EnergyWise West Virginia

Priority Energy Action Plan (PEAP)

WEST VIRGINIA OFFICE OF ENERGY

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West Virginia Priority Energy Action Plan (PEAP) Report
Submitted for the Phase I Report
of the Climate Pollution Reduction Grant Program
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Definitions and Acronyms

Priority Energy Action Plan (PEAP): a narrative report that includes a focused list of near-term, high-priority, and implementation-ready measures to reduce GHG pollution and an analysis of GHG emissions reductions.

Comprehensive Energy Action Plan (CEAP): a narrative report that provides an overview of the grantees' significant GHG sources/sinks and sectors, establishes near-term and long-term GHG emission reduction goals, providing strategies and identifying measures that address the highest priority sectors to help the grantees meet those goals.

Contractor: An entity that has either received authorization for noncompetitive procurement, as defined in 2 CFR § 200.320(c), or has completed the appropriate competitive bid process described in 2 CFR § 200.320(b).

Greenhouse gas (GHG) Inventory: a list of emission sources and sinks and the associated emissions quantified using standard methods. The PEAP must include a "simplified" inventory (see Section 2.1). The CEAP must include a comprehensive inventory of emissions and sinks for the following sectors: industry, electricity generation/use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.

Low Income / Disadvantaged Communities (LIDACs): communities with residents that have low incomes, limited access to resources, and disproportionate exposure to environmental or climate burdens. Although the Inflation Reduction Act does not formally define LIDACs, EPA strongly recommends grantees use the Climate and Economic Justice Screening Tool and the Environmental Justice Screening and Mapping Tool to identify LIDACs in their communities. These tools identify LIDACs by assessing indicators for categories of burden: air quality, climate change, energy, environmental hazards, health, housing, legacy pollution, transportation, water and wastewater, and workforce development.

MSA: metropolitan statistical areas as defined by the U.S. Census 2020 MSA population. A list of eligible MSAs can be found in Appendix 15.2 of the EPA's CPRG: Formula Grants for Planning, Program Guidance for States, Municipalities, and Air Control Agencies.

Project Team: Includes the Pass-Through Entity, Subgrant Entities, other State regulatory agencies, and Contractors.

Project Partners: All Subgrant Entities and Contractors.

SOW: Statement of Work; discusses the role of the Pass-Through Entity, Subgrant Entities, and Contractors.

State: all 50 U.S. states, the District of Columbia, and Puerto Rico. All other Tribes or U.S. territories (the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands) should follow CRPG guidance for Tribes and Territories.

Status Report: The final deliverable of the CPRG; focuses on emissions reductions achieved as a result of actions taken from the PEAP and CEAP.

Subaward Agreement: Contains specific tasks, responsibilities, and duties required of all Subgrant Entities and applicable Contractors.

Subgrant Entity: A nonprofit organization, educational institution, and/or government entity that has been sub-granted a portion of funds by the pass-through entity. The approved Subgrant Entities are as follows:

IN-2-Market (I2M)
Marshall University (MU)
West Virginia University (WVU)

WVDEP: The West Virginia Department of Environmental Protection; a state regulatory agency providing support and emission inventories for the project to the WVOE.

WVOE: The West Virginia Office of Energy; the recipient of the grant. They are also the pass-through entity.

1 Introduction

1.1 State Context

West Virginia has long been a national leader in producing Reliable, Efficient, Affordable, and Local (REAL) energy. By maintaining clean fossil fuels, strengthening the grid, and improving energy efficiency – plugging abandoned gas wells, exploring new technologies such as nuclear and geothermal, and building on existing collaborative networks – the CPRG Planning and Implementation grants will help West Virginia maintain its status within the nation's energy sector while effectively and efficiently reducing GHG emissions.

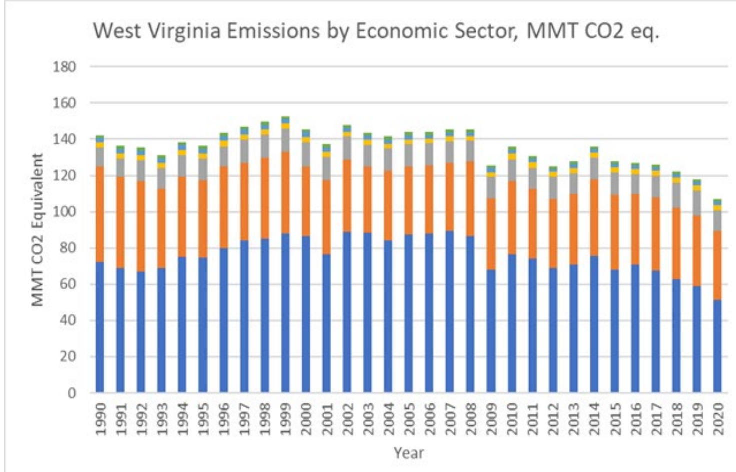

Figure 1.1. *West Virginia Emissions by Economic Sector, in Million Metric Tons (MMT) of Carbon Dioxide Equivalent (CO2e).*

West Virginia's CO2 emissions fell 32.9% from 2005-2020, outpacing reductions in the US at large (25%) and demonstrating that the all-inclusive approach to electric generation does not conflict with appreciable reductions in greenhouse gas emissions (**Figure 1.1**). These CO2 reductions have primarily been the result of significant transitions in electric power generation across the country, leading to large, negative economic impacts across West Virginia and highlighting the historic interdependence between economic activity, energy consumption, and CO2 emissions. Energy consumption and emissions are dominated by the industrial sector, with 45% of energy consumption (primary consumption and electricity) from industrial sources (see **Figure 1.2**).

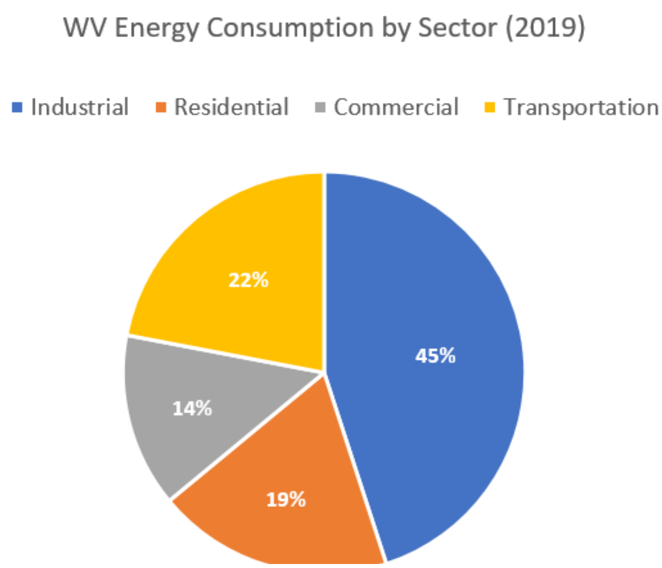

Figure 1.2. *Emissions by Sector and Energy Consumption by Sector. [Source: EPA State Energy Profiles.](#) [Source: EIA Beta.](#)*

Any successful Energy Action Plan must have a focus on job creation and retention, create equitable economic outcomes for residents of the state, and position West Virginia for both resilient and reliable future energy generation. West Virginia has a disproportionate share of disadvantaged communities as defined by the [Climate and Economic Justice Screening Tool](#), with more than 60% of census tracts in West Virginia in this category compared to 37% nationwide.

While this highlights the need for outreach to disadvantaged communities, it also illustrates the magnitude of the issue and the need to grow tangible, impactful relationships with, and drive outcomes in, these communities. Finalizing the Priority Energy Action Plan is the first step in this process.

