MANUFACTURING A DECARBONIZED FUTURE IN SOUTHWESTERN PENNSYLVANIA

C2ES CLIMATE INNOVATION 2050

by

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Pennsylvania is called the Keystone State for a reason: For centuries, the state—and Southwestern Pennsylvania, in particular—has been critical to producing the energy and goods that helped build the nation, including coal, steel, aluminum, and glass. The heavy industrial and manufacturing activity that once defined the region, however, has since waned, leaving many communities searching for new economic opportunities that can revitalize their towns, provide local revenue, and sustain workforces. The push to decarbonize the global economy presents an opportunity for Southwestern Pennsylvania to again become a hub for manufacturing, this time of the goods and technologies that will be critical to achieving net-zero economy-wide greenhouse gas emissions. This brief provides insights from a C2ES roundtable held virtually in Southwestern Pennsylvania in October 2022 on this possibility. It explores the potential future for climate-aligned manufacturing in the region, the challenges to realizing that future, and the policies and investments necessary to align the regional economy with full decarbonization.

INTRODUCTION

REGIONAL ROUNDTABLES

Achieving net-zero emissions will require large-scale changes across all sectors of the economy, and efforts to accelerate this transition are intensifying. To chart a pathway to sustainable, long-term prosperity, communities must be able to leverage their unique strengths and capitalize on emerging economic opportunities, while addressing barriers that are often poorly understood outside of their communities.

To that end, the Center for Climate and Energy Solutions (C2ES) is hosting a series of regional roundtables to bring together local, state, and federal policymakers; businesses of all sizes; community organizations and nonprofits; academics and issue experts; trade associations; investors; philanthropy; and others. These conversations are meant to elevate the perspectives of a diverse set of stakeholders who are deeply embedded in their communities and uniquely positioned to speak to the needs

BOX 1: A note on verbiage

Multiple terms were used at the roundtable to describe various types of manufacturing. These terms included 'clean,' 'climate-aligned,' 'decarbonized,' 'sustainable,' and 'low-carbon' manufacturing. While these phrases may sound similar, they can all connote different meanings, and none had an agreed-upon definition among the group. Some attendees raised concern that 'low-carbon' manufacturing could allow for unabated use of fossil fuels, or that 'sustainable' or 'clean' manufacturing may be overly generic and lead to greenwashing. For the purposes of this brief, the term 'climate-aligned manufacturing' refers to manufacturing of products and technologies that will be necessary for a net-zero future, such as solar components, energy efficiency products, batteries, and more. The term 'decarbonized manufacturing' is used to refer to manufacturing operations with zero or close to zero emissions, regardless of whether the product being manufactured is 'climate-aligned' or not.

of their states and regions. They are also meant to create opportunities to integrate local perspectives into state and federal policy decisions and, importantly, identify concrete steps to better align the long-term vitality of these communities with the urgent task of facilitating economy-wide decarbonization.

Our third roundtable of 2022, held virtually "in" Southwestern Pennsylvania (SWPA), took place in October 2022, and brought together roughly 70 participants. Roughly half of these participants were from nonprofits, a quarter from various levels of government, a fifth from companies, and the remaining attendees from universities and other organizations. The event explored the future of manufacturing in the region, including strategies to reduce emissions from existing manufacturing operations, attract businesses that produce climate technologies to the region, and revitalize communities through low-carbon economic development. This brief summarizes key takeaways from the discussion and—building on insights from the event and other conversations with local stakeholders—provides C2ES recommendations meant to align climate, economic, and equity objectives in Pennsylvania.

FRAMING SOUTHWESTERN PENNSYLVANIA

Pennsylvania is a major energy state with a long history of fossil fuel production. Today it is the second-largest supplier of energy to other states (after Texas); it is also the country's second-largest natural gas producer (after Texas) and third-largest coal producing state (behind Wyoming and West Virginia).[1] Taken together, Pennsylvania's contribution to American energy production means that what happens in the state is critical to the nation's energy transition.

Driven by these vast energy resources, Pennsylvania has been a hub for critical, energy-intensive manufacturing industries, including steel, aluminum, and glass. The industries in Pennsylvania—and in southwestern Pennsylvania in particular—helped fuel growth across the nation. Pittsburgh alone accounted for nearly half the national steel output through the mid-1950s.[2]

The heavy presence of these legacy industries has waned in southwestern Pennsylvania, though. In 2019 manufacturing employment in the Pittsburgh metropolitan area hit an all-time low from its peak in the 1950s.[3] New industries, such as healthcare, life sciences, and information technology, have ramped up and now employ a significant portion of the regional population. While this transition has happened across the region, Pittsburgh in particular acts as a successful model for a de-industrialized, diversified economy and has gained international attention for this transformation.[4] However, not all areas of the region have fully adapted to these shifts. The industrial downturn still reverberates in smaller, rural communities, that can often struggle to attract new economic opportunities to their communities.

Despite declines in manufacturing in SWPA, the industrial sector is still Pennsylvania's largest contributor to greenhouse gas emissions, responsible for roughly one-third of emissions in 2019 (the latest year for which data are available).[5] The combustion of fossil fuels for industrial uses—namely, heating and cooling industrial buildings and equipment—amounts to over half the emissions in the sector, and natural gas is by far the largest source

of fuel in the sector, accounting for roughly two-thirds of fuel combusted (Figure 1).

Across Pennsylvania, there is a growing recognition that to remain competitive in a global economy that is increasingly responding to climate change, the state will need to adapt. In 2019, then-Governor Tom Wolf released an Executive Order stating the state will "strive" to reduce greenhouse gas emissions by 26 percent by 2025 and by 80 percent by 2050 (relative to a 2005 baseline).[6] In 2021, the state released the fifth iteration of its Climate Action Plan (CAP), the first that aims to align with that goal. While these are strong first steps, there is much more to do in moving beyond plans toward implementation in a way that fully aligns the state's economy with a net-zero future.

POLICY RECOMMENDATIONS

Attract new climate-aligned manufacturing

- State government or regional economic development organizations should commission a clean energy supply chain study for Southwestern Pennsylvania to understand existing industry presence, potential growth opportunities, and regional assets that can help attract new, climate-aligned manufacturing to the region.

