxi services are not yet available, and public transport and rail connectivity are limited.[239] While tourist traffic is high, business and infrastructure development around the sector is limited.[193,238] For example, more road connectivity is needed near the Maa Chinnamastika Temple.[193] Poor law and order were also cited in interviews and by enterprise survey respondents as a challenge for businesses and a possible deterrent for prospective tourists.[194,216] Additionally, insufficient awareness about touristic opportunities in Ramgarh pose a barrier to the sector's growth.[193]

To encourage tourism in Ramgarh, steps can be taken to address the above challenges. Infrastructure for this sector could be built out in the district to foster tourism and recreation, e.g. docks and boardwalks for boating and waterfront dining.[240] The district administration and CCL may consider creating options for mine tourism or mine repurposing for ecopark development. The district could also expand public transport to accommodate more tourist traffic. To improve law and order, the local police may consider increased security at tourist spots to ensure tourist safety and encourage future visits. Finally, to create awareness of the district's tourism opportunities, the district administration (including the District Collector and Public Relations Officer) and Jharkhand's Department of Tourism may consider coordinating with local media outlets and using social media influence to promote Ramgarh's religious shrines and old fort, which may not be widely known beyond the region. The state tourism department, along with the District Collector, may also consider official promotional events for tourism in the district.

Though Ramgarh remains heavily coal dependent and does not anticipate imminent coal decline, its government is aware of political pressures on coal from India's net-zero emissions commitments and global efforts to curb greenhouse gas emissions.[193,220,226] The government of Jharkhand has formulated a taskforce on making Jharkhand and districts like Ramgarh future-ready.[241] How these commitments and future local coal decline will relate to one another is an open question, but Ramgarh's community and administration share an understanding of the tax revenue and employment implications of coal decline. Though Ramgarh has not conceptually united its economic development and diversification efforts with risk mitigation vis-a-vis coal decline, the district remains committed to proactive diversification and development. ■

Table 5: Ramgarh District – Identified Sectors

Rationale, key factors and challenges, and current or possible next steps for relevant institutions

Sector	Opportunities	Challenges	Current or possible next steps
Pisciculture	**Market access** The district could supply fresh fish supply to the local market, which is currently import dependent. Undersupply of fresh fish is also an opportunity for the locals in the state. **Existing assets** The district has many open-cast mines that could be repurposed for pisciculture. The district administration along with the Jharkhand Department of Fisheries has taken steps to repurpose coal mines for fishery. The fisheries department also provides technical skilling in cage fishing to the local communities. **Access to finance** Coal companies' CSR budget and funds available under DMF could be used to repurpose mines for pisciculture. **Government incentives** The state government's Food Processing Policy of 2015 provides a variety of sector-enabling subsidies, including a 35%–50% subsidy for fisheries (in cold chain, value addition and preservation infrastructure) and a 50% –70% subsidy for processing and distribution centers in rural areas.	**Infrastructure** Ramgarh currently has no storage facilities sizeable enough for a large-scale fishery and processing industry, and existing processing units are few or rudimentary. Development of commercial-scale infrastructure near mines is also a challenge. **Access to finance** The shallow pool of investors in this sector is a major inhibitor. Additionally, higher interest rates pose a challenge for entrepreneurs interested in entering the sector. **Workforce availability** Required skilled labor may be difficult to source locally or bring into the community.	**Skill development*** The Regional Directorate of Skill Development and Entrepreneurship, the district administration (District Collector), and civil society may further streamline skill development in processing, packaging, and cage techniques for the sector. **Regulatory changes to encourage void repurposing** Facilitating void repurposing for fisheries is done in coordination with many authorities, including the District Mining Officer, the Department of Fisheries, coal company officials, the District Collector, and the District Forest Officer. These authorities could work together to streamline the process. Additionally, streamlining the requirements for assessing pisciculture viability under the formal mine closure process may also be considered. **Infrastructure buildout** The district administration (comprising of the District Collector, Development Commissioner), the Jharkhand Road Construction Department (including the chief engineer) and the Jharkhand Department of Food Processing may collectively develop a systematic road map for proper development of farming, storage and processing facilities in Ramgarh.
Manufacturing Sand	**Targeted job creation** Sand manufacturing could create jobs (both directly and through induced transport) near mine sites where coal-decline would be felt most acutely. **Market demand** Demand for sand is high and growing, in part thanks to strong economic growth and improving quality of life for much of the population.	**Market access** The Indian construction sector has traditionally used natural sand and is at times biased against artificial sand. Manufactured sand would need to overcome this hurdle for greater market access and economic viability. **Workforce availability** Required skilled labor may be difficult to source locally or bring into the community. The workforce likely would need training in stone crushing to particular grades as these skills are uncommon and the sector is relatively new.	**Curbing organized crime** The Superintendent of Police and civil society may consider efforts to further reduce organized crime, which is pervasive in the local sand sector as per interviews and focus group discussions. **Skill Development** National Skill Development Commission may consider a study into this sector's skill requirements and gaps, particularly among existing coal workers, as these are not well understood in the district. Central Coalfields Ltd. (CCL) may also provide training to the local workforce by using their corporate social responsibility funds.

		Law and order Organized crime is pervasive in the sand sector, which may prevent growth of manufactured sand and the sector more broadly. **Lack of formal supply chains** Currently, infrastructure development for overburden-to-sand in the district is concentrated among coal companies.	**Infrastructure buildout** CCL may coordinate with the concerned departments, including the District Development Commissioner, to build infrastructure like crushers and roads to transport sand. **Royalty adjustments** The federal government may consider lower royalties for manufactured sand to encourage its adoption and overcome industry biases.
Manufacturing Food processing	**Market demand** Food product demand is high and growing, in part thanks to strong economic growth and improving quality of life for much of the population. The district is one of the main strawberry-producing regions in the state, and regional demand is high specifically for the district's leafy green vegetables. **Existing sectors** Ramgarh produces vegetables in good quantity and quality; and growth in the food processing sector will only further help diversify local supply chains. Ramgarh's Administrative Block 2 has a good crop intensity, making raw material more readily available for processing and other manufacturing. **Government incentives** The state government's Food Processing Policy of 2015 provides a variety of sector-enabling subsidies, including a 50–70% subsidy for processing and distribution centers in rural areas.	**Poor processing and storage infrastructure** Limited or poor-quality storage and processing is a major deterrent to the growth of food processing in the district. **Workforce availability** Required skilled labor may be difficult to source locally or bring into the community **Law and order** Breaking of law and order (e.g. local crime or rent-seeking by organized groups) presents significant challenges for food processing operations.	**Curbing organized crime** The Superintendent of Police and civil society may consider increasing community patrolling and allocating more resources toward mitigating organized crime. **Skill development** The National Skill Development Commission, the Regional Directorate of Skill Development and Entrepreneurship, the district administration (District Collector), civil society, and the Agriculture Technology Management Agency (ATMA) Ramgarh may consider creating programs to develop food safety and packaging skills among the local workforce. **Strategizing for infrastructure buildout** The district administration, in coordination with others such as the Jharkhand Department of Food, and ATMA Ramgarh, may consider creating a strategy to develop processing units, cold storage units, and other necessary infrastructure crucial for the sector.
Tourism Nature, religious, mining related	**Existing assets** Ramgarh is home to a Hindu shrine of significant religious interest, visited by thousands of devotees each month.	**Limited hospitality and recreation options** Options for tourists are relatively limited for both lodging and dining. Recreational activities are limited to the Patratu area of Ramgarh.	**Infrastructure buildout** To promote the growth of the tourism sector, more recreational activities need to be created in the district. The district administration and CCL may consider creating options for mine tourism or repurposing mines into ecoparks. The district may also consider expanding public transportation to ease movement of tourists.

		Law and Order Law and Order poses a significant inhibiting factor to the growth of tourism in the district. **Lack of Marketing** More advertising through social media channels and by tourism department is needed to tackle the lack of awareness about the region outside the state. **Infrastructure (connectivity)** Accessing certain tourist sites is at times a significant challenge. For example, more road connectivity is needed near the Maa Chinnamastika Temple.	**Increased law enforcement at tourist sites** Police departments may increase security at tourist spots to ensure tourist safety and encourage future visits. **Marketing and publicity** The district administration (including the district collector and the public relations officer), Jharkhand's Department of Tourism, local media, and social media influencers could come together to create awareness of Ramgarh's important religious shrines and old fort, which may not be widely known beyond the region. The state tourism department, along with the district collector, may also consider organizing official tourism promotional events.

*Action underway

Source: This table is a summary of the sector write-ups in this case study. Please see main text for citations.

3.5 Pre-transition: Bokaro District, Jharkhand, India

Section 1: Background and Coal Sector

Bokaro District, formed in 1991 after carving out land from the now-neighboring districts of Giridih and Dhanbad districts, has a population of over 2 million.[242] The district's gender ratio is 109.2, with a notably higher male population, and its two most prominent religions are Hinduism (79.35%) and Islam (11.71%).[31]

The district has a historic dependency on coal and is among the highest coal-producing districts in Jharkhand. Coal production formally began in the 1910s with the operationalization of the coal mines in the Bermo coalfield.[243] Today, mining and quarrying make up about 7% of Bokaro's GDP and 39.30% of Bokaro's primary sector; statewide, the contribution of mining and quarrying is 5.71% to GDP and 22.64% to the primary sector.[217] The district is home to three thermal plants with a total capacity of 1.4GW, and this capacity is currently undergoing expansion.[244]

Coal production is carried out entirely by the Coal India Limited (CIL) subsidiary Central Coalfields Limited (CCL). Bokaro has 14 coal mines and produced 14.24 million tons of coal in FY 2023–24.[30] Twelve of these mines are open cast and the other two are underground with a total project capacity of 33.80 metric tons (estimated peak capacity is 42.66 metric tons).[30,194]

Bokaro's coal dependence manifests in two primary ways:

1. **Employment:** CCL provides direct jobs for 9,924 people.[29] Apart from direct employment, approximately 5,000 contractual workers are employed in coal mining operations.[29] According to qualitative surveys and interviews, roughly 100,000 additional people in the district are employed in coal transportation and manual coal loading.[246–248] CCL's mining operations currently do not have a conveyer system to transport coal to rail, nearby power plants, and other local destinations; thus, production relies heavily on a 10,000-truck transport system.[246,248] This employment is not consistent or necessarily full time, as it is reliant on several variables including daily coal production.[246]

   The coal-fired power plants in Bokaro employ over 1,800 people. Damodar Valley Corporation's two plants alone employ 1,325 people; the Tenughat Thermal Power Station employs roughly 550.[249]

2. **District Mineral Funds (DMF) and government revenue:** Bokaro has the fourth-highest DMF collections in Jharkhand by district.[250] As of 2023, the total DMF accrued from coal in Bokaro amounted to $125 million (₹10.46 billion).[195] Coal DMF collections play a major role in the development of critical road infrastructure in Bokaro, and over 645 such projects worth $106 million (₹8.83 billion) have been sanctioned since 2016.[251] Coal also generates significant indirect revenues that are redistributed to the districts, including Bokaro.[201,202] This

Bokaro District's Coal Sector

Composition

14
Mines (open cast and underground)

3
Power Plants (1.4GW capacity)

Production

16
million tons (Recent; 2023–24)

47
million tons (Expected peak; 2039–44)

Employment

+16,800
Mining & power generation (Total direct; 2024)

+14,924
Mining (Total direct; 2024)

Note: Coal employment as a share of district total not shown due to lack of current census data.

Source: Central Coalfields Limited[29,30], Jharkhand Department of Planning & Development[245]

is identical to Ramgarh's dependence on government revenues.

The district also has many notable second- and third-order dependencies:

1. **Infrastructure:** CCL provides basic infrastructure like water, electricity, and cooking fuel (i.e. coal) to local communities within about 25 kilometers of the mines through its mandatory corporate social responsibility (CSR) spending.[252] As for water access, CCL provides it to the community through community ponds, tanks, and tap water connections to district residents, both employees and non-employees alike.[253,254] Hospitals constructed and run by the coal and thermal power companies also provide healthcare in the district.[255]

2. **Energy supply:** Bokaro gets nearly all its electricity from coal-fired power. District-level data is not available, but over 90% of the state's electricity supply derives from coal-fired power.[212] The district has an installed capacity of 1.42GW of coal-fired generation which not only provides electricity to the district but also comprises more than 26% of Jharkhand's total installed thermal power capacity.[212] Apart from electricity, coal is used as a cooking fuel at all the roadside eateries in Bokaro and in over 50% of households within five kilometers of the coal mines.[192,209]

3. **Induced economy:** The coal sector has induced a significant amount of local economic activity that caters to local miners, supports mining operations, and fuels other sectors. As per this report's field survey, the authors estimate that roughly 110,000 people hold coal-induced employment, which includes truckers, informal miners and employees of businesses dependent upon miners' salaries, among others.[209,256] 10,000 of these laborers work at the Bokaro Steel Plant, which provides some of the highest quality coal-induced employment in the district.[257,258] Direct coal-sector employees contribute a significant amount of money to Bokaro's local economy, making up a significant portion of Bokaro's economic base. Focus group discussions with small- and medium-sized local businesses revealed that local businesses grow temporarily by at least 45%–55% to accommodate the dramatic increases in local spending spurred by CCL's annual performance incentive bonuses.[192,209]

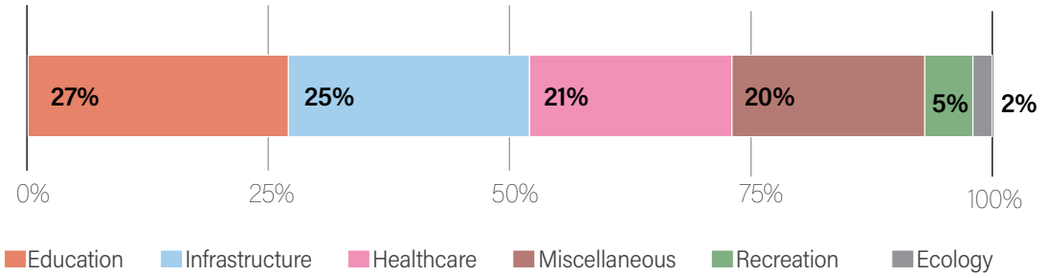
   Finally, major industrial development has taken place in the district with the help of local coal mining. For example, the Bokaro Steel Plant gets much of its coal supply from Bokaro's mines in Bermo.[259] Other coal consumers include auxiliary steel plants (via boilers) and red brickmakers (via brick furnaces).[247,248]

4. **Community Development:** In addition to infrastructure, CSR funds are invested in skill training and other activities within a 25 kilometer radius of the mines.[252] CCL collaborates with the local skill development training center to provide skilling to lower-income individuals.[260] CCL also provides financial support to Bokaro's private schools, which are the main source of affordable and standardized education to the local communities.[261]

In three-to-four years, six coal mines will be closed.[215] The retirement dates for Bokaro's thermal plants are not publicly available but are likely to be in the next several decades.[262] CCL is planning to compensate for these closures by increasing coal production at its other operational mines.[215] As per CCL's current production plans, Bokaro is yet to reach peak coal production, which is expected in the next

Figure 6: CCL Corporate Social Responsibility Spending in Bokaro District, Jharkhand, FY 2022–23

Share of funding allocated by project type. In FY22–23, CSR spending was allocated somewhat uniformly to education, infrastructure, healthcare, and miscellaneous (see note).