1.1.1 Responsible Entities

The State of West Virginia has designated the West Virginia Office of Energy (WVOE) as the Lead Organization under the WV CPRG Planning Grant. The WVOE is the State Agency responsible for the formulation and implementation of fossil, renewable and energy efficiency initiatives designed to advance energy resource development opportunities and provide energy services to businesses, communities, and homeowners in West Virginia. As such, they are responsible for submitting the three (3) key deliverables of West Virginia's CPRG Planning Grant:

1. Priority Energy Action Plan (PEAP)
2. Comprehensive Energy Action Plan (CEAP), and
3. Status Report

1.1.2 Coordinating Entities

The WVOE has identified a strong set of coordinating and partnering organizations to ensure the success of this proposal. The list of coordinating partners includes:

- West Virginia University (WVU) – WVU is the largest university in West Virginia, a public land-grant research university, and the only R1-ranked research university in the state.
- Marshall University (MU) – Marshall is the second largest university in West Virginia and is a public research university.
- In-2-Market, Inc. (I2M) – In-2-Market, Inc. is a Pennsylvania-based 501(c)(3) non-profit corporation serving the tri-state region of Ohio, Pennsylvania, and West Virginia. In-2-Market accelerates industrial innovation with a focus on modern manufacturing, advanced materials, and energy.

Cooperative agreements through the form of Memorandums of Understanding have been executed between the organizations to define expectations, roles and responsibilities, and required deliverables.

1.2 CPRG Scope

Under this project, the WV CPRG Project Team has identified, evaluated, and utilized existing data resources[1] to develop a statewide inventory of the major sources of greenhouse gas (GHG) emissions within West Virginia and used that inventory data to develop an energy action plan. At the inception of the CPRG Planning Grant, the baseline GHG inventory and options analyses developed under this project were designed to be utilized by the WVOE CPRG Project Team for planning purposes to support West Virginia's development of the following three deliverables:

- West Virginia's **Priority Energy Action Plan (PEAP)**, submitted via this report on March 1, 2024. The plan includes near-term, implementation-ready, priority GHG reduction measures and is a prerequisite for any Implementation Grant.
- West Virginia's **Comprehensive Energy Action Plan (CEAP)**, which is due in 2025. This plan will review all sectors that are significant GHG sources or sinks, and include both near- and long-term GHG emission reduction goals and strategies.

[1] EPA, *Environmental Information Quality Policy*, CIO 2105.3, 03/07/2023 (p. 8) provides common examples of environmental information used to support the EPA's mission at https://www.epa.gov/system/files/documents/2023-04/environmental_information_quality_policy.pdf.

− West Virginia's **Status Report** on progress towards its goals, due in 2027. This progress report will include updated analyses, plans, and next steps for key metrics.

For each deliverable, the Project Team was tasked with completing a series of five subtasks:

1. Develop a comprehensive GHG inventory for the largest sources within each sector,
2. Develop options for reducing emissions within each sector,
3. Develop estimates or ranges of estimates for the reductions achievable under each option,
4. Develop forecasts for economic impacts of the options, and
5. Present the inventory, options listing, and associated analyses in a technical report for consideration by state policymakers with the authority to approve the deliverables under the CPRG planning grants.

This report is an accounting of the subtasks for the first deliverable, the Priority Energy Action Plan (PEAP).

1.3 Approach to Developing the PEAP

The central component of the PEAP is a narrative report of high-priority, implementation ready measures to reduce GHG pollution and includes:

- A GHG inventory,
- Quantified reduction measures,
- A low-income and disadvantaged communities benefit analysis, and
- A review of the authority to implement.

The GHG inventory utilizes the EPA's State Inventory Tool (SIT)[2] and state-level GHG inventories prepared by the EPA,[3] and data reported to the EPA's Greenhouse Gas Reporting Program (GHGRP).[4] West Virginia's statewide inventory includes the following sectors and gasses:

Sectors	***Greenhouse Gases (across all sectors)***
1. Electricity generation 2. Industry 3. Transportation 4. Commercial and residential buildings, agricultural sources, and other sources 5. Natural sources (sinks)	carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), fluorinated gasses (F-gasses) including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3)

For each sector included in the statewide inventory **Table 1.1** briefly describes why the sector was included in the inventory and the relative significance of the sector in terms of the magnitude of air emissions from existing inventories, the associated geographic distribution of the sources, and recent trends in readily available activity data for the source category.

[2] https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool
[3] https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals
[4] https://www.epa.gov/ghgreporting/data-sets

Table 1.1. Rationale for Sector Selection

Sectors Included in Inventory	**Rationale for Including in GHG Inventory**
Power Sector	The electric power sector accounted for 25% of total U.S. GHG emissions in 2021. Power consumption and/or generation occurs across all states.
Industry	The industrial sector accounted for 24% of the U.S. GHG emissions in 2021. Since 1990, industrial sector emissions have declined by 11%. In 2021, total energy use in the industrial sector increased by 2% due to an increase in total industrial production and manufacturing output. EPA's GHGRP data provide additional insights into underlying trends in the industrial sector.
Transportation	Transportation activities were the largest source (29%) of total U.S. GHG emissions in 2021. From 1990 to 2021, transportation CO_2 emissions increased by 19%. Transportation activities occur across all states.
Commercial and Residential Buildings, Agriculture, and Other Sources	In 2021, commercial and residential buildings, agriculture, and other sources accounted for about 23% of U.S. GHG emissions. Emissions from the commercial and residential sectors have increased since 1990, and agricultural soil management was the largest source of N_2O emissions. In 2021, an increase in heating degree days (0.5%) increased energy demand for heating in the residential and commercial sectors; however, a 1.8% decrease in cooling degree days compared to 2020 reduced demand for air conditioning in the residential and commercial sectors.
Natural Sources (sinks)	Natural Sources focuses on practices that remove CO_2 from the atmosphere and store it in long-term carbon sinks like forests. In 2021, the net CO_2 removed from the atmosphere by natural and working lands was 12% of total U.S. GHG emissions. Between 1990 and 2021, total carbon sequestration in this sector decreased by 14%, primarily due to a decrease in the rate of net carbon accumulation in forests, as well as an increase in CO_2 emissions from urbanization.

1.3.1 Prior Work: Pathways to a Low Carbon Future

The WVOE/WVDEP has partnered with IN-2-Market, Inc., and I2M's Contractor, who have developed a program called "Pathways to a Low Carbon Future." This program–developed in partnership with several contributors, including West Virginia University–was in development prior to the announcement of the CPRG program and is currently active. "Pathways to a Low Carbon Future" outputs include a fact-based, unbiased view of current conditions within the region, desired future outcomes, and potential solutions.

Prior to CPRG Planning Grant implementation, the Pathways project developed a Fact Base including emission sources, SWOT analysis, and future visioning exercise. The Fact Base incorporated input from a diverse group of stakeholders collected through workshops, interviews, surveys, and focus groups from across the larger region of Ohio, West Virginia, and Pennsylvania. An Advisory Committee composed of academics, economic developers, state entities, and non-profit companies reviewed and shaped the resource.

Information produced by the Pathways project has been applied across the states of West Virginia, Pennsylvania, and Ohio. The WV CPRG Planning Team used the Pathways project, leveraging I2M's data gathering, stakeholder engagement, and analysis to accelerate development of the PEAP and focused on West Virginia's obligations and opportunities, all with a clear understanding of the larger, regional impacts of GHGs and plans for their reduction.

As part of the "Pathways" study, the team prepared a simplified GHG inventory and interactive heat map (**Figure 1.3**). The inventory and heat map includes greenhouse gas emissions that result from the use of fossil fuel in all counties in West Virginia. The emissions are categorized by electricity generation, industry, transportation, commercial and residential. Industry is divided into industry sectors, including chemicals, oil and gas, mining, metals, pulp and paper, minerals, and refineries. The heat map identifies the emitters and the corresponding number of metric tons of GHG in all the counties in the state.