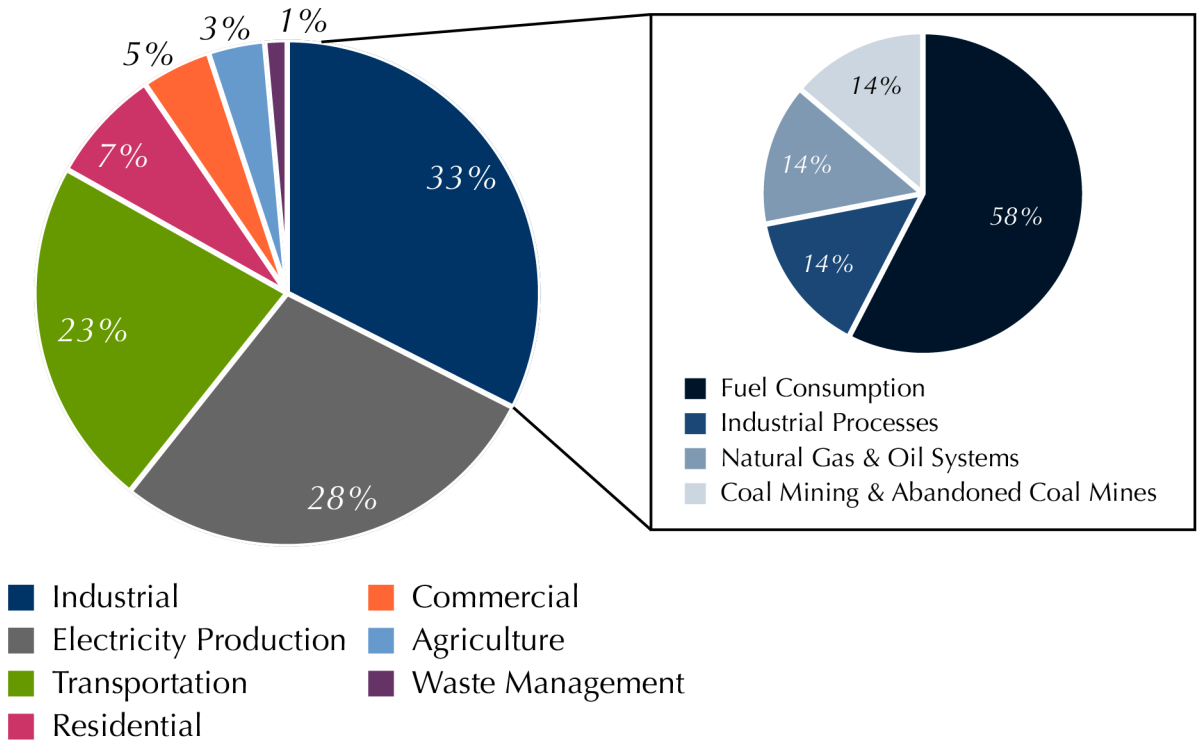
Develop a stronger Innovation ecosystem

- Regional economic development organizations, national labs, the private sector, government, and universities should collaborate to create a regional innovation program focused on decarbonizing the manufacturing and industrial sectors.
- The state should develop a state strategy for innovation that increases funding for Pennsylvania's innovation programs and seeks to develop innovation hubs throughout the state.

Enhance industrial infrastructure

- Bolster DCED's redevelopment playbook program for coal plants, mine lands, industrial sites, and brownfields across the state.

FIGURE 1: Pennsylvania greenhouse gas emissions, total, and in the industrial sector



Source: Pennsylvania Department of Environmental Protection, 2022 Pennsylvania Greenhouse Gas Inventory Report.

Create a coordinated regional strategic planning for manufacturing

- State government, economic development organizations, nonprofits, and industry should collaborate to form a regional planning body to advance climate-aligned decarbonized manufacturing in SWPA.

Enhance rural infrastructure and capacity

- Congress should expand federal resources to support local capacity building and transition planning in rural and energy communities.
- Congress should codify the Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization and provide funding to expand its services across energy communities impacted by the energy transition.
- The state or regional organizations should create community-to-community learning networks centered on overcoming economic development challenges.

Decarbonize manufacturing

- The state should create a state-level 'Buy Clean' program to drive markets for low-carbon manufactured products.
- The state should fund demonstration projects to pilot energy efficiency and fuel switching in a variety of industrial operations.
- The state should place more emphasis on industrial decarbonization strategies when creating the next state Climate Action Plan.

Bolster renewable energy

- The state should pass legislation to modernize the Alternative Energy Portfolio Standard by bolstering the role for zero- emitting energy sources and aligning it with federal climate goals.
- The state should commission a study to explore opportunities and challenges to expanding renewable energy generation in SWPA, including identification of sites suit- able for various types of resource development.

Prepare the workforce

- Training providers, industry, government, and labor unions should expand training and certification opportunities for the clean energy industry in Pennsylvania, including in construction and renewable energy.
- State government, industry, and workforce development organizations should partner to expand on-the-job training opportunities (e.g., apprenticeships, pre-apprenticeships) for young people to gain real-world work experience in the clean energy industry.

Invest in equity and environmental justice

- The state should create a state-level climate justice initiative that ensures the benefits from climate and clean energy investments in the state reach environmental justice and other marginalized communities.

KEY TAKEAWAYS FROM THE DISCUSSION

Takeaways from the discussion will be presented in three sections: the *opportunities* participants saw for SWPA in a decarbonized future; the *assets* the region possesses that can equip it to take advantage of those opportunities; and the *needs* that must be met to fully align local economic development with deep decarbonization.

OPPORTUNITIES

Attracting new, climate-aligned manufacturing

Given southwestern Pennsylvania's long-standing manufacturing expertise, roundtable participants shared excitement about the region becoming a hub to produce the goods and products that will be critical to economy-wide decarbonization. Some of this manufacturing is already present, with roughly 30 facilities producing wind components and 80 manufacturers producing ENERGY STAR-certified products across the Commonwealth.[7]

Participants highlighted multiple industries as opportunities for SWPA:

- **Solar and wind supply chains:** While supply chains for wind and solar energy systems have historically been located outside the United States, recent federal tax credits promoting American manufacturing

have increased interest in building out domestic supply chains.[8] SWPA already hosts industries that can enable it to produce some of the hundreds of parts that go into both solar and wind farms. For example, steel can be used for solar panel mounting structures and for wind turbine castings or bearings, concrete can be used for wind turbine foundations, and aluminum can create solar frames and racking.[9] Already, the private sector is recognizing how SWPA's existing industrial inputs can propel growth in clean energy: Nextracker, one of the world's largest solar tracking manufacturers, has partnered with BCI Steel in Leetsdale, PA, to retool their steel manufacturing capabilities to produce solar tracker components.[10] While this factory is a promising start, attracting a handful of isolated manufacturing investments in SWPA will not be enough to scale supply chains in the region. A cluster of complementary facilities, along with easy access to renewable energy sites, can facilitate streamlined manufacturing as well as reduce logistics challenges associated with transporting clean energy components (especially large wind components) to end sites.[11]