Note: Categories based on authors' interpretation. Included under 'Education' are technical skilling, education-related infrastructure (e.g. libraries, water purifiers for schools), and student supplies (e.g. bookbags). Most (83%) of 'Miscellaneous' spending is for the Har Ghar Tiranga Campaign 2022 but also includes goods donations (e.g. sewing machines, clothing, etc.).

Source: Central Coalfields Limited[213]

five-to-seven years. This peak is expected to plateau for another seven-to-ten years, followed by decline in the late 2030s or early 2040s.[214] Coal has played an important role in the district's development, and the community believes coal will continue to do so in its future development.[209,263,264]

Section 2: Diversification and Development

Bokaro District is heavily coal dependent. Although district GDP numbers suggest that the service and manufacturing sectors have outpaced the primary sector, much of the development in the service and manufacturing sectors is owed to local availability of cheap coal. Bokaro District is considered a hub for manufacturing, which comprises about 40% of the district's GDP, but much of this activity is coal-induced.[217] For example, steel constitutes much of Bokaro's manufacturing activity (the district hosts one of the largest steel plants in the country), but this steel production is coal-dependent, as noted in the previous section.

Though much of this development is coal-centric, there are some efforts underway to diversify the manufacturing sector away from coal. Organizations like the UN Industrial Development Organization are working to introduce non-coal-based boilers (used in many manufacturing subsectors in Bokaro and in India broadly), to decarbonize the sector.[265] However, these efforts primarily target small to medium-sized businesses and focus on reduction of emissions rather than local economic resilience. The state government has also developed the Industrial Development and Promotion Scheme 2016 and Electronic Sector Design and Manufacturing Policy (ESDM) 2016 to promote and develop electronic device manufacturing in the state.[266] Under both the programs, the government envisions the development of an industrial park and promises both financial and non-financial incentives for manufacturing buildout. (Bokaro currently hosts two industrial areas, in Chandankiyari and Bokaro Steel City respectively.) Moreover, 700 acres of land in Bokaro has been identified by the district administration to be developed into an industrial hub.[267] The state government has also identified Bokaro as a district with potential for chemical manufacturing cluster development.[32] The diversification and promotion of the manufacturing

sector also align with both India's 'Make in India' program and with Jharkhand's industrial policy.[266,268]

Bokaro has historically been better placed economically in comparison to many other districts in the state; however, Bokaro faces development challenges similar to other districts.[217] As per interviews and survey data, the district administration's focus is on the improvement of socio-economic parameters (literacy, nutrition, education) and physical infrastructure like roads and highways.[209,270] These priorities also align with state and national priorities, and the district administration also has offices and programs dedicated to other development priorities, including the District Development Office (for government program implementation), the District Welfare Officer, and the District Rural Development Authority. Like Ramgarh, Bokaro also experiences challenges with land availability, acquisition, and use.

Most of these priorities intersect with the requisite efforts to attract new sectors or to help existing ones grow, such as workforce readiness and adequate physical infrastructure for the production and distribution of goods. In the surveys, interviews, and public records, the district's community and industry leaders as well as local households expressed interest in the following sectors:

- **Manufacturing: Solar power**

  Bokaro is a significant manufacturing hub but lacking in solar manufacturing facilities.[271] Interviewees, focus group discussions, and surveys highlighted perceived opportunities in the growing market demand for solar energy.[209,257,269,272] Much of the interest in solar PV manufacturing derives from national- and state-level government programs and promotion: the federal government, under its National Solar Mission, has announced incentives and several programs for the promotion of solar development.[257,273,274] At the state level, targets have been raised for solar capacity addition to 4.2GW by 2027 in tandem with the national PM-Surya Ghar program, which aims to create demand for rooftop solar to the tune of 10 million households.[275,276]

> "Local industries would employ local people. If a solar plant is being set up, it should hire locals."
>
> Focus Group No. 7 with civil contactors in Bokaro District[269]

  Beyond demand generation, the state government is supporting general manufacturing units through financial incentives that include relaxation of existing stamp duties and a 20% subsidy on capital investment.[266,275,276] This upward threshold varies by industry. Presently, the district has two dedicated areas for general industrial development, managed by the state's Industrial Area Development Authority.[275,276]

  There are significant hurdles to this sector's development in Bokaro. A lack of locally available technological expertise in solar cell manufacturing is a challenge, as many of the district's most skilled workers are trained primarily in coal mining and related jobs.[209,256–258,277] The limited existing expertise in the district, in the workforce and elsewhere, may constrict manufacturing opportunities to assembly of solar energy arrays and prevent it from expanding into the production of more advanced parts like solar photovoltaic cells. Attracting investment is an-

other challenge on several fronts, including the capital intensity of manufacturing plants and the high borrowing costs for capital.[224,257,277] Additionally, the district faces competition from other states that are also looking to capitalize on national programs for solar development.

Advancing this sector will involve skilling, industrial site development, and possibly the creation of more incentives, both financial and policy-related. The Jharkhand Industrial Area Development Authority, District Collectorate, and the Jharkhand Department of Industries may consider providing relevant skilling to its labor force to attract businesses. As for site development, the Industrial Development Authority's regional director, the Bokaro Industrial Area Development Authority, the district collector, and the Jharkhand Industrial Area Development Authority may consider collaborating to identify and develop land specifically for solar manufacturing units. Finally, the state government of Jharkhand may consider financial incentives specifically for solar manufacturing, and the district administration may consider giving land subsidies specifically to solar manufacturers.

- **Construction: Solar Power Installation**

  Solar installation, especially the installation of solar rooftop systems, was cited in interviews and the survey as a sector with growth potential. In discussions with community members and private sector actors, optimism around demand growth from government programs was repeatedly highlighted.[257,264] The national government has announced several programs to promote solar deployment, including a plan to train 100,000 youths for residential solar installation.[278] The state of Jharkhand is offering a 100% exemption from transmission and wheeling charges for 10 years for qualifying grid-connected solar storage.[275] Jharkhand is also providing land to solar farms, based on farm capacity and area.[275] Though Bokaro has few existing solar farms today, the state-owned companies CIL and the Steel Authority of India Limited have announced new solar and floating solar plants to be installed in the district to meet the state's solar deployment target of 4.2GW by 2027.[279,280]

  Interviewees noted that local skilling would be a challenge, for example in circuitry and grid interconnection.[248,257,270] Anecdotal evidence suggests that the current workforce in the district is not suitably trained for this work.[248,257,270] Bokaro also has very few, if any, solar panel retail sellers, which may limit opportunities for its installation in the district.[248,257,270]

  To encourage growth in this segment, the Regional Directorate of Skill Development and Entrepreneurship, the district collector, and existing civil society and training centers may consider identifying existing skill gaps and developing training programs for new installers. Additionally, to spur installation demand, the district may also consider creating awareness among, and training for, local retailers who may be unaware of opportunities available in the sale of solar panel. The Jharkhand Industries Department may consider giving financial incentives to both new solar panel retailers and new installers to spur growth and demand across the sector.

- **Pisciculture**

  Pisciculture is not currently a major sector in Bokaro. The district contributes only 6.2% to the state's total fish production; however, the district perceives econo-

mic opportunity in pisciculture given the prevalence of open-cast mines that can be potentially repurposed for pisciculture.[222,281] Interviewees noted that local DMFs may be well suited for mine repurposing activities.[247,248,263,269] Like neighboring Ramgarh, Bokaro anticipates similar market opportunities based on the region's import dependency for fish and the high demand for fresh fish in local and regional markets.[269,282]

Though rail connectivity is fairly robust, supply chain development is a challenge, including poor or limited existing storage, refrigeration, and processing facilities.[247,269,282,283] Development of commercial scale pisciculture infrastructure near the mine sites is another challenge, in part due to a lack of available mines to repurpose. Mine closures are currently limited, as most mines are under expansion and consolidation.[248,269,283] Finally, there is a limited number of workers trained in pisciculture in the district. As per latest available data, there are only 22 fishermen cooperative societies in Bokaro; limited labor availability may inhibit the sector's growth prospectives.[270,282]

To build out this sector, several steps may be considered. For workforce readiness, the district collector, the Regional Directorate of Skill Development and Entrepreneurship, and civil society may consider working towards a systematic development of skills across this sector's supply chain, for processing, packaging, and cage techniques. To spur mine repurposing for fishery, the District Mining Officer, the Department of Fisheries, CCL, the District Collector, and the Divisional Forest Officer may collaborate to streamline the repurposing process which currently requires much coordination across all these institutions. Requirements to assess viability of alternative uses, such as pisciculture, as part of the formal mine closure process may also be considered. Finally, the development of facilities across this sector's supply chain (e.g. farming, storage and processing) in the district may be coordinated by the District Development Commissioner, District Collector, and the Jharkhand Department of Food Processing.

Coal-powered industrial development will continue as the district aims to meet more urgent development needs. District communities and administration are aware that local coal production will eventually decline and have severe impacts on the coal-producing blocks within the district (e.g. Bermo and Gomia); however, per interviews and the report survey, the district is focused on the localized effects of coal decline instead of the broader, district-wide impacts. Diversification away from coal production in Bokaro may occur because of natural resource depletion, but the district does not yet envision a path forward to diversify its broader economic activities away from coal. ■

Table 6: Bokaro District – Identified Sectors

Rationale, key factors and challenges, and current or possible next steps for relevant institutions

Sector	Opportunities	Challenges	Current or possible next steps
Manufacturing Solar power	**Market demand** The national government, under its National Solar Mission, is providing incentives and has announced several programs to promote solar development. The PM-Surya Ghar scheme is projected to create solar PV demand through planned deployment of rooftop solar to 10 million households. At the same time, Telangana has raised its solar capacity addition targets to 4.2GW by 2027. **Manufacturing support from the state government** The state government is giving an incentive to all manufacturing units; for example, through a relaxation of stamp duty, and a 20% subsidy on capital investment (upward threshold varies by industry).	**Technical knowledge** A lack of locally available expertise in the district may limit manufacturing opportunities to only the assembly of solar energy arrays rather than allowing it to expand to the production of more advanced parts such as solar photovoltaic cells. **Attracting Investment** Attracting solar manufacturing operations to the district may prove challenging on several fronts, including the capital intensity of manufacturing plants and high borrowing costs for capital, which may deter investment. Additionally, the district faces competition from other states also looking to capitalize on federal government programs.	**Skilling** The Jharkhand Industrial Area Development Authority, the District Collectorate, and the Jharkhand Department of Industries may consider providing relevant skilling to its labor force to attract businesses. **Industrial site development*** The Industrial Development Authority's Regional Director, the Bokaro Industrial Area Development Authority, the District Collector, and the Jharkhand Industrial Area Development Authority may consider collaborating to identify and develop land specifically for the solar manufacturing units. **State incentives*** The government of Jharkhand may consider additional financial or other policy incentives specific to solar manufacturing. The district administration may consider land subsidies specifically for solar manufacturers.
Construction Solar power installation*	**Market demand and government incentives** The national and state governments have announced incentives and several schemes for promoting solar, which has led to increased demand. For example, grid-connected solar power projects with storage systems selling power within the state will be offered 100% exemption from transmission and wheeling charges for a period of 10 years. The state will also provide the land to solar farms, based on the farm capacity and area.	**Lack of skilled labor force** Solar installation requires skill and knowledge of electrical equipment, circuit connection, and civil work. The district's workforce is not adequately trained to do this work. This is also a challenge at the national level. **Lack of solar panel retail sellers** There is a general shortage of solar panel vendors in the country, which may limit opportunities for widespread installation.	**Skill development*** The Regional Directorate of Skill Development and Entrepreneurship, the District Collector, civil society and training center departments could help with the identification of skill gaps and training new installers. **Awareness and education** The district can create awareness among and train local retailers who may be unaware of the opportunities available in solar panel sales to spur installation demand. **Financial incentives*** The Jharkhand Industries Department may consider giving financial incentives to both new solar panel retailers and new installers to spur growth and demand in the sector.