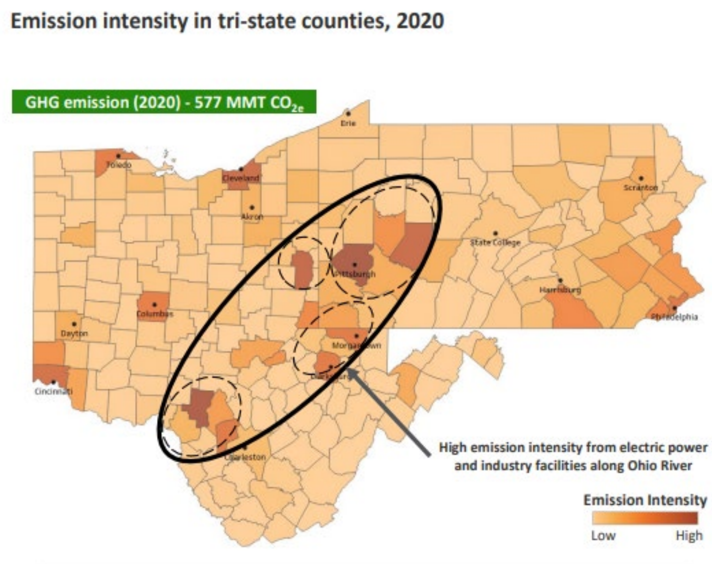

Figure 1.3. *Map of GHG Emissions Intensity in Counties Surrounding the WV-PA-OH Tri-State Area, 2020.*

Besides emissions, the Fact Base includes energy production, electricity, energy consumption and trade, energy transmission and storage infrastructure, supply chain levers, workforce and communities, policies and regulations, and existing low carbon energy projects in the region.

Pathways project work was reviewed for applicability specific to West Virginia, and output graphics and tabulations specific to West Virginia were created and integrated into all WV CPRG data registers.

2 PEAP Elements

2.1 Greenhouse Gas (GHG) Inventory

This section provides a simplified greenhouse gas (GHG) emissions inventory for West Virginia. GHG emissions in West Virginia were categorized by economic sector, gas type, and geography.

2.1.1 Scope and Data Source

The GHG emission inventory included the entire state of West Virginia. The sectors included were Transportation, Electric Power Generation, Industrial, Agriculture, Commercial, and Residential. The absorption of GHGs that result from Land Use, Land Use Change, and Forestry (LULUCF) is also included.

This inventory utilizes data directly from the Environmental Protection Agency's (EPA) state-level GHG data[5]. The EPA state-level data included the transport, electricity, industrial, agriculture, commercial, residential, and land use/forestry economic sectors. The EPA GHG state-by-state inventory also provides state-level data on emissions broken down by greenhouse gas. Data from EPA's GHG inventory for 2021 was chosen as the PEAP GHG inventory baseline year. Historical data which included 1990 and 2005 was also compiled.

The emission intensity for non-CO2 gasses were converted to CO2 equivalences (CO2e) using greenhouse warming potentials from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report[6]. Where data sources reported CO2e emissions using numbers from the IPCC Fourth Assessment Report[7], a conversion was performed to update the emissions data to use the greenhouse warming potentials for CO2 equivalence from the IPCC Fifth Assessment Report.

Once the state-level data was obtained, further analyses were performed to provide county-level breakdowns of data by sector.

2.1.2 County-Level Emission Determination

The 2021 emissions data from the EPA is provided on a state-level and a facility-level. This data was disaggregated according to location of specific emitting facilities and by population to specific counties in West Virginia. This provided an estimate of county-level emissions in each of the 55 counties in West Virginia.

These county emissions on a per-sector basis were determined using the following additional data:

- Point source data for emitting facilities from EPA Facility Level Information on Greenhouse Gases Tool (FLIGHT)[8],
- Point source data for emitting facilities and nonpoint source data for onroad and nonroad transportation from the National Emissions Inventory (NEI) dataset[9], and
- County population data from US Census Bureau[10].

The specific county level disaggregation methodology depended on the emission source. The methods used to obtain county-specific data for each sector are described below:

Transportation emissions

- The 2021 transportation emission data was not available on a county-by-county basis. For this inventory, the 2021 data was distributed proportionally to the county transportation emissions reported for 2020 in the NEI data. This assumes that the distribution of emissions would be essentially the same for 2021 as for 2020.

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[5] Downloaded at https://www.epa.gov/system/files/other-files/2023-02/State-Level-GHG-data.zip, accessed January 30, 2024.
[6] *IPCC's Fifth Assessment Report AR5, Chapter 8, pp. 731-737*, accessed January 30, 2024.
[7] *IPCC's Fourth Assessment Report AR4, Chapter 2.10, pp. 212-213*.
[8] EPA's 2021 *Facility Level GHG Emissions Data (FLIGHT)*, accessed January 30, 2024.
[9] EPA's 2020 *National Emissions Inventory*, accessed January 30, 2024.
[10] Census Bureau's *Population by County*, accessed January 30, 2024.

Electric power generation emissions

- Emissions from specific generation facilities were allocated to the county in which the facility is located. This allocation accounted for approximately 97% of the emissions from electrical generation in 2021 (~58 million metric tons of carbon dioxide equivalent emissions "MMT CO2e"). The remaining approximately 3% of electric power emissions (~2 MMT CO2e) were allocated proportionally to the specific county based on population.
- West Virginia is a net exporter of electricity. In 2021, 46% of the electricity generated was exported out of state[11]. The direct emissions from all the electricity generation within WV are included in this inventory, whether the electricity is used in the state or exported. No electricity was imported to West Virginia in 2021.

Industrial emissions

- Emissions from specific industrial facilities identified in the FLIGHT and NEI data were allocated to the county in which the facility was located. This allocation accounted for approximately 53% of the industrial emissions in 2021 (~20 MMT CO2e). The remaining approximately 47% of industrial emissions (~17.5 MMT CO2e) were allocated proportionally based on the population of each county.

Commercial emissions

- Emissions from municipal landfills (~0.8 MMT CO2e) were allocated to specific counties based on the municipal landfill emissions reported in the 2020 NEI.
- Other sources of commercial emissions (~2.1 MMT CO2e) are from fossil fuel combustion, substitution of ozone depleting substances, wastewater treatment, and stationary combustion. "Substitution of ozone depleting substances" emissions are generated from the use of materials like hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) which are used to substitute for ozone-depleting substances in applications like refrigeration, air conditioning, and fire suppression. "Stationary combustion" emissions are generated in equipment such as boilers, heaters, and furnaces.
- These other sources of commercial emissions (~2.1 MMT CO2e) were allocated proportionally to the county population.

Residential emissions

- Residential emissions (~2.0 MMT CO2e) were distributed proportionally based on each county's population. These emissions result from fossil fuel combustion, substitution of ozone depleting substances, and stationary combustion.

2.1.3 GHG Emission Results by Sector and Gas

GHG Emissions by Sector

GHGs in West Virginia by economic sector, reported in kilotons of CO2e are shown on an annual basis for 1990, 2005, and from 2017 to 2021 in a tabular form in **Table 2.1**.

[11] U.S. Energy Information Administration - EIA - Independent Statistics and Analysis, Table 10, Accessed 2/2/24.

Table 2.1. *GHGs in West Virginia by Economic Sector. Data provided in metric kilotons of CO2 equivalences (CO2e). LULUCF is a net carbon sink and stands for Land Use, Land Use Change, and Forestry*

Sector/Source	1990	2005	2017	2018	2019	2020	2021
Transportation	10,231.0	12,175.5	11,985.7	13,686.0	13,725.1	11,631.5	13,797.1
Electric Power Generation	72,148.5	87,430.8	67,263.4	62,383.1	58,772.5	51,398.4	60,056.1
Industrial	55,582.5	37,630.2	41,816.2	41,329.5	39,367.9	38,713.4	37,486.8
Agriculture	1,651.4	1,729.6	1,465.3	1,546.4	1,589.0	1,458.1	1,438.2
Commercial	2,916.5	2,743.5	2,856.0	3,095.5	3,054.1	2,891.6	2,954.6
Residential	2,460.7	2,253.5	1,704.7	2,032.7	1,921.9	1,926.0	1,961.7
Total Emissions (Sources)	**144,990.5**	**143,963.2**	**127,091.3**	**124,073.2**	**118,430.5**	**108,019.1**	**117,694.6**
LULUCF Sector Net Total	(20,464.3)	(17,128.1)	(15,564.8)	(15,354.6)	(15,194.2)	(15,253.5)	(15,094.9)
Net Emissions (Sources and Sinks)	**124,526.2**	**126,835.1**	**111,526.4**	**108,718.5**	**103,236.4**	**92,765.6**	**102,599.6**

This table shows that the total net emissions for 2021 were 102.6 million metric tons (102,599.6 metric kilotons) of carbon dioxide equivalent emissions (MMT CO2e). The 2021 emissions are 19% lower than the emissions in 2005.