- **Batteries:** Numerous roundtable participants raised batteries as a potentially attractive industry to scale in SWPA, given the massive demand for battery electric vehicles and energy storage for variable renewable resources. Alternative battery chemistries that do not rely as heavily on critical minerals were a particular area of interest. This enthusiasm for batteries was spurred in part by the industry's small, but existing presence in the region: Eos Energy Enterprises (an energy storage company) has a manufacturing facility in Turtle Creek, PA, that has developed and begun producing zinc-based battery chemistries.[12] To date, Eos has been the predominant industry player on batteries in SWPA, and although numerous new battery facilities were announced across the country in 2022 (indicating high private sector interest), none of these facilities were located in Pennsylvania.[13]
- **Energy efficiency and green buildings:** Roundtable participants highlighted Pittsburgh's leadership in green buildings (with a multitude of LEED and other green-certified spaces) as a natural opportunity to grow industries that support the green building sector.[14] These industries could include creating software or manufacturing components that increase energy efficiency (e.g., smart grid technologies, ENERGY STAR-certified products). Some of this activity is already going on in the region: Boss Controls develops software-driven energy management systems in Ligionier, PA, while DMI Companies produces HVAC products in Monongahela.[15] Roundtable participants suggested policymakers could help such industries grow in the region by creating a demand pull for their products and services, including through passing local building codes that emphasize energy efficiency and prioritize low-carbon materials. Such codes would create a demand signal for industry that could help create the stable markets companies need to invest in the region.

While there was shared enthusiasm about multiple industries' potential in the region, no attendees had a clear view of which industries were best positioned to grow in SWPA. All these industries *could* theoretically be located in SWPA, but whether the region could effectively compete to host them and whether these industries made the most sense for the region were both open questions. Indeed, SWPA has already been passed over for recent low-carbon investments that have gone to other areas, for example Intel sited its new chip facility in Ohio and General Motors located its new battery cell factories in Michigan, Ohio, and Tennessee.[16] As a result, numerous attendees called for research into the needs of prospective growth industries, how those needs map to SWPA's assets, and what those industries' economic potential could be for the region. Having this data could better inform regional business attraction efforts by helping SWPA understand its competitive advantage (or disadvantage) relative to other states, as well as focus its attention on industries it is best suited to attract.

Lastly, in pursuing new manufacturing industries, participants pointed to a need to anticipate opportunities before they arrive, rather than directing regional effort toward catching 'ships that have already sailed.' While this strategy could set SWPA apart as a first mover, it may be risky to bet on new industries that are not yet established; as a result, it could also result in economic development promises that are not realized.

RECOMMENDATION:

- **State government or regional economic development organizations should commission a clean energy supply chain study for Southwestern Pennsylvania to understand existing industry presence, potential growth opportunities, and regional assets that can help attract new, climate-aligned manufac-**

turing to the region. This study would fill in knowledge gaps on the industry's potential in the region and highlight possibilities to leverage SWPA's unique infrastructure and expertise in support of various clean energy supply chains, for instance solar, wind, batteries, and energy efficiency products. It should aim to characterize SWPA's competitiveness for attracting clean energy investments to the region relative to neighboring states and other competitors.

Enhancing industrial competitiveness through decarbonization

As the region looks to attract new manufacturing industries that enable a net-zero economy, participants stressed that SWPA must also focus on decarbonizing existing industrial operations. Doing so was presented as an essential component of maintaining regional competitiveness: Pennsylvania is part of a global economy on the road to decarbonization, and investors, shareholders, customers, and policies are increasingly pushing industrial companies to reduce emissions.[17] Standards for reducing the emissions of industrial products are also emerging, for instance the European Union's Carbon Border Adjustment Mechanism will require entities exporting certain carbon-intensive goods to the bloc to pay for the emissions embodied in said products.[18] As a result of these market pressures, SWPA will need to provide industrial companies with the resources and enabling policy environment that can allow them to reduce emissions and compete globally.

Participants raised multiple pathways to decarbonize industry at the roundtable. Most of these pathways identify an efficiency-first model as a necessary starting point to first reduce unnecessary energy use in the industrial sector. Doing so—for instance by upgrading equipment to be more efficient or using processes like combined heat and power—can reduce strains on the energy sector by minimizing industrial energy demand.

As industrial processes often rely on fossil fuels, electrifying these processes with clean power was another popular decarbonization opportunity. Industrial electrification can be a challenge, given that many industries have high heat needs that are difficult to electrify cost-effectively. Innovative technologies, such as thermal energy storage or industrial heat pumps for low-heat industries, offer promise but need to be scaled up.[19] More novel electrification technologies, such as radio-frequency heating, require further research, development, and demonstration. In any case, electrification will require thoughtful infrastructure planning to ensure the grid can handle increased electricity demand.

Given that electrification may be infeasible for certain high-heat industries, some participants saw a role for clean hydrogen in SWPA's industrial decarbonization. Combusting hydrogen fuel offers promise for processes like steelmaking and fertilizer and petrochemical production, which have a challenging path to electrification.[20] But hydrogen fuel switching comes with its own challenges, and multiple participants raised concerns about its impacts. Most of these concerns centered on "blue hydrogen," which is made with natural gas as a feedstock, coupled with carbon capture to reduce greenhouse gas emissions. Some nonprofit participants saw blue hydrogen as extending the region's dependence on natural gas and raised questions about its ability to reduce greenhouse gas emissions compared to burning natural gas directly. Health and air quality concerns were also raised about the technology, given it would require continued extraction (which comes with its own health impacts) and that hydrogen combustion produces nitrous oxides (NOx) that need to be abated. "Green hydrogen" (isolated from water molecules using renewable energy) can help solve for the emissions and natural gas-related concerns with blue hydrogen, but a few nonprofit participants questioned whether Pennsylvania had the requisite renewable energy to create green hydrogen, or whether doing so might divert renewable resources from other uses, such as decarbonizing the power sector.

Carbon capture and sequestration (CCS) technologies were raised as another option to address emissions that cannot otherwise be abated through efficiency, electrification, or hydrogen fuel switching. Like hydrogen, though, CCS was a controversial technology for many environmentalists and community advocates. These participants raised concerns about its cost, technological feasibility, and the potential for CCS to allow continued dependence on fossil fuels. To minimize these concerns, industrial decarbonization efforts should start with easy-to-implement solutions (e.g., energy efficiency) and leverage carbon capture only where other options are insufficient, rather than as a first-resort solution.