Pisciculture	**Market access and demand** The district can provide supply of fresh fish to the local market, which is currently import-dependent. **Existing assets** The district has many open-cast mines that could be repurposed for pisciculture. The district administration, along with the Jharkhand Department of Fisheries, has taken steps to repurpose the coal mines for fishery. The fishery department also provides technical knowledge to the local communities. Currently, fish production in Bokaro makes up only 6% of the state's total. **Access to finance** Coal companies' corporate social responsibility funds, as well as funds available under DMF, can be used for repurposing mines for pisciculture.	**Workforce availability** There is a limited number of trained people traditionally employed in fishing. As per the latest available data, there are only 22 fishermen's co-operative societies in Bokaro. Large-scale commercial pisciculture may be inhibited by unavailable skilled labor. **Supply chain constraints** Bokaro currently does not have the requisite storage facilities required for large-scale fishery and processing industry. **Pisciculture near mines may be difficult** Areas around Bokaro's mines would likely experience coal decline the most severely. Development of commercial scale infrastructure near mines, in advance of coal decline, is a challenge due to lack of available mines to repurpose. Mine closures are currently limited, as most mines are under expansion and consolidation.	**Skill development** The Regional Directorate of Skill Development and Entrepreneurship, the District Collector, and civil society may consider systematic development of skills across this sector's supply chain, in processing, packaging, and cage techniques. **Regulatory changes to encourage void repurposing** The District Mining Officer, the Department of Fisheries, Central Coalfields Limited, the District Collector, and the District Forest Officer may coordinate the streamlining of existing processes for void repurposing. Currently, this requires coordination of all these institutions. Requirements to assess viability of alternative uses like pisciculture as part of the formal mine closure process may also be considered. **Infrastructure buildout** The District Development Commissioner, the District Collector, the Road Construction Department, and the Jharkhand Department of Food Processing may aid in the development of facilities for farming, storage, and processing across this sector's supply chain in Bokaro.

*Action underway

Source: This table is a summary of the sector write-ups in this case study. Please see main text for citations.

3.6 Pre-transition: Peddapalli District, Telangana, India

Peddapalli District's Coal Sector

Composition

9
Mines (open cast and underground)

3
Power Plants (4.3GW capacity)

Production

14.3
million tons (Recent; 2023)

33
million tons (Expected peak; 2036–44)

Employment

+15,900
Mining & power generation (Total direct; 2024)

+15,552
Mining, including coal transporters (Total direct; 2024)

Note: Coal employment as a share of district total not shown due to the unavailability of up-to-date census data.

Source: Singareni Collieries Company Limited [285,288], Telangana Industries & Commerce Department[289] NTPC Ltd.[286], Telangana Energy Department[287], Swaniti Initiative[290,291]

Section 1: Background and Coal Sector

Peddapalli is a district in the northern region of Telangana, a south-central Indian state. Formed in 2016 with the bifurcation of the now-neighboring Karimnagar district, Peddapalli District is one of six coal-producing districts in Telangana.[187] The district has a population of 795,332 with a per capita income of approximately $2,040 (₹170,353).[284] The district's gender ratio is 100.8 (nearly 1:1); its two most prominent religions are Hinduism (93%) and Islam (6%).[31]

Peddapalli's coal sector comprises a mix of coal mining and coal-fired power plants. Its nine mines, five open cast and four underground, produced approximately 14.3 million tons of coal in 2023, accounting for more than a quarter of Telangana's total production.[285] These mines are owned and operated entirely by the state-owned Singareni Collieries Company Limited (SCCL). The district's NTPC Ramagundam coal-fired power plant is the largest in southern India with a capacity of 2.6GW.[286] Peddapalli is home to two additional coal-fired power plants with a combined capacity of 1.7GW.[287]

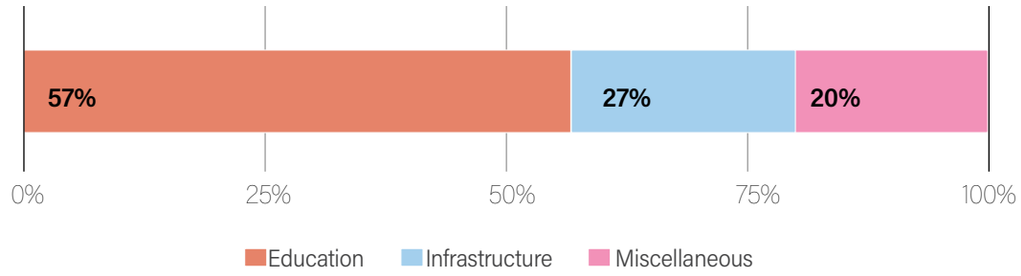
Peddapalli exhibits greater coal dependencies in areas where coal mines and power plants are situated (i.e. Godavarikhani and Ramagundam).[292] Over 50% of the population in these areas are SCCL employees (total population of these areas is approximately 229,644 as per the last census in 2011).[31,293] Other parts of the district are more directly dependent on agriculture, limestone quarrying, or textile manufacturing, rather than on coal mining.[284,294]

The district's coal dependencies primarily manifest in the following ways:

1. **Employment:** According to SCCL data, 13,552 people directly work in the coal mines in Peddapalli as of 2023.[288] The household survey suggests three out of every ten people are directly or indirectly dependent on the coal sector for employment.[292] In addition, over 3,000 people alone are employed in the NTPC Ramagundam coal-fired power plant.[289] Two other thermal power plants in Peddapalli also provide significant employment, but the total number is not publicly available. Focus group discussions with coal transporters highlighted that approximately 800–1,000 coal trucks operate in the district (primarily in Godavarikhani and Ramagundam) employing at least 2,000 people (i.e. one driver and one helper per truck).[291] Unlike Bokaro and Ramgarh, relatively few people in Peddapalli are involved in illegal or informal coal mining and scavenging.[292,293,295]

2. **District Mineral Funds (DMF):** Peddapalli is the top district for DMF collections in Telangana.[296] As of 2023, total DMF accrued from coal in Peddapalli amounted to $8.5 million (₹7.6 billion).[297] Coal DMF collections play a major role in the development of critical road

Figure 7: Singareni Collieries Company Ltd. Corporate Social Responsibility (CSR) Spending in Peddapalli District, Telangana, FY 2022–23



Note: Categories based on authors' interpretation. Included under 'Education' are technical skilling, education-related infrastructure (e.g. libraries, water purifiers for schools), and student supplies (e.g. bookbags). 'Miscellaneous' spending consists of funding for the Har Ghar Tiranga Campaign 2022 (37% of segment) and research (63%).

Source: Singareni Collieries Company Limited[304]

infrastructure in the district, and over 400 such projects worth $38.8 million (₹324 crore) have been sanctioned as of October 2023.[298] These projects have positively impacted much of the district's population.[299]

The district has the following notable second- and third-order dependencies:

1. **Infrastructure:** Much of Peddapalli's infrastructure is paid for directly with coal revenues. Before the era of corporate social responsibility (CSR) spending and DMF mandates from the national government, SCCL established and oversaw several higher education centers and medical facilities in the district (e.g. the Singareni Institute of Medical Sciences).[300] Since CSR spending was mandated in section 135 of the Companies Act, 2013, SCCL has built out infrastructure in Peddapalli more systematically, in consultation with the district. For example, SCCL's Surrounding Habitat Assistance Programme provides drinking water, electricity, street lighting, roads, and other facilities to dwellings (a) fewer than 8 kilometers from townships or within 10 kilometers of the coal mines, and (b) in an area where over 25% of the population consists of SCCL employees.[301]

2. **Energy supply:** Most of Peddapalli's electricity supply is coal derived. District-level numbers are unavailable, but Peddapalli alone generates 45% of the total coal power in Telangana (55.4% of Telangana's electricity derives from coal).[212] NTPC (India's national, state-owned power company) and SCCL provide electricity directly to residential areas of company workers in Ramagundam.[293] The state government has several flagship programs for the power sector in Peddapalli; these programs provide subsidized power to several consumers and sectors including, laundry shops, poultry farms, and power looms.[284] Unlike other coal districts in this study, Peddapalli's population does not broadly depend on coal for cooking fuel.[302]

3. **Induced economy:** The presence of coal mines and thermal power plants in Ramagundam and Godavarikhani areas has spurred an induced economy reliant on coal through:

    a. **Coal worker spending**: SCCL and NTPC employees are highly paid, and

their local spending contributes significantly to the businesses in the area.[291,293,295] This mirrors the experiences of Ramgarh and Bokaro.

b. **Fueling heavy and auxiliary industries:** Peddapalli caters to the coal demand of many coal-dependent industries in the region. For example, there are approximately 148 cement and fly-ash brick units in Peddapalli dependent on coal.[303]

4. **Community development:** SCCL undertakes community development initiatives through its CSR funds. In addition to infrastructure, these funds go toward vocational training, literacy drives, health awareness programs, and other development initiatives. Installation of CCTV cameras at mine sites for women's safety, vocational training to differently abled children in Godavarikhani, and deployment of a hydraulic excavator for desilting canal water were undertaken in Peddapalli in 2022–23 under CSR.[304]

Currently, three of the four underground mines in the district are loss-making.[215] One open-cast mine is likely to be closed in 2024 due to reserve depletion.[215] SCCL plans to compensate for these losses by opening new coal mines, and widespread coal decline is not anticipated.[215]

Section 2: Diversification and Development

Peddapalli is not yet diversified away from coal. Mining and quarrying contribute to approximately 20% of the district's economy, and most of this contribution comes from coal mining.[305] The primary sector (raw materials) contributes 45.2% to the district's GDP, followed by the tertiary (services; 42%) and secondary (manufacturing; 13%) sectors.[305] (Mining and quarrying contribute approximately 45% to Peddapalli's primary sector.) Peddapalli is the second-highest contributing district (12.2%) to Telangana's mining and quarrying GDP segment.[305]

Beyond coal, Peddapalli is known for paddy, cotton, and maize cultivation. The agriculture sector is the backbone of Peddapalli economy; the government has undertaken flagship programs like Mission Kakatiya, the Kaleshwaram Project, and the Rythu Bandhu schemes to boost the sector's growth.[284] There are also plans to turn Peddapalli into a seed bowl for the state, and the district could become a model for these efforts.[306] Currently, Peddapalli's strategy for supporting the agriculture sector is focused on promoting of inclusive growth, enhancing of rural incomes, and maintaining food security.[284]

Peddapalli District also hosts more than 700 manufacturing units (cement, fertilizers, rice mills, food processing, plastic, rubber) and other quarrying industries (limestone, iron ore, granite).[303] Some of these operations are coal-reliant; notably, the largest cement factory in the district uses locally produced coal to operate.[307]

Peddapalli is more socio-economically developed as compared to other coal districts in India. Though the district has a literacy rate (65%) below the national average (71%), and ranks 17th (out of a total 33) in the state in terms of per capita income, support from a well-resourced state, the presence of industrial clusters, and a robust agricultural base contribute to a high quality of life relative to other coal-reliant districts in India.[31,305,308] For example, the quality of its road and railway infrastructure is very high relative to other coal-reliant districts in India.[289,308,309] Peddapalli is

well-equipped with railway lines, including one connecting the northern and southern regions of India. The Rajeev Rahadari highway connects remote coal belts in the district to the state capital of Hyderabad, which serves as an important enabler of economic activity.[289]

Investment of remittances has been an important factor in Peddapalli's development and a differentiator from other coal districts.[291,295] Coal workers have been able to earn enough to educate their children and send them to wealthier parts of India or abroad for work. The money these children earn and send home (i.e. remittances) has contributed to the district's development through consumer spending and small business investments. For other coal districts like Ramgarh and Bokaro, remittances have played a more modest role due, in part due to lower capacity at the state level to support education.[291,295]

> "Options like solar power plants and small-scale industries could be explored, although these may not provide employment on the same scale as Singareni.
>
> Comment during Focus Group No. 3 with labor union officials

The district's economic development priorities lie largely with its industrial, retail, and manufacturing sectors. Industrial development parks are being established in Peddapalli, in addition to existing parks: an area of 25.97 acres has been proposed for the establishment of a transport hub including garages, auto service centers, and spare-part outlets.[289] Additionally, owing to its cotton and paddy production, the district is working to attract and grow rice bran oil manufacturing units (in Sultanabad) and seed processing units and cotton ginning mills (in the Manthani and Kalvasrirampur administrative blocks).[289]

Our industry survey, interviews, and focus group discussions show local awareness of and interest in sectors that could become part of a diversification strategy:

- **Manufacturing: Solar energy**

  As of 2022, Peddapalli has 58 solar rooftops with a total capacity of 495.5 kW.[284] Electricity generation is a rapidly growing economic sector in India; according to the International Energy Agency, India's electricity demand grew by nearly 40% from 2010–20.[310] This has created opportunities for solar energy deployment and manufacturing.

  Our survey shows solar power manufacturing is a sector of interest for diversification in the district.[311] Owing to government initiatives and SCCL's recent efforts to deploy solar energy, the sector shows potential to create employment and to utilize mine land that may have limited prospects for other development. At this time, Telangana is offering loans up to $1.8 million (₹15 crore) for renewable energy projects under the state's priority sector lending programs.[312] There is also a federal 100% stamp duty exemption for land acquired for setting up the manufacturing units.[313] SCCL is generating local demand by increasing local solar generation, with a total capacity of 50MW in Peddapalli as of 2023.[314] SCCL is also

establishing a first-of-its-kind 22MW solar power generation unit atop of its OC-1 coal mine in Ramagundam at an estimated cost of $15 million (₹126 crore).[315] India's largest floating solar power unit (100MW) has also been commissioned in Peddapalli.[316]

Technical expertise, particularly among the local workforce, may prove a significant challenge.[255,311] Limited knowledge in solar manufacturing may restrict manufacturing development to the relatively simple assembly of solar arrays and preclude more advanced and more profitable processes such as solar cell manufacturing. Other challenges include depressed demand for solar energy, in part because of limited land availability for large-scale (i.e. utility-scale) solar farms, maintenance costs of installations over their lifespan, and technical constraints on the grid's ability to accommodate grid-connected solar installations.[289,317]

The government of Telangana may consider expanding the curriculum of local training centers which provide skills and training in solar power installation and maintenance (Suryamitra), into solar manufacturing. To encourage regional demand growth for locally produced solar generation, the state government and relevant state-owned enterprises may consider financial incentives for net metering and maintenance to encourage regional demand growth for solar products.