Data for 2021, the base year for the purpose of the analysis, is shown graphically in **Figure 2.1**. This shows that the total sectoral emissions were 117.7 MMT CO2e. This graphical representation of emissions by sector, though, does not include emission sources and sinks from Land Use, Land Use Change, and Forestry (LULUCF). LULUCF was a net carbon sink of 15.1 MMT, resulting in overall net emissions of 102.6 MMT CO2e in 2021.

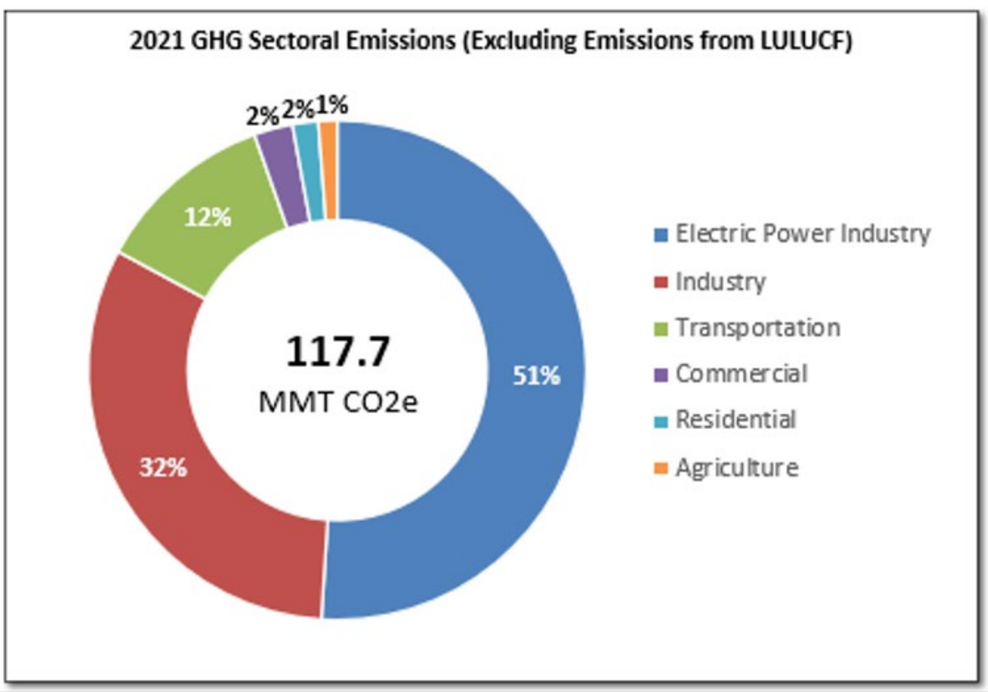

Figure 2.1. *GHGs in West Virginia by Economic Sector. This chart does not include emission from Land Use, Land Use Change, and Forestry (LULUCF), which results in net emissions in 2021 of 102.6 MMT CO2e, if included.*

This sector-by-sector data illuminates the character of emissions in West Virginia. Some conclusions are:

- **Electric power generation makes up the majority of emissions** – Over half of all emissions within West Virginia (51%) result from the electric power generation sector. This is higher than the national average of 25%. Most of the electric power generation sector emissions are from the state's coal-fired power plants, which contribute 95% of electric power generation emissions.
- **The Industrial Sector is the second largest source of emissions** – The industrial sector is the second largest contributor to overall state emissions, accounting for 32% of the state's emissions. This is higher than the national average of 23.5%. Coal mining operations represent the largest category of emitting industrial facilities, contributing 38% of the industrial emissions.
- **Transportation emissions are the third largest category** – The transportation sector represents 12% of the WV emissions. This is lower than the national average of 28.5%.
- **Commercial and residential sector emissions represent a smaller proportion of total emissions** – The smallest proportion of emissions are from the commercial and residential sectors which collectively make up approximately 4% of the total emissions. This is lower than the national average of approximately 13%.

GHG Emissions by County

The county-level disaggregation of GHG emissions highlights where within the state of West Virginia emissions primarily occur. An Emissions Intensity Map is shown in **Figure 2.2**. This county-by-county map shows the distribution of emissions across the state on a color scale.

This county-by-county map can be used to gain insight regarding the distribution of emissions across the state. This representation shows:

- **Counties with coal-fired electricity generation have the largest emissions across the state - Power generation, especially coal fired generation, is the largest source of emissions** – Given that power generation, especially coal fired generation, is the largest source of emissions this is not surprising. The three counties that are the highest emitters are shown with the darkest color in the figure (Putnam, Harrison, and Monongalia counties). Coal generation accounts for over 80% of emissions within these three counties. The location of the coal plants is overlaid onto the county emissions intensity map in **Figure 2.3**.
- **Counties with more industrial facilities also have higher emissions from the industry sector (Figure 2.4)** –This can most clearly be seen in the county that contains Charleston (Kanawha County) and the county that contains Martinsburg (Berkeley County). More than half of Kanawha county's emissions are from industrial sources, mostly from chemical plants

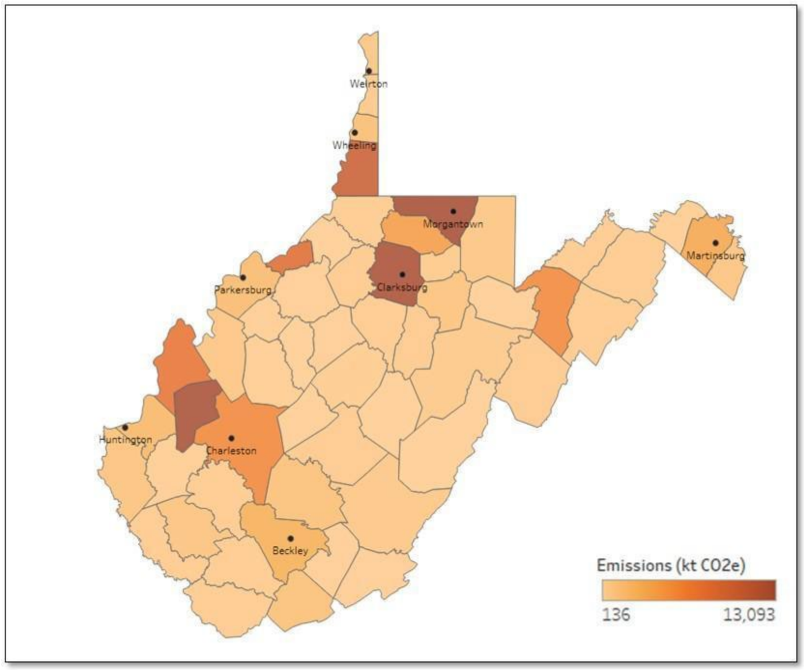

Figure 2.2. *WV Emissions Intensity Map*

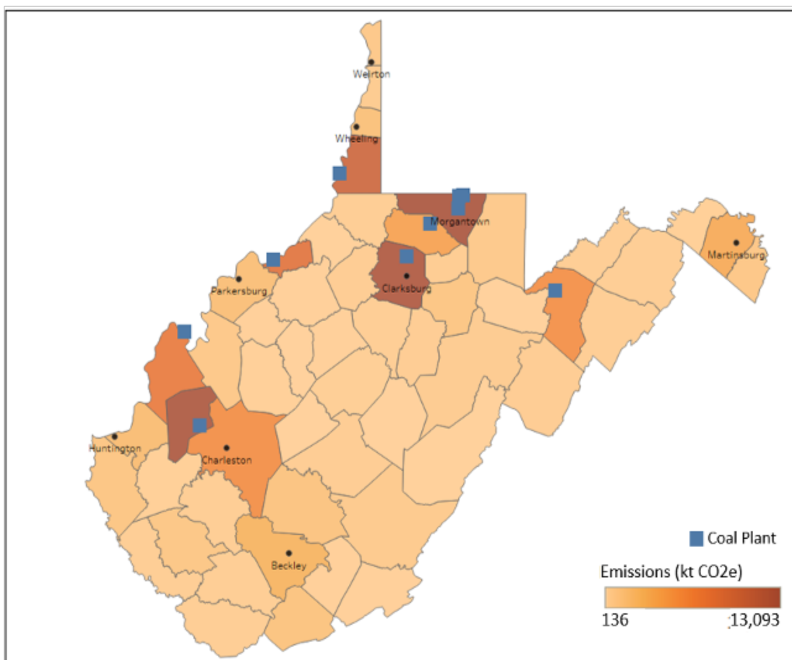

Figure 2.3. *WV Emissions Map by County Overlaid with the State's Coal-Fired Generation Facilities, Showing Relationship Between Coal Plants and County-Level Emissions.*

and petroleum and natural gas systems. More than 60% of Berkeley county's emissions come from industrial sources, primarily from cement and mineral production facilities.