An essential component of successfully reducing emissions and increasing regional competitiveness is tracking industry's progress in doing so. Both companies and other roundtable participants emphasized a need for better data to understand specific sources of emissions at

industrial facilities and along supply chains, to map out high-impact opportunities to reduce emissions, and to monitor progress toward goals.[21] Given efforts by policymakers (in the United States and elsewhere) for companies to disclose and report on their emissions, this data will be key for compliance.[22] Southwestern Pennsylvania's expertise in information technology fields was pointed to as a resource that can help it lead on data-driven solutions for emissions monitoring and reductions.

ASSETS

Workforce

Southwestern Pennsylvania's skilled workforce was widely emphasized at the roundtable as a strategic asset for the state in decarbonization efforts. With a long history of manufacturing expertise that continues into the present (as of December 2022, ten percent of jobs in the state were concentrated in the manufacturing sector), the state's workforce has transferrable skills that can enable it to take advantage of emerging opportunities in a decarbonized economy.[23] Expertise in welding, fabrication, steel working, and other areas is in-demand to support the manufacture of clean energy components, electric vehicles, and other products critical to reaching climate goals.

Organized labor was a particular emphasis of workforce-related conversations at the roundtable. With a strong history of organized labor in SWPA and across the state, participants pointed to unions as necessary partners in the ideation, design, and implementation of decarbonization efforts. Partnerships between the private sector and unions in support of low-carbon industries have been working well in other regions: US Wind and the United Steelworkers union (USW) are partnering to transform a former steel mill at Sparrows Point, Maryland, into a manufacturing facility for the offshore wind industry.[24] USW is playing a critical role in cultivating a workforce to support the facility, including by recruiting and training local workers. Such partnerships could be replicated in SWPA to ensure local labor is able to fully reap the advantage of new low-carbon investments.

Innovation ecosystem

Southwestern Pennsylvania has a strong knowledge economy well-suited for innovation, with multiple universities, a Department of Energy national lab, and numerous private sector research facilities scattered across the region. The region's innovation ecosystem is particularly established in the robotics and life sciences industries. Pittsburgh is a hub for life sciences startups, seeing 155 established in the region between 2000 and 2021, and it consistently attracts significant federal funding in support of its life sciences research.[25] The region has also gained federal support for its robotics industry; in 2022, it won a $62.7 million grant through the federal Build Back Better Regional Challenge to build out workforce training, manufacturing, business development, and other needs in support of the robotics and automation industries.[26]

While it is clear from these developments that research and innovation are strengths of SWPA, roundtable participants expressed that there is a lack of a coordinated regional approach to research and innovate on decarbonization specifically. Existing regional initiatives built around other industries could be expanded or replicated to pursue decarbonization in the region, particularly when it comes to the manufacturing sector. This focus can be complementary to existing innovation efforts given that advanced manufacturing is a component of the region's work in robotics.

In addition to fostering innovation for decarbonization, participants called for more emphasis on translating early-stage innovation investments into sustained economic opportunity. Some innovation experts noted the region has strong support for business ideation, but that a lack of follow-through support for startups in SWPA has resulted in some companies leaving the region to expand in states with stronger support systems. There was a shared desire to help companies that are created in the region, stay in the region, by providing them with the financing and other resources needed to grow their businesses. Research by the Brookings Institute points to the need for later-stage investments in innovation across the state, noting that Pennsylvania's above-average investments in research translate into mostly below-average startup formation and employment in advanced industries (e.g., technology, sciences).[27]

When investing in innovation, participants stressed a need to make sure efforts reach those that have traditionally been left out of the innovation economy. Jobs in innovation-adjacent industries—that is, industries supporting innovative technologies—have seen strong growth in Allegheny County, but most surrounding counties have experienced flat or negative growth in such jobs, pointing to a need to expand innovation op-

portunities beyond Pittsburgh.[28] In addition to a need to help surrounding areas take advantage of the innovation economy, there is also a need to increase diversity in Pennsylvania's innovation economy. Roundtable participants noted traditionally marginalized communities (including low-income communities and communities of color) may struggle to participate in innovation efforts due to a lack of access or training. Indeed, disparities in education, entrepreneurship, and business ownership all result in lower participation by women and people of color in innovation-adjacent industries across the state.[29] An approach to innovation that emphasizes reaching underserved areas can ensure widespread economic benefit from innovation while strengthening the regional innovation economy by involving the diversity of viewpoints, skills, and experiences of the region's diverse population.

RECOMMENDATIONS:

- **Regional economic development organizations, national labs, the private sector, government, and universities should collaborate to form an innovation cluster with the goal of accelerating research and technologies to decarbonize the manufacturing sector.** Ensuring broad participation and access in this initiative across the region will be key to ensuring equitable economic benefits from its creation.
- **The state should develop a strategy for innovation that increases funding for Pennsylvania's innovation programs and seeks to develop innovation hubs throughout the state.** A concrete strategy for innovation across Pennsylvania could help the state fill gaps in its innovation economy by more effectively translating high levels of research funding into business creation and job opportunities. In creating this strategy, the state could draw from successful examples in neighboring states. Roundtable participants pointed to Ohio as a leader in government-led innovation; indeed, its JobsOhio Innovation Strategy invests in research and development, startup formation, capital for business growth, workforce training, and multiple innovation districts.[30] Creating a comparable strategy for Pennsylvania could strengthen the state's competitiveness in attracting talent and new business investment.

Industrial infrastructure

Participants agreed that Pennsylvania's significant industrial infrastructure can be a resource in decarbonization and economic revitalization efforts. Now-abandoned industrial sites (for instance, steel facilities, coal plants, and other brownfields) offer enabling infrastructure that can be used for new purposes, including access to rail, water, and the electric grid (via substations and interconnection points).

Significant federal resources have recently gone to revitalizing brownfield sites. For instance, the Infrastructure Investment and Jobs Act channels $1.5 billion to EPA's brownfields redevelopment program.[31] The Inflation Reduction Act also includes provisions incentivizing companies to locate at legacy industrial sites, including coal facilities and other brownfields. The Advanced Energy Manufacturing and Recycling Grant program, for instance, recently opened for applications and will grant $750 million to small- and medium-sized manufacturers who build or retrofit existing manufacturing and industrial facilities to produce 'advanced energy products' (e.g., those that support clean transportation, clean electricity, etc.).[32] The program is aimed at providing for investments in communities experiencing coal mine and power plant closures, and much of SWPA is eligible for investment through the program.[33] In addition to grant programs, new tax credits through the Inflation Reduction Act offer additional bonuses for projects established in energy communities (i.e., at brownfield sites and in communities facing coal mine and power plant closures), incentivizing clean energy generation and manufacturing projects to take advantage of the infrastructure these communities have to offer.[34]

While these programs are a strong start to bolstering industry's interest in using industrial sites in SWPA, roundtable participants expressed that more needs to be done to prepare those sites for redevelopment by placing heavy emphasis on reclamation and remediation at both the state and federal levels. Existing state programs, such as the Department of Community and Economic Development's (DCED) Industrial Sites Reuse Program or the coal-fired power plant redevelopment playbooks offer strong examples for the region to emulate.