- **Manufacturing: Food Processing**

  Manufacturing in Peddapalli comprises about 13% of Peddapalli's GDP.[305] Peddapalli produces approximately 40,000 metric tons of paddy and 28,537 metric tons of maize annually.[305] Across sources (survey, discussion, interviews), respondents cited food processing as an aspirational sector for creating high-value products. Much of the existing food processing in the area is centered around small-scale, lower-value rice processing units.[303] Creating higher-value supply chains to capture more value from an existing sector could result in higher wages and contributions to the local GDP.

  Concerning food processing, respondents noted opportunities for small to medium-sized businesses as an option toward diversification.[318] District reports also suggest investment opportunities in seed processing, feed mixing plants, and cotton gins in the Peddapalli, Odela, Manthani, Srirampur, and Sultanabad blocks of Peddapalli District.[289] Currently, the district has an annual seed production capacity of 27,000 million metric tons.[289] Additionally, the Telangana state government is incentivizing creation of food parks, for example, by offering a capital subsidy of 50% and a power rebate of ₹2 per unit for five years.[319]

  Limited local initiative and capacity in the district administration to capitalize on these state programs may prove a barrier to sector growth; the district has not yet widely implemented these incentives in Peddapalli.[302,320] The dearth of medium-to-large scale units may be indicative of a limited capacity (e.g. land) for food processing at an industrial scale.[303] Challenges also include power reliability: the district regularly experiences 1–3 hours of power cuts daily, which may present challenges for the sector, including for food safety (i.e. consistent refrigeration for raw materials and products).[311]

  To move this sector forward, the district government—via the District Industries Center and the District Rural Development Authority—may consider increasing access to financing. This could include streamlining loan approval processes

and having a single-track system for setting up and authorizing food processing units in Peddapalli. Additionally, the state of Telangana could consider developing relevant infrastructure, including industrial parks in the district targeting the sector.

- **Manufacturing: Textiles**

  The district's annual 140,000 metric ton production of high-quality cotton could also feed into higher-value textile and garment manufacturing, which in turn could capitalize on international export markets.[284] Interviewees, discussants, and survey respondents noted existing road infrastructure, which is unique among Indian coal communities, as an opportunity to get the product to markets in Peddapalli and as an enabling factor in building out textile supply chains.[307,318] Additionally, the Telangana state government is offering a one-time skill upgradation support and training of $36 (₹3,000) per worker for new textile units, which can be leveraged for Peddapalli.[321] There are currently 12 registered textile manufacturing units in the district; 11 are micro or small scale, and one is a large unit.[303,307]

  Efforts to grow this sector in Peddapalli may face several barriers. These include the challenging economics of textiles and limited government incentives to establish or grow textile manufacturing in the district.[307,318] Textile manufacturing units across Telangana have faced a significant drop in fabric prices and demand, causing unsustainable financial losses and widespread closures. In 2023, roughly 50 textile units were shut down near Peddapalli in Sircilla Textile Park, across the state border in neighboring Andhra Pradesh, due to these reasons.[322]

  The district administration, via the District Industries Centre and the District Rural Development Authority, may consider promoting existing schemes for capital and power subsidies available to new textile units in Peddapalli. Additionally, the state may consider creating similar financial incentives for the expansion of existing textile manufacturing operations. The District Industries Centre, the Telangana State Industrial Infrastructure Corporation, and the Telangana State Handloom and Textiles Department may consider developing land to foster medium- and large-scale textile operations, which could both grow the sector and make it more economically viable and resilient due to economy of scale.

To the community, a transition away from coal remains a far-fetched idea. This is for two primary reasons: (1) coal production in the district does not show immediate signs of decline; and (2) discussion of any transition away from coal at the state or district-level has not been initiated generally.[293] At the community level, surveys and focus group discussions show that local understanding of coal transition is limited; locals do not view coal decline as an existential threat in major parts of the district due to the prominence of other sectors, like agriculture.[323,324] However, locals—particularly in the Ramagundam area—remain highly dependent on coal for their livelihood.

Currently Peddapalli does not have a strategy in place for diversifying away from coal.[325] The coal sector remains socio-economically central in several a including Ramagundam and Godavarikhani. Peddapalli District certainly has development agendas, but they do not account for any future coal decline within the district. To successfully diversify away from coal, Peddapalli would need to anticipate this future

and to channel its resources into efforts to foster sectors which are not reliant upon coal, while ensuring that currently reliant sectors become less dependent. ■

Table 7: Peddapalli District – Identified Sectors
Rationale, key factors and challenges, and current or possible next steps for relevant institutions

Sector	Opportunities	Challenges	Current or possible next steps
Manufacturing Solar power	**State incentives** Loans up to ₹15 crores are available for renewable energy projects under priority sector lending in Telangana, easing access to capital for this sector. Additionally, there is a 100% stamp duty exemption for land acquired for setting up the manufacturing units nationally. **Land acquisition and utilization** Land that has limited reuse options (particularly former mineland) can be repurposed to install solar panels. **State-led solar demand growth** India's largest floating solar power project (100MW) commissioned in Peddapalli is expected to boost the share of renewable energy.	**Technical knowledge** A lack of expertise in the district, including among the local labor force, may limit manufacturing opportunities to assembly of solar energy arrays rather than the production of more advanced parts such as solar photovoltaic cells. **Power intermittency** Technical constraints on the grid's ability to balance solar generation intermittency may serve as a limiting factor for solar deployment/installations and therefore solar demand growth. Additionally, this may prove a challenge for manufacturing facilities, which require significant amounts of electricity.	**Introduction of financial incentives for net metering and maintenance** The government of Telangana, the Telangana State Northern Power Distribution Company Limited, and Telangana State Southern Power Distribution Company Limited could consider introducing subsidies for solar asset maintenance and net metering to grow regional demand for solar energy. **Training centers*** The government of Telangana is working to expand its Suryamitra training centers, which provide skilling and training opportunities to the youth in solar power project installation and maintenance. The Telangana government could work with existing district skilling centers and industrial training institutes to create more training opportunities in solar manufacturing within Suryamitra training centers.
Manufacturing Food processing	**Building on existing sectors** Peddapalli currently produces 40,000 metric tons of paddy and 28,537 metric tons of maize annually. Food product manufacturing could create higher-value supply chains to capture more value from an existing sector, generating higher wages and higher contributions to local GDP. **State government support** State-level incentives exist for starting food processing units (e.g. a capital subsidy of 50% or a power rebate of ₹2 per unit for five years, and a single-window clearance system).	**District initiative and capacity** The district, which is responsible for locally implementing state programs, has not yet capitalized on incentives provided by the state government at a large scale. **Limited scale** Peddapalli's food processing operations are currently limited to small and micro units. The district only has one medium-sized food processing unit on record.	**Improved access to financing*** The district government (including the District Industries Centre and the District Rural Development Authority) could facilitate access to financing, including through the streamlining of loan approval processes and the introduction of a single-track system for setting up food processing units in Peddapalli. **Establishment of industrial food manufacturing units** The Telangana State Industrial Infrastructure Corporation could consider developing industrial food parks, leveraging transportation networks, and providing logistic support for the sector.

Manufacturing Textiles	**Natural resources** Peddapalli produces 140,000 metric tons of cotton per year, presenting an opportunity for higher-value products from fiber manufacturing units. **State support** Currently, this sector is part of the state of Telangana's job creation initiatives. The government is offering a one-time skill upgradation and training for local manpower of $36 (₹3,000) per worker for new textile units.	**Infrastructure development** There is a need for development and investment in textile parks in Peddapalli. Currently, there is only one large-scale textile manufacturing unit in Peddapalli despite existing state incentives. **Economic viability** Fabric prices have created challenges for this sector in the district. In 2023, around 50 textile units near Peddapalli (in Sircilla Textile Park, across the state border in Andhra Pradesh) were closed down because of increased yarn and chemical costs, causing unsustainable losses.	**Financial incentives** The district government (including the District Industries Centre, the District Rural Development Authority, and the District Collectorate) could consider promoting schemes such as capital and power subsidies (in alignment with state policies for textiles) for setting up new textile units in Peddapalli. **Establishment of areas for industrial textile manufacturing development** The District Industries Centre, the Telangana State Industrial Infrastructure Corporation, and the Telangana State Handloom and Textiles Department may consider developing land for larger textile operations.

*Action underway

Source: This table is a summary of the sector write-ups in this case study. Please see main text for citations.

4.0 Discussion and Conclusion

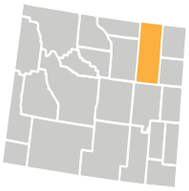
Earlier work on coal-related just transition globally has focused on creating frameworks, quantifying coal dependency, or understanding how renewable energy jobs may replace coal jobs. Some additional work has also focused on quantifying the scale of retraining coal workers or the overall costs of just transition. However, mitigating the risks of coal dependence and decline in coal-reliant communities requires economic diversification. Diversification can reduce coal's local economic footprint by attracting new sectors or helping existing ones to grow, thereby making the coal sector's economic benefits, like jobs and revenues, less existentially important in a community.

Focusing on six local regions—three in the United States and three in India—we conducted a large fieldwork-based study to understand the scale and type of coal dependency in each of these regions and their economic diversification prospects.

Based on this study, we first list several key lessons for just transition planners. Next, we provide recommendations for key stakeholders in the United States, India, and globally.

Figure 8: United States Case Study Summaries – Coal Dependence and Identified Sectors

Coal production declining



	Fayette County	Person County	Campbell County
Coal sector composition	Mining	Power generation	Mining, Power generation
Primary coal dependencies	**Jobs:** ~606 **Revenue:** >$390,000 **Others:** Electricity, Induced economy	**Jobs:** 328-524 **Revenue:** >$7 million **Others:** Induced economy, Real estate, Electricity, Community development	**Jobs:** 5,246 **Revenue:** >$30 million **Others:** Induced economy, Electricity, Community development
Identified sectors	• Tourism • Real estate • Recreation equipment manufacturing • Solar and hydroelectric power	• Power generation • Semiconductor and microelectronics manufacturing • Non-woven textile manufacturing • Agriculture	• Coal-to-products manufacturing • Carbon Capture, Utilization, and Storage (CCUS) • Tourism (sports and conferencing) • Data centers

4.1 Key Observations

4.1.1 Observations on coal dependency

1. **Coal sector dependencies vary considerably across counties, states, and countries.** While all case studies show some level of dependence on the coal industry for jobs and government revenues, the degree of a community's dependence on the coal industry for either may vary considerably. For coal-mining communities, there can be a markedly greater dependency on jobs compared to power plant communities, where the largest dependency may be revenues. Second- and third-order dependencies also vary widely: in India, especially in the old coal-mining regions, informal jobs are widespread, but this is not the case in the United States or even in other regions in India. Person County is unique among case studies in that it has valuable real estate directly related to the reservoirs created for its Roxboro and Mayo coal-fired power plants.

2. **Acceptance of a post-coal future remains a barrier for coal communities.** In all three Indian case studies, interviewees were generally skeptical of coal decline, and many sectors identified in these districts could remain indirectly reliant on coal even in the face of its decline locally. In the United States, the un-

Figure 9: India Case Study Summaries – Coal Dependence and Identified Sectors

Coal production growing or plateaued

	Ramgarh District	Bokaro District	Peddapalli District
Coal sector composition	Mining	Mining, Power generation	Mining, Power generation
Primary coal dependencies	**Jobs:** 10,968 **Revenue:** >$15 million **Others:** Infrastructure, Induced economy, Energy	**Jobs:** 16,800 **Revenue:** >$12.5 million **Others:** Induced economy, Energy, Community development	**Jobs:** 15,900 **Revenue:** >$8.5 million **Others:** Infrastructure, Induced economy, Electricity
Identified sectors	• Pisciculture • Sand manufacturing • Food processing • Tourism	• Solar manufacturing • Solar power installation • Pisciculture	• Food processing • Textile manufacturing • Solar manufacturing

derstanding of coal decline as an economic reality is growing, but interviewees in coal-mining communities noted that acceptance remains a political challenge.

3. **Coal sector dynamics can affect different dependencies at different times.** For coal-mining communities, employment may decline well ahead of revenues. In Fayette County, interviewees noted that decline in coal employment has historically begun over a decade before the start of significant decline in local revenue, largely because of mechanization of mining processes and shifts away from labor-intensive underground mining.[36] This phenomenon also holds true in Indian case studies. Temporary resurgences in the sector (e.g. increased employment or coal price), also noted by interviewees, can be a challenge, as they can serve as false signs to the community of the coal sector's positive performance in the longer term.[36,160]

4. **Data availability remains a challenge in quantifying coal dependencies.** Local-level data sets, when available, do not often organize government revenue data by sector, or job data below the macro level. For example, in the United States, coal employment data is typically aggregated with other extractive industry data such as oil and gas. For Indian case studies, surveys were needed in order to establish the necessary data points for mapping employment and broader economic dependencies.

4.1.2 Observations in development and diversification

1. **Economic transitions for coal communities may not necessarily be energy-to-energy.** Diversifying from coal to lower-carbon energy, either through coal asset repurposing or general deployment, is often touted by policymakers, activists, and politicians as a way to simultaneously transition fossil fuel-reliant economies and energy systems. These case studies show that, in reality, coal-reliant communities view diversification more holistically, often seeking to diversify their economies into sectors beyond energy. Across the six case studies, over 12 non-energy sectors were identified, ranging from pisciculture to data centers.

2. **Economic development—the constellation of activities meant to attract, foster, and grow economic activity—is where the rubber meets the road for diversification.** A community's approach to economic development affects if and how prospective sectors can emerge or grow locally. For Person County, industrial site development has factored heavily into its efforts to attract investment from different sectors. For Ramgarh and Bokaro districts, raising literacy rates, education, and skilling are important priorities to develop its workforce for existing and prospective sectors. In all communities, many of these activities are broad-based rather than sector-targeted.