- **Emissions are correlated with population density** – Generally, counties in West Virginia with higher population densities are also the counties with higher emission intensities. This is particularly the case when considering emissions that result from sources other than electricity generation facilities. The ten counties with the largest populations are overlaid on the county emission intensity map in **Figure 2.5**.

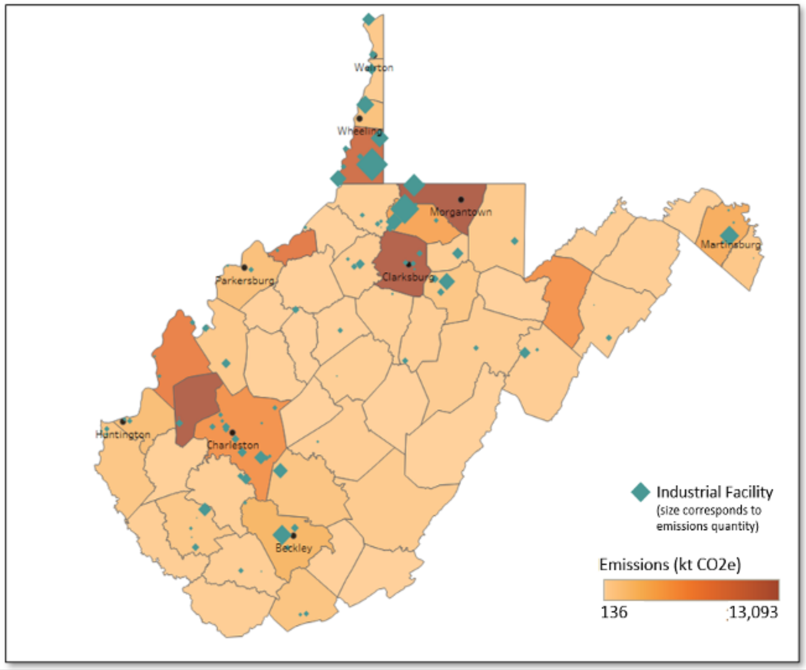

Figure 2.4. *WV Emissions Map by County Overlaid with the State's Industrial Facilities, Showing Relationship Between Industrial Facilities and County-Level Emissions.*

GHG Emissions by Facility

The facility-based point source data extracted from the EPA FLIGHT and NEI data was displayed on a map of West Virginia for the power sector and industrial sectors. These facility maps are shown in **Figure 2.6.** The magnitude of emissions is shown by the size of the circle. Note that the scale of the magnitudes of emissions for the power sector and the industrial sectors are different in the two figures. The largest circle in the power sector represents emissions of 11,526 kilotons of CO_2e (11.5 MMT of CO_2e). The largest circle in the industrial sector represents emissions of 2,388 kilotons of CO_2e (2.4 MMT of CO_2e).

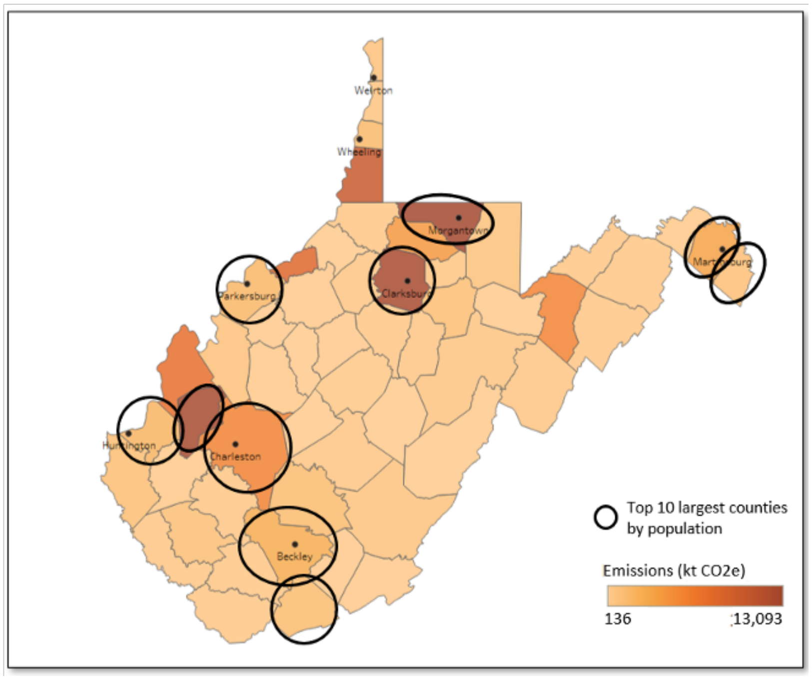

Figure 2.5. *WV Emissions Map by County Overlaid with Circles Indicating the 10 Largest Counties by Population, Showing the Correlation Between Population and Emissions.*

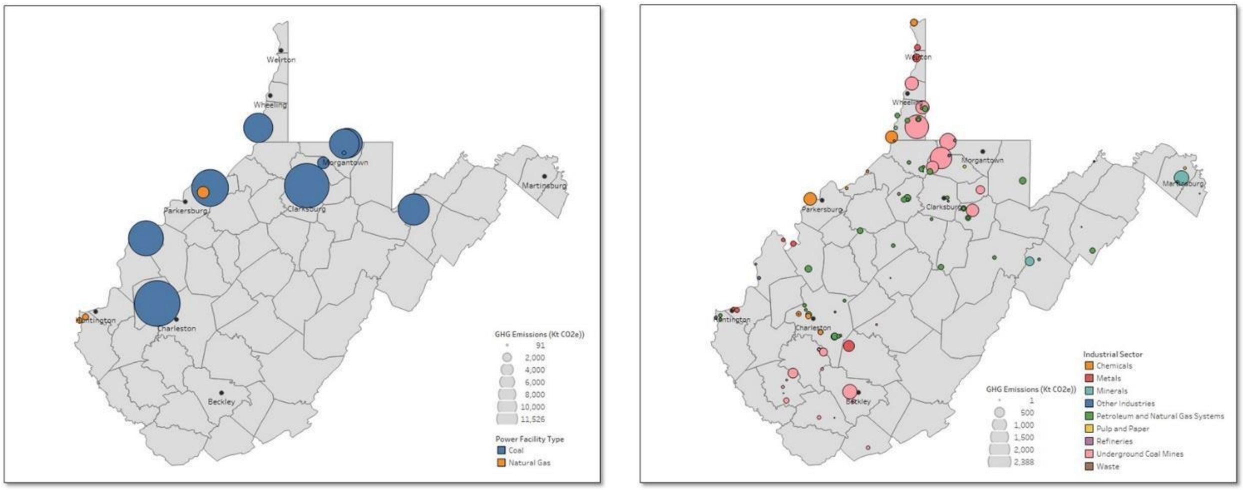

Figure 2.6. *Emissions Intensity Maps for Power Generation and Industrial Facilities. The magnitude of emissions is shown by the size of the circle. The scale of the magnitudes of emissions for the power sector and the industrial sectors are different in the two figures.*

Evaluation of the power generation facility map (the left map in **Figure 2.6**) provides the following observations:

- **West Virginia uses coal-fired generation for more than 90% of its electricity consumed** – Most of the electricity generated within West Virginia comes from coal fired electricity generating facilities (~93% of annual electric power sector energy consumption in 2021[12]). This means that almost all the power generation related emissions in West Virginia come from coal-fired power plants, accounting for approximately 95% of power generation emissions in 2021 (~59.0 MMT CO2e in 2021).
- **Coal plants are in the northern and western part of the state** – Coal generating facilities are primarily located along the Ohio River and near the population centers of Charleston, Clarksburg, and Morgantown. As a result, this corresponds with economic activity and jobs associated with coal plants also being located in these areas that will need to be considered if the electricity generation profile shifts in the state.
- **Natural gas plants are located along the Ohio River, similar to some of the coal plants** – There are three natural gas facilities within the state that produce fewer GHG emissions than coal plants. They are located along the Ohio River, near Parkersburg and Huntington. They are predominantly used as peaking power plants, primarily used during times of particularly high electricity demand on the grid. These plants accounted for approximately 3% of the annual electric power sector energy consumption and less than 2% of power generation emissions in 2021 (~1.0 MMT CO2e in 2021).