RECOMMENDATIONS:

- **The state should bolster DCED's redevelopment playbook program for coal plants, mine lands, industrial sites, and brownfields across the state.** DCED's coal-fired power plant redevelopment playbook program collates site-specific condition reports and suggests decommissioning and revitalization opportunities for selected coal sites across

the state.[35] To date, though, only five playbooks have been created, representing a fraction of the potential sites for redevelopment. The state should direct additional funding to DCED to expand the playbook program to encompass other priority sites in need of reclamation and remediation, including mine lands, industrial sites, and brownfields. It should ensure that these playbook sites are accessible in company location decisions, for instance by prominently displaying them on websites like PA SiteSearch.

NEEDS

Creating a coordinated regional strategic plan for manufacturing

Southwestern Pennsylvania is fortunate to have numerous entities fostering regional collaboration and strategic planning for a range of economic development and climate opportunities. The Allegheny Conference on Community Development's Energy Task Force and Team Pennsylvania Foundation's Pennsylvania Energy Horizons Cross-Sector Collaborative offer strong examples of coordinating bodies that have defined a vision for the region's (or state's) energy future.[36] To date, both of these entities have predominantly focused on carbon capture and hydrogen. Numerous roundtable participants noted an opportunity to replicate the regional coordination, planning, and political leadership currently being leveraged in support of hydrogen and carbon capture to other areas, expressing that investment in a single facet of decarbonization is insufficient. Several participants raised clean energy supply chains and climate-aligned manufacturing as potential focus areas for regional planning. Establishing comparable task forces and collaboratives for other decarbonization strategies could help create a comprehensive regional vision for a decarbonized future and enhance the region's ability compete for federal funds across a variety of areas.

In pursuing this strategic planning and visioning, multiple participants encouraged a systems approach that would link strategies for business attraction, technology innovation, decarbonization, workforce development, social supports, and other critical 'puzzle pieces' together, rather than addressing them in isolation. While such an approach could be resource intensive and far reaching, it can also help foster transformations across the region that result in concurrent gains in equity, economic development, community revitalization, and decarbonization.

RECOMMENDATIONS:

- **State government, economic development organizations, nonprofits, and industry should collaborate to form a regional planning body to advance climate-aligned decarbonized manufacturing in SWPA.** The body should be tasked with creating a vision for low-carbon manufacturing in the region, pursuing research in support of that vision, and coordinating among actors to pursue federal funding opportunities. Representation of communities and labor will be critical to ensuring equitable representation in this effort.

Enhancing rural infrastructure and capacity

There are myriad resources attracting business to SWPA, however, rural roundtable participants noted challenges attracting new investment to their communities. Central among these challenges is the lack of enabling infrastructure in rural communities, including public transportation, high-speed broadband, reliable sewer and water infrastructure, and other critical needs. The quality of infrastructure available in rural Pennsylvania communities is largely insufficient when compared to more urbanized areas of the state. For example, the state has some of the highest shares of rural roads and bridges in poor condition in the country, and broadband speeds in rural areas straggle considerably behind those in neighboring urban counties.[37]

Despite significant federal funds being put toward addressing these infrastructure gaps (for instance, through the Infrastructure Investment and Jobs Act), roundtable participants noted that limited local government capacity in rural areas can inhibit communities' ability to access and effectively use such funds. Rural communities often have part-time councils or commissions and are short staffed, meaning they may lack the budgets and expertise for strategic planning, grant writing, project implementation, and other tasks that more resourced, urban areas can undertake.[38] For rural communities that have historically been dependent on legacy industries (e.g., coal or steel), local capacity challenges may be even more acute, as facility closures leave them with slashed local revenues that affect critical government services. Federal efforts, for instance the services offered by the Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization (IWG), offer promise to help close these gaps in rural and energy communities, but sustained funding and staffing are necessary to create change at scale. Congress should codify the IWG and

expand federal funding resources to meet these needs.

Lastly, given that many rural areas in SWPA directly border Ohio and West Virginia, one roundtable participant shared that attracting investment to those communities can present even more of a challenge, as investors not only have to contend with infrastructure challenges, but also might be deterred from investing in Pennsylvania due to higher corporate tax rates than neighboring states.[39] While the need to compete with surrounding states for investment is one shared across Pennsylvania, this challenge may be particularly acute in rural areas with less of a competitive advantage over other areas of the state.

RECOMMENDATIONS:

- **Congress should expand federal resources to support local capacity building and transition planning in rural and energy communities.** These resources should include creating new grants to fund regional strategic planning in communities impacted by the energy transition, as well as additional funding and staffing for technical assistance programs that support local capacity (e.g., programs through the Department of Energy, Environmental Protection Agency, and other agencies).[40]
- **Congress should codify the Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization and provide funding to expand its services across energy communities impacted by the energy transition.** The IWG, established via executive order, offers numerous resources and information to energy communities that help them navigate economic transitions in their communities. To ensure its staying power, Congress should make the IWG permanent by codifying it into law. It should also increase funding and staffing for the IWG, particularly for its direct community service programs, such as its Rapid Response Teams that offer sustained economic development assistance to regions being acutely impacted by the energy transition (e.g., through facility closures).[41]
- **The state or regional organizations should create community-to-community learning networks centered on overcoming economic development challenges.** These networks could allow for joint capacity building, best practice sharing, and collaboration between a diversity of SWPA communities to allow them to address their joint economic and climate challenges. The learning networks should encompass both rural and urban areas (including environmental justice and low-income communities) to allow participants to share resources, jointly pursue funding opportunities, and exchange perspectives on the unique challenges facing communities across the region. Roundtable participants suggested that activities such as resource fairs could then be coordinated through such a network. The National Association of Counties' Building Resilient Economies in Coal Communities (BRECC) National Network offers a strong example of a learning network that explicitly supports coal communities.[42] In SWPA, such a network could be hosted through a regional organization, such as the Allegheny Conference on Community Development or the Southwestern Pennsylvania Commission.