3. **Energy transition is a story of rural economic development in many fossil fuel-reliant communities.** Like many other coal-reliant communities, all six communities studied in this report are rural. The many factors that influence diversification in these communities—geographic isolation, workforce readiness and availability, infrastructure buildout, etc.—are also rural development challenges that go beyond, and long predate, challenges emerging from coal decline.[58]

4. **Meeting first-order development needs is often required in coal-reliant com-**

munities to foster economic diversification. These needs—which can include community beautification, improving literacy, or erecting basic infrastructure—vary by community and geography, but all factor into businesses' decisions to locate to a given community. In Fayette County, addressing dilapidated and abandoned buildings is a first-order issue to help facilitate diversification, as these buildings may deter possible business investments. In Ramgarh and Bokaro, literacy is a major priority, one that directly impacts workforce skilling and readiness for new sectors. In Peddapalli, the literacy rate is higher, but gender inequality (i.e. a lower rate of female literacy) currently locks out a major segment of the population from significant parts of the labor market.

5. **Balancing the development of different sectors is an important overarching challenge.** Different sectors have different requirements for their development in a given area, and these requirements may at times conflict. For example, Fayette County's desire to grow tourism and agriculture can be, or seem, at odds with the development of other sectors like commercial real estate, power generation, or energy storage and transmission.[326]

6. **Responsibility for managing economic diversification is often diffuse, potentially complicating diversification efforts.** The levers of economic development are often decentralized, resulting in a complex network of government entities, civil society organizations, state-owned enterprises, and private-sector actors where no single organization is responsible for cohesive, successful diversification and development. In Person County, assorted leaders in economic development may include the Piedmont Community College, the Kerr-Tar Regional Council of Governments, the North Carolina Department of Commerce, along with various departments and boards of the county itself. In India, while much of the activity is centralized within the government, responsibilities are spread across administrative levels, departments (e.g. Industries Department), and, particularly in mining communities, state-owned enterprises like Central Coalfields Limited. Coordinating many institutions with varied authorities and capacities, or the lack of a coordinating body at all, may dilute sector-targeted development activities and thereby diversification.

7. **Economic diversification alone cannot solve all dependencies.** Across the case studies, it is clear that local economic diversification efforts need to extend beyond attracting new sectors or helping existing ones grow. In India, state-owned enterprises are responsible for funding and infrastructure that other industries, private or public, may not be obligated to provide. In the United States, coal revenue dependencies are not only affected by the coal sector but by the existing tax code and, in some instances, by mandated royalty payments; without tax reform, government revenues may not be replaced through diversification.

8. **There is no universal understanding of economic diversification or its relationship to coal dependence.** Communities may or may not link diversification with general coal sector decline or broader efforts to change energy systems. In Bokaro and Ramgarh, for example, diversification is sometimes viewed as diversifying away from coal mining but not necessarily away from coal-fired power or coal-reliant sectors like steel. Thus, diversification might relieve dependency on coal mining but not on coal consumption. In Campbell County, diversification is considered both the addition of non-coal sectors and the fostering of new economic pathways for its coal resources. This variation in the local understanding of diversification

is influenced by types of coal dependencies, status of coal decline, types of local coal assets, and priorities and initiatives at the state and national levels.

9. **Whether and how sector-targeted development for diversification should be undertaken by these communities remains an open question.** Economic development is often conducted with a "if you build it, they will come" approach; industrial sites and other infrastructure (alongside tax incentives) are deployed to attract investment. This is typically done in a broad manner, to cast a wide net for businesses across different sectors. Sector-targeted development is less common in under-resourced communities, where it can be viewed as a riskier undertaking, and is typically conducted in areas richer in resources.

4.2 Recommendations

Based on the above observations, the authors propose the following recommendations:

4.2.1 Global Recommendations

1. **Governments, philanthropies, academia, international organizations, and civil society need to consider coal dependencies more holistically when planning for just transition.** Coal-sector dependencies differ spatially, by degree, and by type. While all case studies show some level of dependence on the coal industry for jobs and government revenues, the degree of dependence on either varies substantially. Other dependencies also vary widely: in India, informal coal jobs are widespread in some communities, but this is not the case in the United States. Some dependencies are unique among case studies: for example, some of Person County's most valuable real estate directly derives from the reservoirs created for its Roxboro and Mayo coal-fired power plants. Holistic consideration of the coal industry's role in these communities can help foster more robust transition planning and management that also account for critical but less obvious impacts.

2. **State and federal governments, philanthropy, academia, international organizations, and civil society should approach coal decline in coal-reliant communities first as an economic development challenge and second as an energy transition issue.** At the local level, coal decline in coal-reliant communities is first and foremost experienced as an economic issue. Non-energy sector alternatives to coal may prove as or more beneficial to these communities, leading to a local economic future beyond or apart from energy. Governmental, philanthropic, intergovernmental, and other funders for coal communities in transition should extend their funding to initiatives beyond low-carbon deployment. Transition funding should support broader economic development activities that can help these communities diversify, beyond clean energy deployment and fossil asset repurposing. Additionally, local coal transition work should heavily involve, or be led by, those working in economic development (e.g. the inclusion of rural economic developers in the U.S. Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization's Rapid Response Teams).

3. **Governments, philanthropic organizations, IGOs, and other funders should increase longer-term funding opportunities**. Strategies can take a decade or

more to bear fruit; stable funding is thus a huge boon. Funding for transition projects, including economic diversification, should not be limited to clean energy projects. The case studies demonstrate that communities in both the United States and India aspire to diversify into a range of sectors, from tourism to food processing. Activities meant to help coal-reliant communities should involve programming or funding that is guaranteed over longer periods to instill stability in community transition efforts (e.g. the North Carolina NCWorks Customized Training Program)[327].

4. **State and national governments should help localities holistically define, track, and measure local-level economic diversification.** A common definition for diversification at the local level does not currently exist. Providing a data-driven, multidimensional definition and assessment for diversification—one that considers variables like GDP, employment, revenues—could help communities and external supporters alike better understand how diversification should be undertaken. For example, Person County's diversification needs vis-a-vis coal derive primarily from its reliance on coal sector-derived tax revenues rather than GDP—a unidimensional measurement may efface this fact. A data-driven, multivariate definition of diversification, and a means to measure it, could help communities and external supporters more strategically diversify local economies.

5. **More research into matching sectors with coal communities should be conducted and funded, including by academic institutions, state governments, IGOs, and philanthropic organizations.** Prospective sectors identified in each case study—ranging from pisciculture to data centers—were named by interviewees and discussants on the basis of local assets, existing sectors, or incentives given by the state and national governments. But what is not well understood is how these sectors may or may not fill the socio-economic gaps left by coal decline. More research is needed to better understand which sectors are best suited for coal communities both in terms of filling the gaps left by coal decline and the community's unique characteristics and assets. Furthermore, future research should be conducted into balancing sector-specific development efforts with broader economic development activities, given limited resources and the risk of making unduly targeted efforts.

4.2.2 U.S. Recommendations

1. **State and county governments should consider broader institutionalization and empowerment of regional economic development planning and coordination.** Local governments often have limited ability to manage broader economic forces on their own. By coordinating economic development planning on a regional level, counties can be better positioned to capitalize on the development of their neighbors and pool resources to anticipate future economic trends. For example, Fayette County and its neighboring counties are uniquely supported by two regional developers—New River Gorge Regional Development Authority and the Region 4 Planning and Development Council—who help counties with business development and public infrastructure, respectively.

2. **The federal government should establish clear, targeted qualifications for funding intended for coal-dependent communities in order to direct more resources to them for diversification.** Federal development funding that spe-

cifically target coal communities is limited, leaving these communities to compete nationally with other counties for economic diversification funding.[328] Coal communities, generally located rurally, often end up being out-competed by richer and larger urban areas for both private and federal investments because of the too broad and vague nature of funding requirements for qualification.[329] For example, the Inflation Reduction Act's definitions of "energy community" can encompass larger urban areas that may not be heavily dependent upon coal or other fossil fuels.[330] On the other hand, the IRA is also in some ways too narrow; Person County is notably not considered an energy community under the law.[331] Through more specialized requirements, the federal government may alleviate some of the difficulties brought on by this double-edged funding challenge facing economic development and diversification.

3. **The federal government should work with state and local governments to identify key data and streamline relevant digital tools for economic development.** Many different entities work in economic development, resulting in myriad digital databases and platforms that provide access to a community's data, leading to confusion and outdated information for prospective developers. Federal agencies should work with relevant bodies at the state and local levels to create a consolidated, navigable, and up-to-date digital system for looking up local-level information, e.g. a community's workforce composition or any prospective sites for commercial and industrial development. Additionally, the federal government should work with state and local governments to identify and provide more robust and relevant data for prospective development opportunities, looking beyond standard statistics like GDP and population.

4.2.2 India Recommendations

1. **As coal dependency and economic diversification prospects vary spatially across districts, we recommend that governments, state-owned enterprises, and philanthropic organizations fund baseline research on coal dependency and economic diversification in various districts across the country.** Our research shows large variations in the scale and type of coal dependency in Peddapalli, Ramgarh, and Bokaro. For example, unlike the districts of Bokaro and Ramgarh in Jharkhand, there is barely any informal or illegal coal mining in Peddapalli. There are about 50 coal-dependent districts in India; therefore, understanding these districts' coal dependencies and diversification prospects will be essential for any future planning.

2. **Government administrations at the district, state, and national levels should create and empower district-level transition committees constituting government bodies and local community organizations.** While the state of Jharkhand and state-owned enterprises like Coal India have just transition task forces, there are no district-level just transition bodies. However, all tangible just transition activity has to happen at the district level. These communities can work towards achieving economic diversification of their districts using the sectors identified in the baseline studies. These committees can create short-, medium-, and long-term plans for diversification into identified sectors, find funding to undertake pilot programs, and liaise with state and federal governments to achieve their goals.

3. **Federal and state governments must align future economic development**

programs with economic diversification planning. Case studies show that economic development in the form of infrastructure development, health, and education should complement economic diversification planning. For example, as pisciculture is an aspirational sector for diversification, skill training programs—whether run by state governments or state-owned enterprises—should have training modules on pisciculture.

4. **For implementation of any large-scale economic diversification roadmap, state governments should collaborate with local universities to build the capacity of local stakeholders**. Our case studies highlight various challenges for coal districts to diversify into new sectors. These require community stakeholders, including government officials, to be trained in the skills required for undertaking integrated resource planning. Local universities should design and teach courses to local government officials and local community leaders on each of the identified sectors.

References

1. U.S. Energy Information Administration. *Annual Coal Report 2022*. (2023).
2. Russell, C. India's coal sector sees huge leaps in output and demand. *Reuters* (2024).
3. May 2024 was Earth's warmest May on record. *National Oceanic and Atmospheric Administration* https://www.noaa.gov/news/may-2024-was-earths-warmest-may-on-record (2024).
4. Carrington, D. 'Hopeless and broken': why the world's top climate scientists are in despair. *The Guardian* https://www.theguardian.com/environment/ng-interactive/2024/may/08/hopeless-and-broken-why-the-worlds-top-climate-scientists-are-in-despair (2024).
5. United Nations Framework Convention on Climate Change. First Global Stocktake. (2023).
6. Pai, S. Fossil fuel phase outs to meet global climate targets: investigating the spatial and temporal dimensions of just transitions. (2021) doi:10.14288/1.0398719.
7. Our Members. *Powering Past Coal Alliance* https://poweringpastcoal.org/members/ (2022).
8. Pai, S., Harrison, K. & Zerriffi, H. *A Systematic Review of the Key Elements of a Just Transition for Fossil Fuel Workers*. https://institute.smartprosperity.ca/transition-for-fossil-fuel-workers (2020).
9. Vona, F. Job losses and political acceptability of climate policies: why the 'job-killing' argument is so persistent and how to overturn it. *Clim. Policy* **19**, 524–532 (2019).
10. Weller, S. A. Just transition? Strategic framing and the challenges facing coal dependent communities. *Environ. Plan. C Polit. Space* **37**, 298–316 (2019).
11. Agarwal, S. Ministry's Action and Approaches on Coal Mine Closure and Just Transition Date: 23 Aug, 2023. (2023).
12. World Bank. *Just Transition Taxonomy - Narrative Report*. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099060624112518330/p181026100f25402a19c59168957f0848c3 (2024).
13. Mitra, J., Singh, A. & Victor, A. *Just Transition Framework for a Sustainable Future in India's Coal Mining Regions*. https://www.teriin.org/policy-brief/just-transition-framework-sustainable-future-indias-coal-mining-regions (2024).
14. Dominish, E., Briggs, C., Teske, S. & Mey, F. Just Transition: Employment Projections for the 2.0 °C and 1.5 °C Scenarios. in *Achieving the Paris Climate Agreement Goals* (ed. Teske, S.) 413–435 (Springer International Publishing, Cham, 2019). doi:10.1007/978-3-030-05843-2_10.
15. Pai, S., Emmerling, J., Drouet, L., Zerriffi, H. & Jewell, J. Meeting well-below 2°C target would increase energy sector jobs globally. *One Earth* **4**, 1026–1036 (2021).
16. Pai, S., Allen, M. M. & O'Hare, K. *Understanding Just Transitions in Coal-Dependent Communities*. https://www.csis.org/analysis/understanding-just-transitions-coal-dependent-communities (2021).
17. Pai, S. & Ranjan, V. Understanding the arc of global just transition: case studies from the India, South Africa and US. *SSRN Electron. J.* (2023) doi:10.2139/ssrn.4450353.
18. NITI Aayog. *Report of the Inter-Ministerial Committee on Just Transition from Coal*. https://www.niti.gov.in/sites/default/files/2022-11/Report_Just-Transition-Committee_compressed.pdf (2022).
19. Rai, V., Tongia, R., Shrimali, G. & Abhyankar, N. Data for development: The case for an Indian energy information administration. *Energy Res. Soc. Sci.* **25**, 105–109 (2017).
20. Bingham, A. J. From Data Management to Actionable Findings: A Five-Phase Process of Qualitative Data Analysis. *Int. J. Qual. Methods* **22**, 16094069231183620 (2023).
21. U.S. Census Bureau. American Community Survey, ACS 1-Year Estimates Data Profiles. Selected Economic Characteristics (2022).