[12] Electric Power Sector Consumption Estimates – State Energy Data System (EIA), Table C9, Accessed 2/5/24

Evaluation of the industrial facility map (**Figure 2.6**, right image) provides the following observations:

- **Coal mining is the largest source of industrial emissions, accounting for approximately 38% of industrial emissions** – Coal mining is the largest source of industrial emissions within West Virginia (~14.3 MMT CO2e in 2021). Underground coal mining operations are concentrated in the north-central and south-central coalfields of West Virginia. The facility-based emissions map shown in **Figure 2.6** only includes underground coal mine emissions due to dataset availability. Emissions for underground and surface coal mines, though, are included in the total state-level Industrial GHG emissions.
- **Petroleum and Natural Gas Systems are the second largest source of industrial emissions,** which includes methane leakage from wells and pipeline systems (among other things) – The operation of petroleum and natural gas systems contributes to the emissions in West Virginia (~10.0 MMT CO2e in 2021). These include both facilities associated with the production and storage of natural gas and petroleum within the state as well as the operation of transmission pipelines that run across the state.
- **Facilities tend to be located near population centers and rivers** – Most industrial facilities tend to be clustered in areas near population centers, along the Ohio River, and in the northern West Virginia panhandle between PA and OH. As a result, reducing emissions associated with these facilities may have both positive impacts (for example, air quality) and negative impacts (for example, impacts on economic activity and jobs availability). These need to be considered and balanced as the state considers appropriate policy measures to implement to drive emissions reductions.

GHG Emissions by Greenhouse Gas

The WV GHG Emissions Inventory was also identified by specific greenhouse gas types. GHG emissions by greenhouse gas, reported in kilotons of CO2e using greenhouse warming potentials from the IPCC's fifth assessment report, are shown in **Table 2.2**. In this table, emission sources and sinks associated with Land Use, Land Use Change, and Forestry (LULUCF) are not included in the totals by greenhouse gas.

This tabulation shows that in 2021, CO2 represents 77.8% of the total emitted CO2e. Methane (CH4) represents 19.8% of the total emitted CO2e. CO2 and Methane represent nearly 98% of the total emitted CO2e in the state.

Table 2.2. GHG Emissions by Gas, Reported in Kilotons of CO2e. "NO" designates emissions of that gas are identified as "Not Occurring"

Gas/Source	1990	2005	2017	2018	2019	2020	2021
CO_2	103,004.1	113,926.6	93,246.0	91,800.9	89,436.2	79,911.3	91,595.4
CH_4	39,723.2	26,987.4	31,179.2	29,496.4	26,423.9	25,500.6	23,347.6
N_2O	1,849.2	2,224.5	1,858.9	1,881.6	1,715.4	1,686.6	1,795.7
HFCs	1.8	546.7	776.2	862.0	819.9	881.7	918.5
PFCs	163.7	164.1	0.2	0.2	0.3	0.3	0.3
SF_6	248.4	113.9	30.8	31.9	34.9	38.5	37.1
NF_3	NO	NO	NO	NO	NO	NO	NO
Total Emissions (Sources)	**144,990.5**	**143,963.2**	**127,091.3**	**124,073.2**	**118,430.5**	**108,019.1**	**117,694.6**
LULUCF Sector Net Total	(20,464.3)	(17,128.1)	(15,564.8)	(15,354.6)	(15,194.2)	(15,253.5)	(15,094.9)
Net Emissions (Sources and Sinks)	**124,526.2**	**126,835.1**	**111,526.4**	**108,718.5**	**103,236.4**	**92,765.6**	**102,599.6**

2.1.3.1.1 Case Study: Methane

Methane (CH_4) is a powerful greenhouse gas: the second-largest contributor to global emissions after carbon dioxide (CO_2). Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices, land use, and the decay of organic waste in municipal solid waste landfills. Human activities emitting methane include leaks from natural gas systems and the raising of livestock. Methane is also emitted by natural sources such as termites. In addition, natural processes in soil and chemical reactions in the atmosphere help remove CH_4 from the atmosphere. Methane's lifetime in the atmosphere is much shorter than carbon dioxide (CO_2), but CH_4 is more efficient at trapping radiation than CO_2. Over a 20-year period, it is 80 times more potent for emitted GHGs than CO_2.

Figure 2.7 illustrates methane emissions in West Virginia between 1990 and 2021 and contributions from each sector. Overall, methane emissions in West Virginia have decreased since 1990. In 1990, methane emissions were 39.84 million metric tons of CO_2 equivalent (MMT CO2e), and in 2021, they were 23.46 MMT CO2e. This represents a decrease of 41%. As a comparison, overall methane emissions in the United States have decreased by 16 % between 1990 and 2021.