Decarbonizing manufacturing

As previously described, reducing greenhouse gas emissions in Pennsylvania's manufacturing sector will be critical to maintaining the competitiveness of industry in the state. While roundtable participants explored multiple strategies to do so, the state currently has no concrete emissions reduction program for manufacturing and industry. Roundtable participants pointed to a need for more supportive policy to drive decarbonization in the state, noting that, to present, the Regional Greenhouse Gas Initiative (RGGI) has been the predominant avenue for climate policy. While RGGI can be a strong vehicle to reduce emissions, it has also been embroiled in political controversy and only applies to the power sector, necessitating further actions for industry.[43]

Pennsylvania's 2021 Climate Action Plan (CAP) outlines 22 actions to reach an 80 percent emissions reduction by 2050, only one of which directly pertains to the industrial sector, despite that sector being the largest contributor to greenhouse gas emissions in the state. That action aims to increase industrial efficiency and fuel switching through existing Department of Environmental Protection (DEP) programs, including by providing virtual trainings and partnerships for smaller and hard-to-reach industries. Fuel switching is a particularly urgent priority for industry in Pennsylvania, considering that—without intervention—emissions from fossil fuel combustion in the sector are anticipated to increase by roughly a third by 2050 (relative to a 2005 baseline).[44] Another related action—increasing adoption of com-

bined heat and power (CHP)—suggests expanding CHP via microgrids at critical facilities (e.g., hospitals) and industrial plants, including through incentives and direct project funding. While both these strategies are strong starts to reducing emissions in the manufacturing sector, progress on these items is unclear, and there is a lack of clear governmental mandate to carry forward the recommendations in the plan.

Pennsylvania needs a more robust strategy to reduce industrial and manufacturing emissions that outlines concrete actions, implementable next steps, and responsible parties. These strategies then need to be complemented by laws and regulations that make them a reality. Potential actions to explore include developing state procurement programs for low carbon intensity manufactured goods, creating certification programs for industrial plants that reduce their emissions, establishing efficiency standards for industry, and funding pilot and demonstration programs for fuel switching. Pennsylvania could look to other states for ideas that are easily transferable to its unique context; Louisiana's climate action plan, for instance, details a wealth of clearly defined ideas to reduce industrial sector emissions, including those mentioned above.[45]

In creating these decarbonization plans and policies, it is critical that the private sector be engaged to help find strategies that deliver on emissions reductions while offering flexibility to manufacturers and maintaining cost effectiveness.

RECOMMENDATION:

- **The state should create a state-level 'Buy Clean' program to drive markets for low-carbon manufactured products.** Buy Clean programs are government procurement programs that give preference to low-carbon goods for direct government purchasing and state-funded projects.[46] Given the carbon intensity of the materials going into federal projects (e.g., cement, steel), such programs can be powerful drivers of change in some of the most difficult-to-decarbonize industries. The federal government, Colorado, California, and other states all have versions of such a program that could be adapted to Pennsylvania.[47] Doing so would help create local demand for low-carbon industrial goods and send a market signal to low-carbon manufacturers that they will have a ready buyer for their products in Pennsylvania.
- **The state should fund demonstration projects to pilot energy efficiency and fuel switching in a variety of industrial operations.** Energy efficiency (including CHP) and fuel switching are two central—yet under-utilized—strategies to reduce emissions in Pennsylvania's industrial sector, and manufacturers may be skeptical to adopt them. Creating pilot projects or demonstrations for these decarbonization strategies at a variety of industrial facilities in Pennsylvania could offer a proof of concept to manufacturing companies that gives them confidence to invest. These projects could also help grow local markets for technologies that facilitate industrial decarbonization, such as industrial heat pumps. A focus of the demonstrations and pilots should be to track the economic impacts of energy efficiency and fuel switching at industrial facilities over both the short- and long-term.
- **The state should place more emphasis on industrial decarbonization strategies when creating the next state Climate Action Plan.** With updated CAPs required every three years in Pennsylvania—the most recent of which released in 2021—the state has a near-term opportunity to strengthen its planning for industrial decarbonization by outlining detailed, actionable recommendations and assigning state agencies (or other parties) as responsible for next steps. The state could draw from other detailed plans in updating the CAP, including the Department of Energy's Industrial Decarbonization Roadmap or Louisiana's Climate Action Plan, which includes detailed and specific strategies to reduce emissions in the state's large industrial sector.[48]

Bolstering renewable energy

There is a significant linkage between Pennsylvania's manufacturing and energy sectors. Currently, fossil fuels—namely natural gas—power much of the state's manufacturing processes. As such, it is virtually impossible to embrace the need for sustainable manufacturing in SWPA without also grappling with the broader energy transition in the region.

Positively, there are strong signs that manufacturers and other companies in the region are pushing for that transition. Multiple companies involved in the roundtable expressed a need for greater access to renewable energy to power their operations. Indeed, several companies noted that easy access to renewables is a factor that directly influences their investment decisions, with a

handful noting that they intend to de-couple their manufacturing and industrial businesses from fossil fuels.

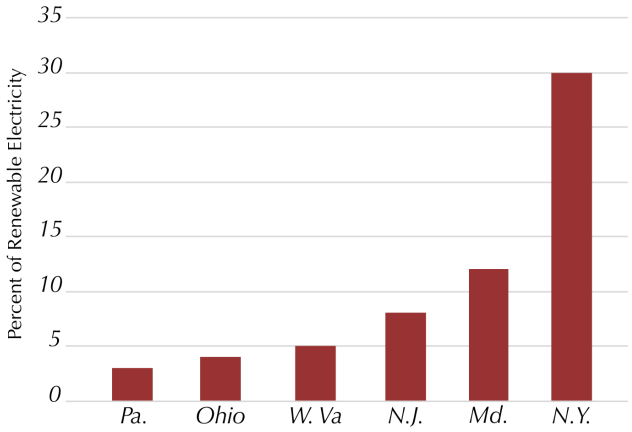
This private sector demand points to the need for enabling renewable energy policy in the state. Numerous roundtable participants stressed that Pennsylvania's energy policies put it behind regional competitors when it comes to facilitating clean and renewable energy development. Currently, Pennsylvania has an Alternative Energy Portfolio Standard (AEPS), passed in 2004, requiring alternative energy sources to generate 18 percent of the state's electricity retail sales by 2021, with at least 0.5 percent from solar photovoltaics.[49] Those alternative sources include traditional renewable resources (wind, solar, hydropower, geothermal), as well as less conventional sources such as the byproducts of pulping and wood manufacturing and waste coal. With the 2021 deadline now past, the compliance levels of the AEPS will remain in effect in perpetuity, or until the law is amended.