22. QuickFacts: Fayette County, West Virginia; United States. *U.S. Census Bureau* https://www.census.gov/quickfacts/fact/table/fayettecountywestvirginia,US/HSG651222.

23. QuickFacts: Campbell County, Wyoming. *U.S. Census Bureau* https://www.census.gov/quickfacts/fact/table/campbellcountywyoming/POP010210.

24. QuickFacts: Person County, North Carolina. *U.S. Census Bureau* https://www.census.gov/quickfacts/fact/table/personcountynorthcarolina/LND110220.

25. U.S. Bureau of Economic Analysis. CAGDP6 Real GDP by county and metropolitan area. (2023).

26. U.S. Mine Safety and Health Administration. Mine Employment and Coal Production [1983-2022]. Mine Data Retrieval System.

27. Singareni Collieries Company Limited. Annual coal production data. (2024).

28. Singareni Collieries Company Limited. Untitled annual coal employment dataset. (2024).

29. Central Coalfields Limited. Untitled coal employment dataset. (2024).

30. Central Coalfields Limited. Untitled coal production dataset. (2024).

31. India Ministry of Home Affairs. *Census of India 2011*. https://censusindia.gov.in/nada/index.php/home (2014).

32. Department of Planning and Development, Government of Jharkhand. *Jharkhand Economic Survey 2023–2024*. https://finance.jharkhand.gov.in/pdf/Budget_2024_25/Jharkhand_Economic_Survey_2023_24.pdf (2024).

33. Directorate of Economics and Statistics. *Telangana Economy.* https://www.telangana.gov.in/wp-content/uploads/2023/12/Telangana-Economy-2023.pdf (2023).

34. District Industries Centre. Peddapalli District Profile. (2019).

35. Environmental activist. Interview No. 23. (2024).

36. Former resident and West Virginia academic. Interview No. 1. (2024).

37. U.S. Energy Information Administration. Most U.S. coal is mined in the West, but most coal mining jobs are in the East. *Today in Energy.* https://www.eia.gov/todayinenergy/detail.php?id=54579 (2022).

38. Local community developer. Interview No. 2. (2023).

39. Local government official. Interview No. 4. (2023).

40. Former local business owner and activist. Interview No. 5. (2023).

41. U.S. Census Bureau. All Sectors: County Business Patterns, including ZIP Code Business Patterns, by Legal Form of Organization and Employment Size Class for the U.S., States, and Selected Geographies: 2021. (2021).

42. West Virginia Office of Miners' Health Safety and Training. 2021 Production and Employment - Broken Down By County. *WV Office of Miners' Health Safety and Training* https://minesafety.wv.gov/2021-production-and-employment-broken-down-by-county/.

43. Headley, T. & Bezdek, R. How Many Coal-Dependent Jobs Are There and How Important Are They? *Public Utilities Fortnightly* (2020).

44. National Mining Association. Annual Coal Wages vs. All Industries, 2021. (2022).

45. The Fayette Tribune. Levy Estimate (Budget). *West Virginia Legals* https://wvlegals.com/levy-estimate-budget-4/ (2022).

46. West Virginia State Treasury. Coal Severance Tax - Archive [April 2005 - October 2023]. (2024).

47. Fayette County Sheriff's Tax Office. West Virginia Fayette County Property Tax Records. Fayette County Property Tax Records (2024).

48. National Association of Counties. West Virginia: County Government Overview. (2022).

49. U.S. Energy Information Administration. *Short-Term Energy Outlook*. https://www.eia.gov/outlooks/steo/archives/jun22.pdf (2022).

50. Tate, C. Coal's Rebound May Not Last, and Here's Why. *West Virginia Public Broadcasting* https://wvpublic.org/coals-rebound-may-not-last-and-heres-why/ (2021).

51. West Virginia: Profile Analysis. *U.S. Energy Information Administration* https://www.eia.gov/state/analysis.php?sid=WV (2024).

52. James, J. & Shannon, D. *Charging West Virginians*. 1–24 https://downstreamstrategies.b-cdn.net/wp-content/uploads/2023/05/Charging-West-Virginians-Report-FINAL-4-14-2023.pdf (2023).

53. Beyer, A. To land green energy plant, West Virginia lawmakers bypassed their own utility regulators. *Mountain State Spotlight* (2022).

54. Lavelle, M. Soaring West Virginia Electricity Prices Trigger Standoff Over the State's Devotion to Coal Power. *Inside Climate News* (2022).

55. Clark, W. HB 4553. *West Virginia Code* vol. 8A (2022).

56. Jackson, R. & Jarosi, P. *An Economic Analysis of the Appalachian Coal Industry Ecosystem*. https://www.arc.gov/wp-content/uploads/2018/01/CIE2-CountyLevelCIESupplyChainAnalysis-2.pdf (2018).

57. Fayette County Commission. Fayette County Comprehensive Plan. (2023).

58. Regional economic developers. Interview No. 9. (2023).

59. Cassada, M. Meeting held in Fayette County discusses better access to broadband internet. *WVNS* (2024).

60. U.S. Census Bureau. Resident Population in Fayette County, WV [WVFAYE5POP]. FRED, Federal Reserve Bank of St. Louis (2024).

61. Doyle, D. A Canary Named *West Virginia*. *Harvard Medicine* (2017).

62. West Virginia Department of Economic Development. State of West Virginia FY 2022 State Appalachian Development Plan and Annual Strategy Statement for the Appalachian Regional Commission. (2022).

63. Pacific Northwest Regional Economic Analysis Project. Gross Domestic Product by Industry Fayette County, 2001-2022. West Virginia REAP (2023).

64. Colias, C. Almost Heaven Still? Post-Industrial Development and Local Response in Fayette County, West Virginia. *J. Appalach. Stud.* **8**, 91–119 (2002).

65. Tate, C. New River Gorge Drew A Record 1.7 Million Visitors Last Year. *West Virginia Public Broadcasting* (2024).

66. Hanshaw. HB 3168. *West Virginia vols* 5B–2E (2023).

67. Moore, C. V. Owners of county's dilapidated buildings to be put on notice. *The Fayette Tribune* (2012).

68. NRGRDA and Fayette County Post Dilapidated Buildings Survey on Websites. *New River Gorge Regional Development Authority* https://nrgrda.org/nrgrda-and-fayette-county-post-dilapidated-buildings-survey-on-websites/ (2023).

69. Leith, M. Fayette County Commission helping property owners demolish dilapidated buildings. *ABC4 WOAY* (2023).

70. Freddie Mac. 30-Year Fixed Rate Mortgage Average in the United States [MORTGAGE30US]. Primary Mortgage Market Survey (2024).

71. West Virginia Department of Commerce. West Virginia Energy Inventory. (2022).

72. Solar Energy Industries Association. Major Solar Projects List. *SEIA* https://www.seia.org/research-re-

sources/major-solar-projects-list (2024).

73. Pollin, R., Wicks-Lim, J., Chakraborty, S. & Semieniuk, G. *Impacts of the Reimagine Appalachia & Clean Energy Transition Programs For West Virginia*. 1–111 https://justtransitionforall.com/wp-content/uploads/2022/11/WV-CleanEnergy-2-22-21.pdf (2021).

74. Hall, D. G. et al. *Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydro Classes of Hydroelectric Plants*. 1–206 https://inldigitallibrary.inl.gov/sites/sti/sti/3384095.pdf (2006).

75. Conner, A. M., Francfort, J. E. & Rinehart, B. N. *U.S. Hydropower Resource Assessment for West Virginia*. 1–7 https://www.osti.gov/servlets/purl/573331 (1998).

76. James, J. & Hansen, E. *Prospects for Large-Scale Solar on Degraded Land in West Virginia*. 1–27 https://downstreamstrategies.com/wp-content/uploads/2023/05/utility-scale-solar-report_2-21-17-1.pdf (2016).

77. Yarmuth, J. *Inflation Reduction Act of 2022*. *United States Code* vol. Public Law 117-169 (2022).

78. Capito, S. M. HB 3310. *West Virginia Code* vol. 24 (2021).

79. Kennedy, R. West Virginia Governor vetoes bill that would double allowable solar project size. *pv magazine* (2024).

80. Risch, C. *Energy Efficiency in West Virginia: Research for 5-Year Energy Plan*.1–28 https://energywv.org/assets/files/EnergyPlan/Energy-Efficiency-Opportunities-for-West- Virginia-2017-Update.pdf (2017).

81. Kosnik, *L. R. From Cournot to the Commons: An Analysis of Regulatory Property Rights.* https://www.umsl.edu/~kosnikl/Cournot%20Commons.pdf (2010).

82. Kosnik, L. The potential for small scale hydropower development in the US. *Energy Policy* **38**, 5512–5519 (2010).

83. Stroud, A., Boettner, F., Gilmer, B. & Betcher, M. *West Virginia Food Hub Feasibility Assessment*. 1–38 https://downstreamstrategies.com/wp-content/uploads/2023/05/wv-food-hub-final-report_1-23-15.pdf (2014).

84. Fayette County Urban Renewal Authority. Agriculture and Conservation Resource Center: Feasibility assessment and business plan for the Fayette County Commission. (2017).

85. Economic Research Service. Large-scale family farms show stronger operating profit margins than other farms between 2011 and 2020. *U.S. Department of Agriculture* http://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId= 104361 (2021).

86. Economic Research Service. USDA ERS – Farm Labor. *U.S. Department of Agriculture* https://www.ers.usda.gov/topics/farm-economy/farm-labor.

87. Who We Are. *New Roots Community Farm* https://www.newrootscommunityfarm.com/whoweare.

88. Moore, J. Land purchase part of local farmland conservation effort. *The Montgomery Herald* https://www.montgomery-herald.com/news/land-purchase-part-of-local-farmland-conservation-effort/article_62173ec6-b6b9-11ec-a9c8-239dac73c58c.html (2022).

89. Saunders, A. A Tale of Two Cities: Mayors of Smithers and Montgomery come together to revitalize the Valley. *WOAY* (2020).

90. Appalachian Regional Commission. County Economic Status in Appalachia. *Appalachian Regional Commissio*n https://www.arc.gov/classifying-economic-distress-in-appalachian-counties/ (2024).

91. U.S. Energy Information Administration. Table 2A. Ten largest plants by capacity, 2022 – North Carolina.

92. Our Company - Regulated Utilities. *Duke Energy* https://www.duke-energy.com/our-company/about-us/businesses/regulated-utilities.

93. U.S. Department of Energy. 2022 County Energy Jobs. United States Energy and Employment Report (2023).

94. Duke Energy. Mayo Plant - Power Plants. *Duke Energy* https://www.duke-energy.com/our-company/about-us/power-plants/mayo-plant.

95. Duke Energy. Roxboro Plant - Power Plants. *Duke Energy* https://www.duke-energy.com/our-company/about-us/power-plants/roxboro-plant.

96. Wamsted, D. Two of Duke Energy's plants in North Carolina reflect national trend in baseload slippage for coal. *Institute for Energy Economics and Financial Analysis* https://ieefa.org/resources/ieefa-us-two-duke-energys-plants-north-carolina-reflect-national-trend-baseload-slippage (2018).

97. Person County. Person County Petition to Intervene - Docket No. E-100, Sub 179. (2022).

98. Bell, J. HB 951. *North Carolina Code* vol. 62 (2021).

99. Watson, S. North Carolina Utilities Commission Press Release. (2022).

100. Somers, L. B. Duke Energy Progress, LLC 2017 Integrated Resource Plan Update and 2017 REPS Compliance Plan Docket No. E-100, Sub 147. (2017).

101. Duke Energy Progress. *Integrated Resource Plan (Annual Report)*. 1–164 https://starw1.ncuc.gov/NCUC/ViewFile.aspx?Id=badec175-5e4f-4bea-a267-80e113db8c16 (2014).

102. Major Employers. *Person County Economic Development Commission* https://personcountyedc.com/business-advantages/major-employers/ (2023).

103. Local community developer. Interview No. 13. (2023).

104. DiPietro, G. Advancing the future of energy with Person County, NC. *illumination* https://illumination.duke-energy.com/articles/advancing-the-future-of-energy-with-person-county-nc (2024).

105. National Association of Counties. North Carolina: County Government Overview. (2022).

106. Demographics. *Person County Economic Development Commission* https://personcountyedc.com/workforce/demographics/ (2023).

107. Local economic developer. Interview No. 12. (2023).

108. Local economic developer. Interview No. 15. (2023).

109. U.S. Bureau of Labor Statistics. May 2023 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates: Durham-Chapel Hill, NC. (2024).

110. Duke Energy Progress, LCC. Duke Energy Progress, LLC Supplemental Rebuttal Testimony, Docket No. E-2, Sub 1204. (2020).

111. Local community developer. Interview No. 14. (2023).

112. Person County Economic Development. Person County Mega Park. (2023).

113. Aeppel, T., Klayman, B. & Groom, N. Insight: US manufacturing boom has a real estate problem. *Reuters* https://www.reuters.com/markets/us/location-location-location-us-manufacturing-boom-has-real-estate-problem-2023-04-13/ (2023).

114. Walton, R. US electricity prices outpace annual inflation. *Utility Dive* https://www.utilitydive.com/news/us-electricity-prices-rise-customer-eia-outlook/710113/ (2024).

115. U.S. Energy Information Administration. *Short-Term Energy Outlook*. https://www.eia.gov/outlooks/steo/archives/mar24.pdf (2024).

116. Local economic developer. Interview No. 16. (2023).

117. Wang, Z. et al. Legacy of Coal Combustion: Widespread Contamination of Lake Sediments and Implications for Chronic Risks to Aquatic Ecosystems. *Environ. Sci. Technol.* **56**, 14723–14733 (2022).

118. Sorg, L. Coal ash found in lake beds in North Carolina, contaminating waterways and fish with arsenic, selenium and other toxic elements. *NC Newsline* https://ncnewsline.com/briefs/coal-ash-found-in-lake-beds-in-north-carolina-contaminating-waterways-and-fish-with-arsenic-selenium-and-other-toxic-elements/ (2022).