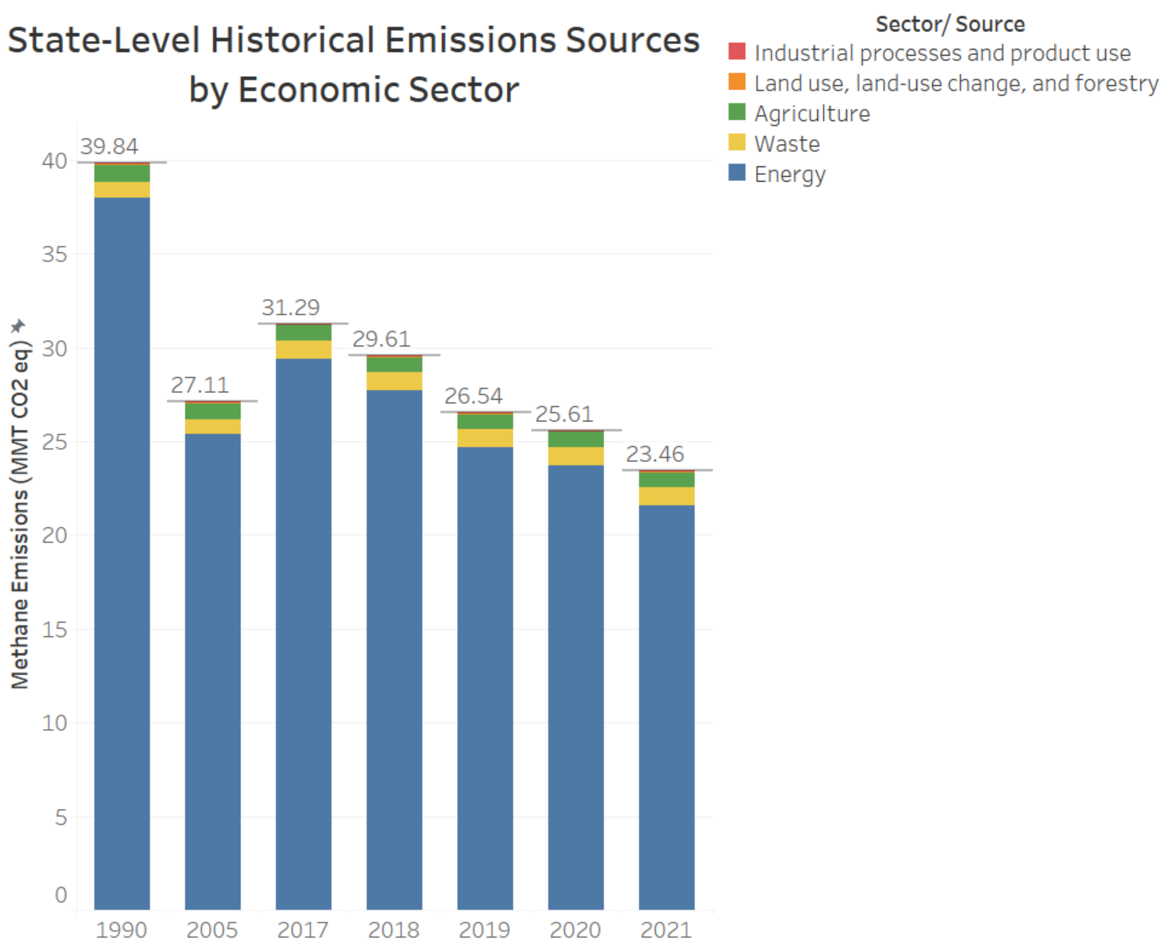

Figure 2.7. *Historic data of methane emissions in WV since 1990.*

The largest source of methane emissions in West Virginia is the power generation sector. In 2021, the power generation sector emitted 21.56 MMT CO2e of methane, which accounted for 92% of total methane emissions as shown in **Figure 2.8**. Emissions from the power generation sector have dropped by 43% since 1990, primarily because of reduced coal mining activities. The second largest source is waste from homes and businesses, but it only takes 4.26 %. The source of methane emissions from industrial processes and product use is the smallest relative to other sources. In 2021, this sector emitted 0.002 MMT CO2e of methane, which accounted for less than 1% of total methane emissions in WV. Methane emissions from this sector have risen by 352% since 1990, correlating with the growth in total industrial production and manufacturing output, but are still small compared to emissions from other sectors.

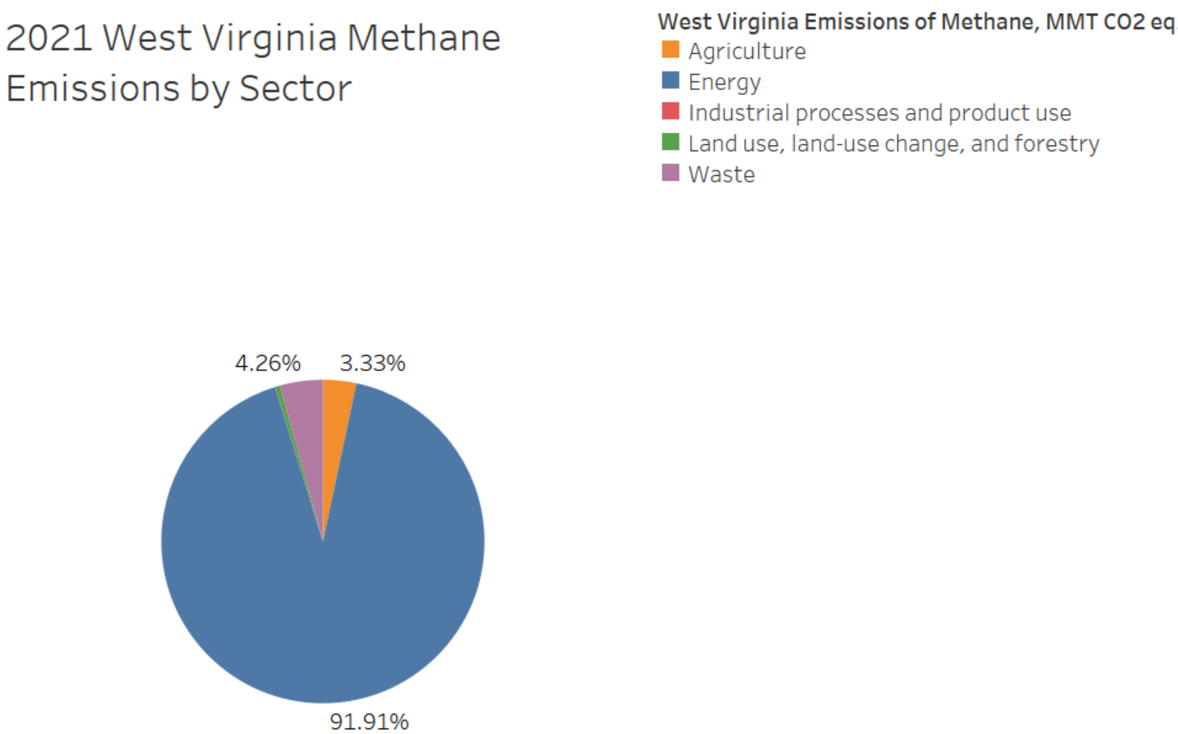

Figure 2.8. *Methane Emissions by Contributing Sectors in 2021.*

In power generation, which is the largest contributing sector, fossil fuel combustion, and fugitives account for 0.60 % and 99.40 % respectively, as shown in **Figure 2.9**. Fugitive emissions are caused by defective equipment, such as valves and pipes, and the migration of gasses from faulty fossil fuel wells or mines. One primary way fugitive emissions escape is from the extraction and transport of coal: West Virginia has a rich history of coal mining and in the 21st century, and continues to be the second-largest coal producer in the nation after Wyoming. The extraction and transport of oil and gas is also a source of fugitive methane. West Virginia is one of several states that is home to the Marcellus Shale (also known as The Marcellus Formation), one of the largest onshore natural gas fields in North America, and the state has experienced a rapid increase in natural gas extraction operations since the discovery of these fields. Because of these facts, coal mining and natural gas systems have the most significant contribution to fugitive methane emissions in West Virginia, which account for 53.89 % and 31.56 % of total emissions respectively.

Among them, underground liberated coal mining contributes to 52.77 % of overall state fugitive methane emissions. Natural gas production & exploration contribute to 22.72 %, and natural gas processing contributes to 5.05 % as shown in **Figure 2.10.** In coal mining, underground recovered & used methane leads to the reduction of total fugitive methane emissions by 14.50 %, but underground liberated methane contributes to 97.92 % of overall fugitive methane emissions from coal mining operations. This implies that coal mining operations continue to be a net contributor to methane emissions due to the release of methane from underground sources.