While the AEPS has been effective at increasing electricity generation from *alternative* energy sources, only a small portion of the state's electricity comes from renewables. As of 2021, renewables generated just 3 percent of Pennsylvania's electricity. Wind provided roughly 40 percent of that renewable electricity, followed by hydropower (30 percent), biomass (20 percent), and solar (11 percent).[50] Among neighboring states, Pennsylvania has the lowest share of renewables in its electricity mix, falling behind both Ohio and West Virginia (Figure 2).

To better compete with other states, roundtable participants expressed that Pennsylvania needs to align its clean energy goals with private sector goals by raising the ambition of its AEPS and centering zero-emission resources in that standard. Multiple attendees stressed that an updated, net-zero aligned standard can attract manufacturers looking to procure clean power, as well as for clean energy companies who could see such a standard as a market signal to invest in the state. Without policy certainty for such companies, Pennsylvania will struggle to attract investments from a growing cohort of companies demanding access to clean power.

While there is a strong desire for greater access to renewable energy by stakeholders across SWPA, renewables development may be constricted by regional topography. Southwestern Pennsylvania has some of the state's best wind resources along the Appalachian Mountains, but the same terrain that creates strong wind conditions can prove a challenge for utility-scale solar development.[51] Roundtable participants pointed to a need to better understand opportunities for renewable energy development in the region given local conditions.

FIGURE 2: Share of renewables in state electricity mix, 2021



Source: U.S. Energy Information Administration, "Pennsylvania: State Profile and Energy Estimates."

RECOMMENDATIONS:

- **The state should pass legislation to modernize the Alternative Energy Portfolio Standard by bolstering the role for zero-emitting energy sources and aligning it with federal climate goals.** With the targets for Pennsylvania's AEPS flat lining in 2021, the standard requires an update to enhance the Pennsylvanian energy sector's long-term competitiveness relative to other states. Nearby states have standards far exceeding Pennsylvania's: Maryland and New Jersey require 50 percent of electricity sales be renewable by 2030, New York requires 100 percent zero-emissions electricity by 2040, and Virginia requires 100 percent renewables between 2045 and 2050 (depending on the utility).[52] Without ambitious clean energy targets, Pennsylvania will miss out on the private sector investments that policies in neighboring states can help attract. The state legislature should pass legislation to update the state's AEPS in line with President Biden's goal of a zero-emitting electricity sector by 2035. This legislation should evaluate and redefine eligible energy sources that meet the goal, with preference given to renewable and other zero-emitting resources. Given Pennsylvania's strong energy efficiency economy, energy efficiency measures should be built into and heavily promoted through the standard. Doing so can create economic benefits up and

down energy efficiency supply chains in the state.

- **The state should commission a study to explore opportunities and challenges to expanding renewable energy generation in SWPA, including identification of sites suitable for various types of resource development.** This study should characterize the renewable resource potential in the region, map sites best suited to certain resources, and offer suggestions for how to overcome barriers to renewable generation.

Preparing the workforce

While SWPA already has a skilled manufacturing workforce, roundtable participants expressed that additional efforts are needed to equip workers with the skills to meet the needs of the emerging clean energy economy. State-level research affirms this assertion; a 2021survey of clean energy employers in Pennsylvania found that 84 percent had hiring difficulty, even before the COVID-19 pandemic. Factors contributing to that difficulty included having a small pool of applicants, candidates lacking needed experience, and job competition with other industries.[53]

To ensure Pennsylvania's workforce can support clean energy industry needs, the state must prepare its workers for the growing clean energy economy. Doing so necessitates focusing both on existing workers who might look to transition into the industry, as well as young people just starting their careers.

Roundtable attendees highlighted that workers in SWPA in the manufacturing and energy industries have a variety of transferrable skills (e.g., expertise in welding, fabrication, engineering, and steel working) that are in demand in a net-zero economy. Workforce preparation efforts for workers in related industries involve expanding and applying those skills in ways that can offer new work opportunities. In some cases, this skills transfer will be straightforward and require little to no training, while in others, niche skillsets may have a harder time translating to new industries. Expanding opportunities for workers to receive clean energy-related certifications is an effective way to help trainees land work, as more than half of clean energy employers require or prefer such certifications in the state.[54]

Roundtable participants also emphasized the importance of targeting youth in workforce development programs. Programs tailored toward young people must showcase concrete job opportunities in the clean energy industry to make it clear that it is possible to create a long-term career, just as it is in legacy industries like coal. Doing so can encourage young people to identify and join emerging, growth industries rather than industries in decline (e.g., coal). Pre-apprenticeships, apprenticeships, internships, and job shadowing opportunities can all give students a feel for potential career paths and in some cases can allow them to earn money while doing so. These programs are especially important in Pennsylvania's clean energy industry, where employers frequently prefer on-the-job work experience to formal degrees and where a significant portion of workers reported such programs helped them land a job.[55] In addition to preparing youth for specific careers, some roundtable participants stressed the importance of equipping them with the life skills that can enable them to be motivated for—and succeed in—their careers, including effective time management and professionalism.

Across both existing and young workers, participants raised a number of considerations for designing effective workforce development programs:

- Workforce development efforts must be informed by regional job market analysis and include strong private sector partnerships to design programs that meet employer needs. Without this data-driven, collaborative approach, there is a risk that workers may be trained for jobs that do not exist or equipped with skills that are not in demand.
- Jobs in the clean energy economy must be competitive against legacy industries to attract top talent. Certain industry segments (e.g., solar installation) may not be widely unionized and may not offer family-sustaining wages that rival those in heavy-emitting industries. These factors can be a deterrent to attracting qualified workers.
- Creating a strong regional workforce must be more holistic than simply training workers; it necessitates attracting talent to, and keeping talent in, the region (especially in rural counties experiencing brain drain) by strengthening social services, regional infrastructure, transportation networks, housing, education, and other essential resources.

RECOMMENDATIONS:

- **Training providers, industry, government, and labor unions should expand training and certification opportunities for the clean energy industry in Pennsylvania, including in construction and renew-**

able energy. Pennsylvania already offers a strong training ecosystem for energy efficiency, with nearly 90 percent of the state's clean energy training programs relating to that sub-sector.[56] Pennsylvania's training programs should be expanded to develop skilled workforces in other clean energy sub-sectors, such as renewable energy and construction. Concurrently, industry and government should work to ramp up opportunities for workers to receive in-demand certifications for their trades, such as through the North American Board of Certified Energy Practitioners and other organizations. Labor unions should be partners in designing training programs and channeling workers to both trainings and certifications.