119. Person County Economic Development Commission. EDC Minutes for March 23, 2021. (2021).

120. Duke Energy Progress, LCC. Duke Energy North Carolina coal plant employees give back to surrounding communities with nearly $60,000 in grants to area nonprofits. *Duke Energy* https://news.duke-energy.com/releases/duke-energy-north-carolina-coal-plant-employees-give-back-to-surrounding-communities-with-nearly-60-000-in-grants-to-area-nonprofits (2024).

121. Duke Energy grant goes towards new county park. *The Courier-Times* https://www.personcountylife.com/news/duke-energy-grant-goes-towards-new-county-park/article_88cce92c-0314-11ef-9d3a-6781f019a94e.html (2024).

122. Tobin, B. Triangle county with the fastest GDP growth isn't Wake, Durham or JoCo. *Triangle Business Journal* https://www.bizjournals.com/triangle/news/2024/01/03/north-carolina-counties-gpd-growth-person-county.html (2024).

123. Ohnesorge, L. Why megasite in Greater Triangle could land next blockbuster manufacturer. *Triangle Business Journal* https://www.bizjournals.com/triangle/news/2021/06/20/person-county-megasite-semiconductor-manufacturing.html (2021).

124. Digital Inclusion. Person County, *NC Website* https://www.personcountync.gov/government/departments-a-h/county-manager-s-office/digital-equity-taskforce.

125. Home Page | Welcome to Uptown Roxboro. *Uptown Roxboro* https://uptownroxboro.com/ (2024).

126. Person County Economic Development Commission. EDC Minutes for July 26, 2022. (2022).

127. Local government official. Interview No. 11. (2023).

128. Willoughby, G. Duke Energy proposes new natural gas plant at Hyco, pushes back coal retirement. *The Courier-Times* https://www.personcountylife.com/news/duke-energy-proposes-new-natural-gas-plant-at-hyco-pushes-back-coal-retirement/article_7468bb5a-428a-11ee-8337-ffc4479bb118.html (2023).

129. EPRI. *Coal Repowering a White Paper Series: Repurposing Coal-Fired Power Plants to Anchor Net-Zero Industrial Clusters.* https://www.epri.com/research/programs/116793/results/3002026481 (2023).

130. Moriah Energy Center. *Dominion Energy* https://www.dominionenergy.com/projects-and-facilities/natural-gas-projects/moriah-energy-center (2024).

131. Baltzegar, A. Q&A: Duke Energy unveils new energy proposals. *The Carolina Journal* https://www.carolinajournal.com/qa-duke-energy-unveils-new-energy-proposals/ (2023).

132. Person County Commission. Person County Energy System Ordinance. (2022).

133. Kao, S.-C. et al. *New Stream-Reach Development: A Comprehensive Assessment of Hydropower Energy Potential in the United States.* ORNL/TM-2013/514, 1130425 http://www.osti.gov/servlets/purl/1130425/ (2014) doi:10.2172/1130425.

134. U.S. Department of Energy. WINDExchange: North Carolina 50-Meter Community-Scale Wind Resource Map. *Office of Energy Efficiency & Renewable Energy* https://windexchange.energy.gov/maps-data/75.

135. U.S. Energy Information Administration. Table 11.1 Total consumption of electricity by manufacturing industry and region. (2002).

136. Use of energy explained: Energy use in homes. *U.S. Energy Information Administration* https://www.eia.gov/energyexplained/use-of-energy/electricity-use-in-homes.php (2023).

137. Person County Economic Development Commission. Target Industries. *Person County Economic Development* https://personcountyedc.com/business-advantages/target-industries/ (2024).

138. U.S. Bureau of Labor Statistics. May 2023 National Industry-Specific Occupational Employment and Wage Estimates, NAICS 334400 - Semiconductor and Other Electronic Component Manufacturing. (2024).

139. National Agricultural Statistics Service. County Profile: Person County, North Carolina. (2019).

140. Voluntary Agricultural District Programs. *Person County, NC Website* https://www.personcountync.gov/government/departments-i-z/soil-and-water/voluntary-agricultural-district.

141. Herath, J. & Hill, D. Harnessing Agricultural Potentials for Economic Growth in North Carolina. Sustain. *Agric. Res.* 2, 142 (2013).

142. Wyoming State Profile and Energy Estimates. *U.S. Energy Information Administration* https://www.eia.gov/state/analysis.php?sid=WY (2023).

143. Coal explained: Where our coal comes from. *U.S. Energy Information Administration* https://www.eia.gov/energyexplained/coal/where-our-coal-comes-from.php (2023).

144. Campbell County Office of the Assessor. Assessed Value - Past 5 Yrs. (2023).

145. Wyoming Mining Association. 2019 Wyoming Coal Overview. (2019).

146. Campbell County Office of the Assessor. Campbell County Mill Levies. (2023).

147. Wyoming Legislative Service Office. 2023 Budget Fiscal Data Book. (2022).

148. Wyoming Coal Information Committee. *Concise Guide to Wyoming Coal.* https://www.wyomingmining.org/wp-content/uploads/2023/01/2022-23-Concise-Guide-to-Wyoming-Coal.pdf (2023).

149. Campbell County CARE Board. *Campbell County Community Needs Assessment.* https://www.campbellcountywy.gov/DocumentCenter/View/20439/2022-Campbell-County-Community-Needs-Assessment-Report?bidId= (2022).

150. Powder River Energy Corporation. By the Numbers: Member Statistics. *Powder River Energy Corporation* https://precorp.coop/numbers (2023).

151. Tan, C. A federal forecast shows wind and solar will surpass coal this year. What does this mean for Wyoming? *Wyoming Public Media* https://www.wyomingpublicmedia.org/open-spaces/2024-01-23/a-federal-forecast-shows-wind-and-solar-will-surpass-coal-this-year-what-does-this-mean-for-wyoming (2024).

152. Gillette College Foundation. Why Campbell County? (2024).

153. Energy Capital Economic Development. Members. *Energy Capital Economic Development* https://www.energycapitaled.com/about/investors/.

154. Community Partners. *Gillette Main Street* https://gillettemainstreet.us/community-partners/.

155. Gillette College Foundation. Gillette College Foundation Recognizes our Pronghorn Partners. *Gillette College Foundation* https://gillettecollegefoundation.org/news-events/gillette-college-foundation-recognizes-our-pronghorn-partners.html.

156. Gillette Festival of Trees. Sponsorship. *Gillette Festival of Trees* https://www.gillettefestivaloftrees.com/sponsorship2.

157. Barlow, I. Notes from Energy Capital Economic Development Board Meeting. (2024).

158. North Antelope Rochelle Mine. Site Visit No. 4. (2024).

159. Gillette Vision 2040 Steering Committee. *Gillette Vision 2040.* https://www.gillettechamber.com/assets/pdf/Gillette+Vision+2040+Report_Final (2023).

160. Local economic developer. Interview No. 19. (2024).

161. Local economic developer. Interview No. 18. (2024).

162. About. *Wyoming Integrated Test Center* https://www.wyomingitc.org/about/.

163. Energy Capital Economic Development. Wyoming Innovation Center (WyIC). (2022).

164. Goodrick, J. & Gallardo, J. Gillette College to become separate district. *Powell Tribune* https://www.powelltribune.com/stories/gillette-college-to-become-separate-district,34178 (2021).

165. Area 59. *Area 59* https://www.area-59.com.

166. Campbell County Recreation Center. *Campbell County, WY* https://www.campbellcountywy.gov/facilities/facility/details/Campbell-County-Recreation-Center-20.

167. CAMPLEX. *CAMPLEX* https://www.cam-plex.com/.

168. Wyoming academic. Interview No. 22. (2024).

169. Local government official. Interview No. 61. (2024).

170. Coal explained: Use of coal. *U.S. Energy Information Administration* https://www.eia.gov/energyexplained/coal/use-of-coal.php.

171. Luppens, J., Scott, D., Haacke, J., Osmonson, L. & Pierce, P. *Coal Geology and Assessment of Coal Resources and Reserves in the Powder River Basin, Wyoming and Montana*. https://doi.org/10.3133/pp1809 (2015).

172. Wyoming Innovation Center. Site Visit No. 1. (2024).

173. Zwonitzer, D. *HB 200 - Reliable and Dispatchable Low-Carbon Energy Standards. Wyoming Code* vol. 144 (2020).

174. David, J. & Herzog, H. J. *The Cost of Carbon Capture.* https://sequestration.mit.edu/pdf/David_and_Herzog.pdf (2011).

175. Solomon, M., Gimon, E. & O'Boyle, M. *Coal Cost Crossover 3.0: Local Renewables Plus Storage Create New Opportunities for Customer Savings and Community Reinvestment*. https://energyinnovation.org/publication/coal-cost-crossover-3-0-local-renewables-plus-storage-create-new-opportunities-for-customer-savings-and-community-reinvestment/? (2023).

176. World Resources Institute. Aqueduct 4.0 Current and Future Global Maps Data. (2023).

177. Integrated Test Center. Site Visit No. 2. (2024).

178. Dry Fork Power Station. Site Visit No. 3. (2024).

179. Rosa, L., Sanchez, D. L., Realmonte, G., Baldocchi, D. & D'Odorico, P. The water footprint of carbon capture and storage technologies. *Renew. Sustain. Energy Rev.* **138**, 110511 (2021).

180. Goodrick, J. & Gallardo, J. What to know about the 2024 Camporee and its 50,000 visitors to Gillette. *Gillette News Record* https://www.gillettenewsrecord.com/news/local/article_f8871841-dc1e-59b9-80df-d3c8aaaecaf2.html (2023).

181. Campbell County Convention and Visitors Bureau. Campbell County Travel & Tourism Master Plan. (2022).

182. DatacenterDynamics. Campbell County seeks to become Wyoming's datacenter hotspot. *DCD* https://www.datacenterdynamics.com/en/news/campbell-county-seeks-to-become-wyomings-datacenter-hotspot-2/ (2008).

183. Dodson, D. Data centers: Wyoming's next Powder River Basin? *WyoFile* http://wyofile.com/data-centers-wyomings-next-powder-river-basin/ (2021).

184. Education and Taxability Section, Wyoming Department of Revenue, K. *The Effects of the Sales and Use Tax Exemption*. https://wyoleg.gov/InterimCommittee/2020/03-2020111915.DataCenterExemptionReport2020.pdf (2020).

185. Bhardwaj, P. Fiber optic wires, servers, and more than 550,000 miles of underwater cables: Here's what the internet actually looks like. *Business Insider* https://www.businessinsider.com/how-internet-works-infrastructure-photos-2018-5.

186. Local economic developers. Interview No. 20. (2024).

187. Pai, S. & Zerriffi, H. A novel dataset for analysing sub-national socioeconomic developments in the Indian coal industry. *IOP SciNotes* **2**, 014001 (2021).

188. NITI Aayog. India National Multidimensional Poverty Index: *A Progress Review 2023*. https://www.niti.gov.in/sites/default/files/2023-08/India-National-Multidimentional-Poverty-Index-2023.pdf (2023).

189. Tata Steel. *Integrated Report and Annual Accounts 2022-23*. https://www.tatasteel.com/investors/integrated-reportannual-report/integrated-report-annual-accounts-2022-23-116th-year-and-related-documents/ (2023).

190. About Us. *Patratu Vidyut Utpadan Nigam Limited*. https://www.pvunl.co.in/about.

191. Informal coal workers (Ramgarh). Focus Group No. 13. (2024).

192. Swaniti Initiative. Jharkhand Baseline Survey. (2024).

193. Trade union members (Ramgarh). Focus Group No. 6. (2023).

194. State-owned coal company official. Interview No. 50. (2023).

195. Jharkhand DMF. *Ministry of Mines, Government of India* https://mines.gov.in/webportal/content/jharkhand-dmf.

196. District Mineral Foundation Trust, Ramgarh. *Annual Report FY 2021-2022*. (2023).

197. Home Page. *District Mineral Foundation Trust, Ramgarh* https://www.dmftramgarh.com/.

198. Coal India Limited. *Integrated Annual Report 2022-23*. https://d3u7ubx0okog7j.cloudfront.net/documents/annuareportnsebse.pdf (2023).

199. Jharkhand Department of Finance. Budget 2022-23. (2022).

200. PRS Legislative Research. Jharkhand Budget Analysis 2022-23. *PRS Legislative Research* https://prsindia.org/budgets/states/jharkhand-budget-analysis-2022-23 (2022).

201. Government of India. Taxation in India. *Invest India* https://www.investindia.gov.in/taxation.

202. Rai, D. Rich states don't mean rich districts: Is it time to reimagine tax distribution? *India Today* https://www.indiatoday.in/diu/story/rich-states-districts-reimagine-tax-distribution-india-poverty-cities-2499462-2024-02-08 (2024).

203. Central Coalfields Limited. Corporate Social Responsibility (CSR) policy of CCL. (2021).

204. Home Page.Central coal fields https://www.centralcoalfields.in/hindi/ind/indexh.php.

205. Central Coalfields Limited. Status Report of Existing Patient Care Facility in CCL. (2018).

206. State-owned coal company official. Discussion No. 2. (2024).

207. Ministry of Finance. Budget 2023-2024. (2023).

208. Joint Bipartite Committee for the Coal Industry. National Coal Wage Agreement (NCWA)-XI. (2023).

209. Small Businesses from Phushro Main Market (Bokaro). Focus Group No. 10. (2023).

210. District government official. Interview No. 42. (2023).

211. Industry association representative. Interview No. 52. (2023).

212. Central Electricity Authority. Dashboard: Installed Capacity (Resource-wise Installed Capacity for States).

213. Central Coalfields Limited. List of CSR Projects Approved in the FY 2022-23. (2023).

214. Central Coalfields Limited. Peak capacity and production data. (2024).

215. Ministry of Coal. Unstarred Question No. 2359 To Be Answered on 16.03.2022. (2022).

216. Local elected representatives (Ramgarh). Focus Group No. 12. (2024).

217. Jharkhand Department of Economics and Statistics. Gross State Domestic Product 2021-22(P) and District Domestic Product 2011-12 to 2022-23(P). (2024).

218. District Profile. *Krishi Vigyan Kendra, Ramgarh* https://ramgarh.kvk4.in/district-profile.php (2018).

219. MSME-Development Institute, Ranchi. *Brief Industrial Profile of Ramgarh District*. https://dcmsme.gov.in/old/dips/Ramgarh.pdf (2013).

220. District government official. Interview No. 41. (2023).

221. Ashok, S. et al. State Nutrition Profile: Jharkhand. (2022).

222. Directorate of Economics and Statistics. *Jharkhand Statistical Profile 2022*. http://www.des-jharkhand.nic.in/index.html (2024).

223. Ministry of Statistics and Program Implementation, Government of India. Women & Men in India - 2016. (2017).

224. Swaniti Initiative. Jharkhand Enterprise Survey. (2024).

225. Tandon, A. Land banks in Jharkhand may become a recipe for conflicts. *Mongabay* (2022).

226. Coal industry workers (Ramgarh). Focus Group No. 17. (2024).

227. Fishery cooperative members (Ramgarh). Interview No. 62. (2023).

228. Jharkhand Department of Industries. Jharkhand Food Processing Industry Policy 2015. (2015).

229. Bhushan, C. & Banerjee, S. *Reform of Coal Mine Closure Guidelines to Support a Comprehensive Mine Closure Framework Based on Just Transition Principles*. https://iforest.global/research/reform-of-coal-mine-closure-guidelines-to-support-a-comprehensive-mine-closure-framework-based-on-just-transition-principles-request-download-copy/ (2023).

230. Industry co-op representative. Interview No. 56. (2023).

231. Industry co-op representative. Interview No. 57. (2023).

232. Major Reforms made in Draft Mining Plan Guidelines 2024 issued by Ministry of Coal. *Press Information Bureau* https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=2027083 (2024).

233. IANS. Sand crisis halts construction projects worth Rs 5K cr in Jharkhand. *Investing.com* (2022).

234. SANDRP. East India Sand Mining 2018: Will NGT order help restore Subarnarekha River? *South Asia Network on Dams, Rivers and People* https://sandrp.in/2019/02/21/east-india-sand-mining-2018-will-ngt-order-help-restore-subarnarekha-river/ (2019).

235. State-owned coal company official. Discussion No. 3. (2024).

236. Vegetable vendor in Gola Block. Discussion No. 1. (2023).

237. Infrastructure. *Krishi Vigyan Kendra, Ramgarh* https://ramgarh.kvk4.in/infrastructure.php.

238. Daily footfall down to 500 from over 20,000 at Rajrappa temple. *The Times of India* (2022).

239. Hindustan Team, Ramgarh. BLO holds meeting to prepare for assembly elections in Dark block. *Hindustan Hindi News* (2024).

240. Mishra, R. Serene 'Patratu Valley' of Jharkhand to get a lake resort for perfect tourist experience. Financial Express (2019).

241. Government of Jharkhand. About Us. *Task Force – Sustainable Just Transition* https://www.justtransition-jharkhand.in/about-us/.

242. History. *District Bokaro, Government of Jharkhand* https://bokaro.nic.in/history/.

243. Central Coalfields Limited. Environmental Statement of Kargali Opencast Project for 2016-17. (2017).

244. Installed Capacity. TVNL - *Tenughat Vidyut Nigam Limited* https://tvnl.in/icap.php.

245. Directorate of Economics and Statistics. District Statistical Handbook Bokaro 2021-22. (2022).

246. Coal transport workers (Bokaro). Focus Group No. 9. (2023).

247. State-owned coal company official. Interview No. 58. (2023).

248. State-owned coal company official. Interview No. 47. (2023).

249. Damodar Valley Corporation. *Annual Report 2022-23.* https://www.dvc.gov.in/storage/app/press_release/1709874751080324.pdf (2024).

250. Ministry of Mines, Government of India. Jharkhand - Dataset.

251. Home Page. *District Mineral Foundation Trust, Bokaro* https://dmftbokaro.com/.

252. Central Coalfields Limited. About CSR. (2019).

253. Central Coalfields Limited. CCL CSR Expenditure 2023-2024. (2024).

254. Central Coalfields Limited. Central Coalfields Limited. (2021).

255. Ministry of Skill Development and Entrepreneurship. Annexure 3_PMKK Job Roles for 15th Jan 2021.

256. Outsourced workers (Bokaro). Focus Group No. 15. (2023).

257. Industry association representative. Interview No. 48. (2023).

258. District government official. Interview No. 43. (2023).

259. Facilities. *SAIL* https://www.sail.co.in/en/plants/bokaro-steel-plant/facilities.

260. Central Coalfields Limited. Standard Operating Procedure (SOP) for Corporate Social Responsibility (CSR) activities in CCL (Approved in 478th Board Meeting held on 19.10.2019). (2019).

261. Central Coalfields Limited. Untitled document on education-related CSR spending. (2021).

262. Ministry of Power, Government of India. Minutes of the Meeting held under the Chairmanship of Hon'ble Minister of Power & NRE on 06.12.2022 at 03:30 PM to discuss Life Extension (LE) and Renovation and Modernization (R&M) of Coal Based Thermal Power Plants. (2022).

263. Coal industry workers (Bokaro). Focus Group No. 8. (2023).

264. Local elected representatives (Bokaro). Focus Group No. 11. (2024).

265. Swaniti Initiative. Notes from Bokaro Industrial Area Development Authority workshop on March 5, 2024. (2024).

266. Jharkhand Department of Industries. Jharkhand Industrial and Investment Promotion Policy 2021. (2021).

267. Khare, D. Central team inspects biz corridor site in Bokaro. *The Times of India* (2022).

268. Ministry of Information and Broadcasting. Make In India. (2022).

269. Civil contractors (Bokaro). Focus Group No. 7. (2023).

270. District government official. Interview No. 45. (2023).

271. Bokaro Industrial Area Development Authority. List of Industries. (2024).

272. District government official. Interview No. 46. (2023).

273. Ministry of New and Renewable Energy. Solar Overview. *Ministry of New and Renewable Energy* https://mnre.gov.in/solar-overview/.

274. Industry association representative. Interview No. 54. (2023).

275. Jharkhand Department of Energy. Jharkhand State Solar Policy 2022. (2022).

276. Government of India. PM Surya Ghar Yojana. *PM Surya Ghar Yojana* https://pmsuryaghar.org.in/ (2024).

277. Industry association representative. Interview No. 49. (2023).

278. TOI Business Desk. PM Surya Ghar Muft Bijli Yojana jobs boost! 1 lakh people to be trained to install solar panels in homes. *The Times of India* (2024).

279. Ray, D. Green energy: BCCL, CCL eye 400 MW solar power by 2025. *The Times of India* (2023).

280. BPSCL. Solar Power – Bokaro Power Supply Company (P) Limited (BPSCL). *Bokaro Power Supply Company (P) Limited (BPSCL)* https://bpscl.com/bpscl-performance/solar-power/.

281. Jharkhand Department of Agriculture, Animal Husbandry, and Co-operative. Fish Production Report, 2021-2022.

282. District government official. Interview No. 55. (2023).

283. State-owned coal company official. Interview No. 59. (2023).

284. Chief Planning Officer, Peddapalli District. *Handbook of Statistics: Peddapalli District (2021–22)*. (2022).

285. Singareni Collieries Company Limited. Area-mine wise production as on 25/12/23. (2023).

286. NTPC Limited. Ramagundam. *NTPC Limited* https://ntpc.co.in/ramagundam.

287. Telangana Energy Department. Telangana State Power Sector - White Paper. (2023).

288. Singareni Collieries Company Limited. Men on roll as on 30.11.2023. (2023).

289. District Industries Centre. Peddapalli District Profile. (2019).

290. State-owned coal company official. Interview No. 29. (2023).

291. Coal transport workers (Peddapalli). Focus Group No. 4. (2023).

292. Swaniti Initiative. Telangana Baseline Survey. (2024).

293. Coal workers (Peddapalli). Focus Group No. 5. (2023).

294. Economy. *Peddapalli District* https://peddapalli.telangana.gov.in/economy/.

295. District government official. Interview No. 28. (2023).

296. About Us. *DMF Telangana* https://mines.telangana.gov.in/MinesAndGeology/DMFT/Index.aspx.

297. Office of the Assistant Director of Mines and Geology, Peddapalli. Untitled revenue report of the District Mineral Fund Trust, Peddapalli. (2023).

298. PEDDAPALLI DMF Statistics (Up to October 2023). *DMF Telangana* https://mines.telangana.gov.in/MinesAndGeology/DMFT/SanctionProjectReport.aspx?district=7.

299. Statistics (Up to January 2024). *DMF Telangana* https://mines.telangana.gov.in/MinesAndGeology/DMFT/Index.aspx#portfolio.

300. Home Page. *Singareni Institute of Medical Sciences* (GMC) https://www.gmcramagundam.in/.

301. Community development. *The Singareni Collieries Company Limited* https://scclmines.com/scclnew/csr_community.asp.

302. Pande, D. & Kishore, R. Observation of local infrastructure during pilot for Telangana Baseline Survey. (2023).

303. District Industries Centre, Peddapalli. List of Industries. (2024).

304. Singareni Collieries Company Limited. Statement of CSR sanctions for the FY 2022-23. (2024).

305. *District Domestic Product, Telangana (2021-22)*. (2022).

306. Plans to turn Peddapalli into seed bowl of State. *The Hindu* (2017).

307. District government official. Interview No. 32. (2023).

308. Industry association representative. Interview No. 51. (2023).

309. Labor union officials (Mancherial). Focus Group No. 3. (2023).

310. IEA. *India Energy Outlook 2021*. https://www.iea.org/reports/india-energy-outlook-2021 (2021).

311. Swaniti Initiative. Telangana Enterprise Survey. (2024).

312. Sharma, N. Solar in Telangana: Potential, Policy and Solar Subsidy (2023). *Ornate Solar* https://ornatesolar.com/blog/potential-of-solar-power-in-telangana (2022).

313. Times News Network. 100% stamp duty exemption to MSME units in Bundelkhand. *The Times of India* (2023).

314. Singareni Collieries Company Limited. *SCCL Solar Generation Report*. (2023).

315. SCCL establishing solar power plant at 120 meter height in Ramagundam. *Telangana Today* (2024).

316. NTPC Limited. Untitled. *NTPC Limited* https://ntpc.co.in/index.php/media/press-releases/ntpc-commissions-indias-largest-floating-solar-project-telangana (2022).

317. Kumar, M. With land acquisition challenges, Telangana eyes floating solar parks. *Mongabay* (2021).

318. District government official. Interview No. 31. (2023).

319. Why Invest in Telangana? *Ministry of Food Processing Industries* https://foodprocessingindia.gov.in/state/telangana.

320. Ministry of Food Processing Industries. *Food Processing: Toward Sustainable Growth Opportunities*. https://wfindia.s3.ap-south-1.amazonaws.com/website_images/pdf/1694687520_50830546.pdf (2023).

321. Department of Handlooms and Textiles. Telangana Textile and Apparel Policy (2017-18). (2017).

322. Tallam, N. K. May Day gloom: All units in Telangana's Sircilla Textile Park closed. *The New Indian Express* (2022).

323. Labor union official. Interview No. 35. (2023).

324. Local elected representative. Interview No. 26. (2023).

325. District government official. Interview No. 30. (2023).

326. Keenan, C. Commission nixes early start to revisiting comprehensive plan. *The Fayette Tribune* (2020).

327. Crawford, J. HB 2436. *North Carolina Code* vol. 115D (2008).

328. Congressional Research Service. *Federal Economic Assistance for Coal Communities*. https://crsreports.congress.gov/product/pdf/R/R47831 (2023).

329. Shelton, R. et al. *POWER for Transition: Investment in Coal Communities through the Partnerships for Opportunity and Workforce and Economic Revitalization (POWER) Initiative*. https://www.rff.org/documents/3449/Report_22-07.pdf (2022).

330. Raimi, D. & Pesek, S. What Is an 'Energy Community'? Resources (2024).

331. Energy Community Tax Credit Bonus. *National Energy Technology Laboratory* https://arcgis.netl.doe.gov/portal/apps/experiencebuilder/experience/?id=a2ce47d4721a477a8701bd0e08495e1d. ■

Appendix – Interviewees and Discussants

Name	Organization
Additional collector	Peddapalli District Administration
Binay Agarwal	Ramgarh Chamber of Commerce
Riyaz Ahmed	Hind Mazdoor Sabha
Shannon Anderson	Powder River Basin Resource Council
Eric Autenreith	Community member and former business owner
Samantha Bagbey	Roxboro Area Chamber of Commerce (formerly)
Rusty Bell	Gillette College Foundation
Deputy District Commissioner (Collector)	Ramgarh District Administration
Deputy District Commissioner (Collector)	Bokaro District Administration
Bo Freeman	NC Cooperative Extension
General manager	Singareni Collieries Company Ltd.
General manager	Central Coalfields Limited
Adam Hodges	West Virginia State University Extension Service
Holly Krutka	University of Wyoming
Rajkumar Pathak	Maa Bhavani Matsyajivi Sahyog
Janak Prasad	Indian National Trade Union Congress
Rakesh Verma	Prabhat Khabar
Prem Sagar	Member of Legislative Assembly
Sunny Singh	Bokaro Industrial Area Development Authority
Kim Strickland	Person County
Samuel Workman	West Virginia University
Cassandra Lawson	Region 4 Planning & Development Council
John Tuggle	Region 4 Planning & Development Council

Note: This is not a complete list of outreach for this report, and this list should be considered an illustrative sample of total outreach conducted for this report.

SWANITI GLOBAL
THE GLOBAL CLIMATE AND
DEVELOPMENT INSTITUTE

Website: www.swaniti.com