- **State government, industry, and workforce development organizations should partner to expand on-the-job training opportunities (e.g., apprenticeships, pre-apprenticeships) for young people to gain real-world work experience in the clean energy industry.** A potential program to model is the Vocational Internship program through the Massachusetts Clean Energy Center (a state-wide economic development organization), which funds paid internships for vocational high school students at clean energy companies.[57]

Investing in equity and environmental justice

The environmental and health impacts of SWPA's energy and industrial sectors reverberate across the region, especially when it comes to air quality. The Greater Pittsburgh region was ranked 14th-worst in the country for year-round particulate pollution between 2018 and 2020.[58] Allegheny County in particular ranks among the top one percent of all counties when it comes to cancer risk from point source air pollutant emissions (i.e., pollutants that come from stationary sites like industrial facilities and power plants).[59] While these impacts can affect the region as a whole, roundtable participants stressed that they concentrated more heavily in some communities than others. For instance, a 2015 study indicated that the census tracts in Pennsylvania most exposed to pollution from unconventional wells (e.g., fracking) have a significantly higher percentage of people living in poverty than other areas.[60] A 2019 environmental justice index of Allegheny County showed that census tracts with a mostly racial minority population scored 80 percent higher than mostly white tracts when it came to their exposure to environmental and health burdens (as measured by various community health metrics).[61]

Recent state and federal policy developments may help lessen some of these disparities. DEP's Office of Environmental Justice has identified environmental justice (EJ) areas across the state, which is an integral first step to tailoring resources to these communities. In addition, DEP is preparing to release its revised environmental justice policy (an update from its 2004 policy) in spring 2023, which will include opportunities for community participation in permitting activities in EJ areas, as well as guidelines to advance EJ and equity more broadly in DEP's work.[62] The draft policy includes considerations specific to the state's oil and gas, climate, and community development programs and outlines at a high-level how EJ is prioritized across these programs. Still, more can be done to ensure that EJ areas receive an equitable portion of Pennsylvania's climate and clean energy investments.

Roundtable attendees noted the long-term nature and inherent challenge of addressing environmental injustice in Pennsylvania. They noted EJ and other disadvantaged communities have faced burdens to their health and the environment that have lasted for generations. Significant investments are needed to first mitigate those negative impacts, then create positive impacts that are sustained intergenerationally to fully address inequities.

RECOMMENDATION:

- **The state should create a state-level climate justice initiative that ensures the benefits from climate and clean energy investments in the state reach environmental justice and other marginalized communities.** The Justice40 initiative at the federal level, created by Executive Order 14008, requires that at least 40 percent of the benefits of climate and related investments flow to disadvantaged communities (where statutory authority allows), helping to rectify decades of disinvestment.[63] Multiple states have their own version of Justice40: California, New York, and Washington state all require at least 35 percent of various climate-related investments flow to certain disadvantaged communities.[64] Other states take a more flexible approach: Maryland prioritizes disadvantaged communities in distributing clean energy-related funds, while Illinois law creates carve-outs for solar and wind projects in low-income communities.[65] Pennsylvania's state legislature or governor's office should create a statewide initiative that either directs a portion of climate investments to environ-

mental justice and other marginalized communities, or prioritize these communities for receiving climate and clean energy funding. Such a step would ensure the benefits of climate-related investments in Pennsylvania reach the communities most in-need, while helping all Pennsylvanians participate fully in the net-zero transition.

Diversifying and revitalizing the economy

The need for economic diversification and revitalization was a common theme in discussions with roundtable participants. SWPA has undergone decades of 'boom-and-bust' cycles as industries like coal and steel rapidly expand in the region, then decline. This history of investment, then disinvestment, has left many communities distrusting of new economic opportunities and concerned that the promise of new industries entering the region may amount to false hope. Any decarbonization effort that establishes new industries in the region should understand this history and seek to regain trust that has been lost between communities and industry.

The boom-and-bust pattern in SWPA has been facilitated in part by a lack of economic diversification across the region. With many communities heavily dependent on a single industry, the region is particularly vulnerable to global and national market shifts. For decarbonization efforts to lead to long-term economic prosperity in SWPA, they must avoid the faults of the past by intentionally cultivating a diversity of economic opportunities across the region. State government, regional economic development organizations, and industry must recognize that no single industry should hold the key to the region's economic future. A patchwork of investments across a variety of sectors (e.g., manufacturing, information technology, energy efficiency, renewable energy, life sciences) will be essential to creating a robust and resilient regional economy.

Successful economic diversification efforts should naturally contribute to community revitalization, especially in the communities most impacted by past economic downturns. But community revitalization also extends beyond merely attracting private sector investment to a region. Some participants described the need for a systems approach to economic revitalization that bolsters the wrap-around infrastructure that helps communities thrive. A robust and livable housing stock, educational capacity, childcare centers, community and cultural networks, and other resources are all vital pieces of community revitalization efforts that must be prioritized alongside attracting new investment.

CONCLUSION

With a robust history in the manufacturing sector, a skilled workforce, an emphasis on innovation, and ample industrial infrastructure, Southwestern Pennsylvania is well-positioned to become an investment destination for climate-aligned manufacturing. Stakeholders across the region have expressed interest and excitement about attracting such investment, in particular in industries that manufacture technologies and goods critical to the clean energy transition. But while there is high potential in Southwestern Pennsylvania, there are also considerable challenges to overcome to help the region thrive in a net-zero economy. Investments in strategic planning, rural capacity building, renewable energy, industrial decarbonization, environmental justice, and other needs are all required to help Southwestern Pennsylvania compete in a global economy increasingly pushed by the demand for sustainability. Such investments can help revitalize local economies across the region and secure Southwestern Pennsylvania's long-term prosperity in a fully decarbonized future.

Other C2ES Resources

C2ES Regional Roundtables
https://www.c2es.org/accelerating-the-us-net-zero-transition/regional-roundtables

Securing Louisiana's Role in a Decarbonized Future
https://www.c2es.org/document/decarbonizing-louisianas-industrial-sector-the-importance-of-community-centric-approaches/

Investing in West Virginia's Future: Aligning Climate and Economic Development
https://www.c2es.org/document/investing-in-west-virginias-future-aligning-climate-and-economic-development//

A Building Block for Climate Action: Reporting on Embodied Emissions
https://www.c2es.org/document/a-building-block-for-climate-action-reporting-on-embodied-emissions/

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