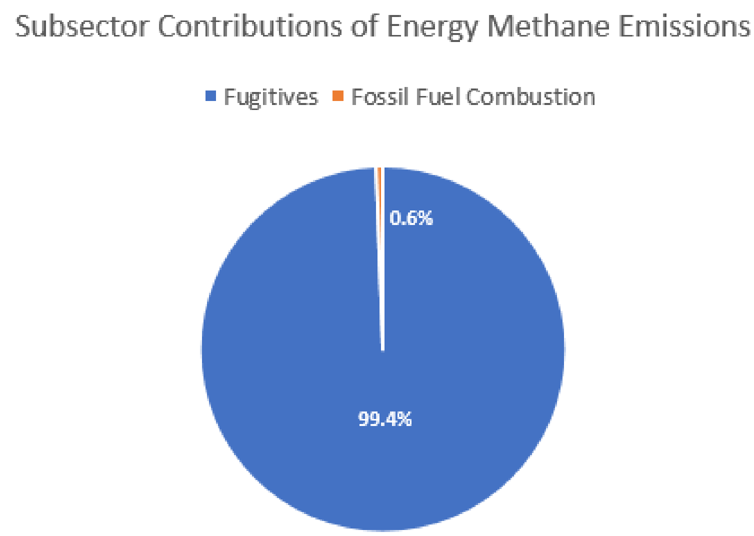

Figure 2.9. *Methane Emissions in the Energy Sector in WV*

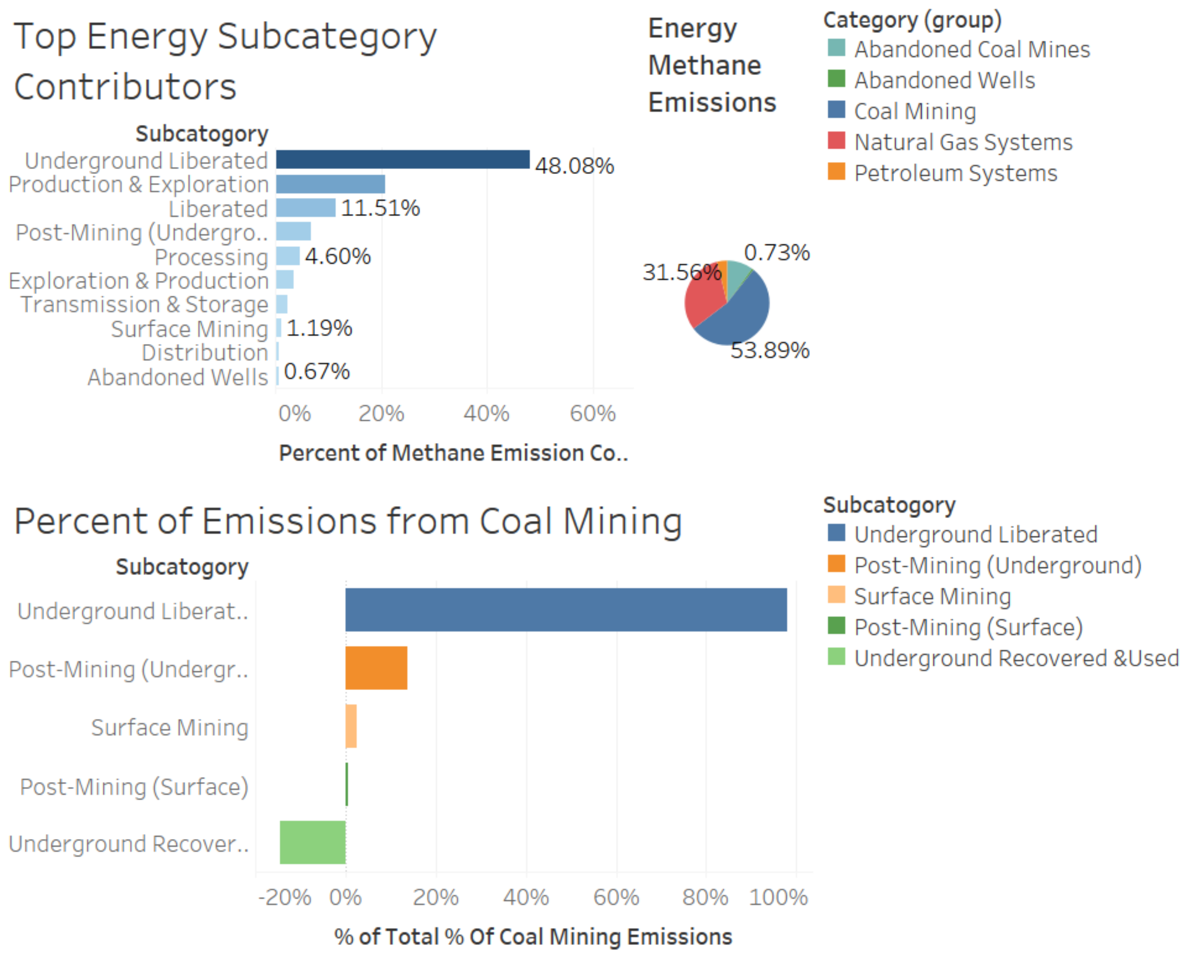

Figure 2.10. *Methane Emissions Routes in the Fugitives of the Energy Sector in WV*

In West Virginia, 112 large facilities are reporting to the EPA their methane emissions. **Figure 2.11** illustrates those facility-level methane emissions through WV. The methane emissions map at the facility level corresponds to the overall methane emission intensity map of WV. This connection arises because the primary methane emissions in WV predominantly originate from the energy sector, with fugitive gasses from this sector constituting the largest contribution to overall methane emissions.

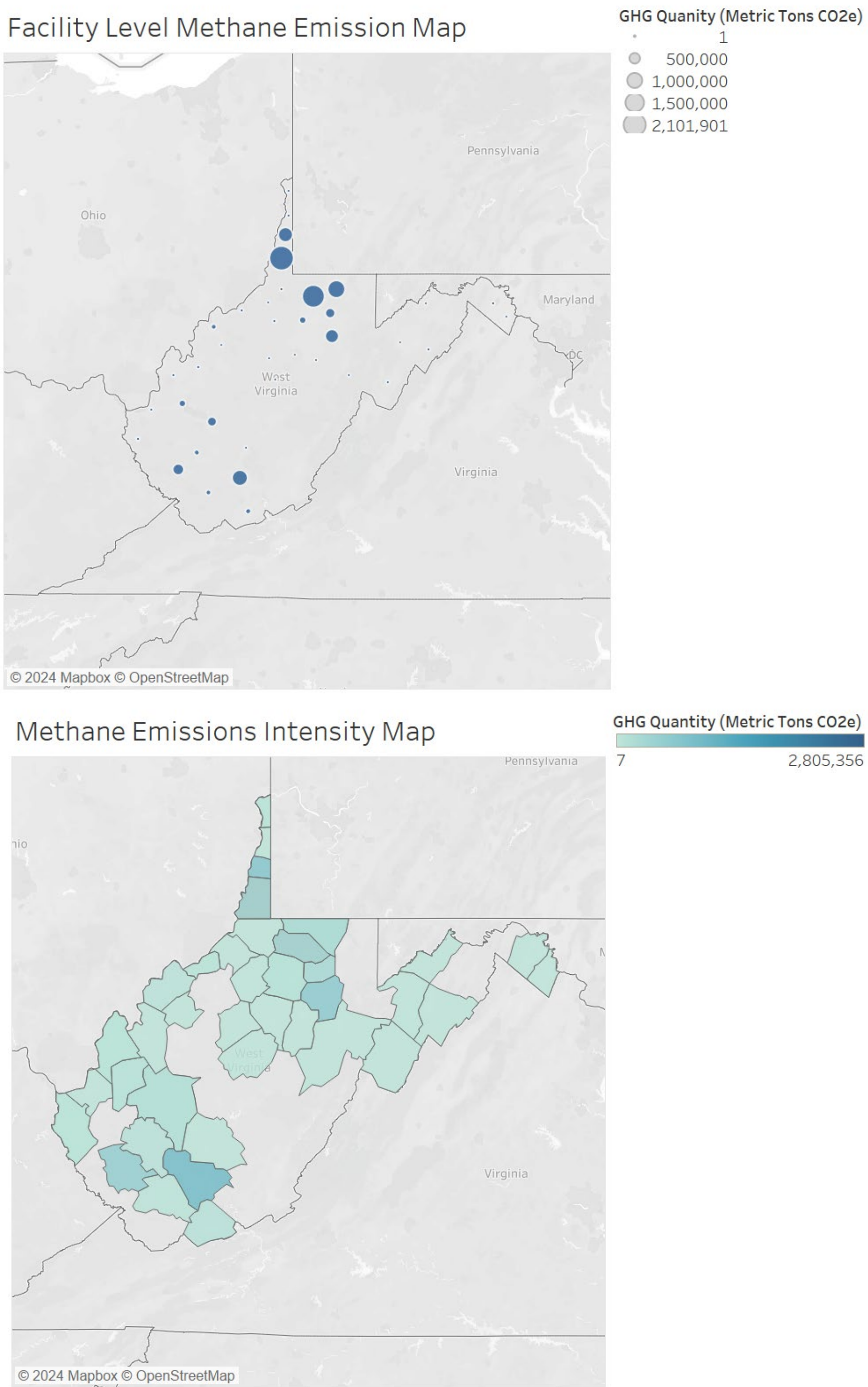

Figure 2.11. *Facility Level Methane Emission Map of WV (Top), and Overall Methane Emission Intensity Map of WV (Bottom).*

2.1.3.1.2 Case Study: Fluorinated Gasses

Unlike many other greenhouse gasses, fluorinated gasses have no natural sources and only come from human-related activities. Fluorinated gasses are emitted through their use as refrigerants. They are also emitted through a variety of industrial processes such as aluminum and semiconductor manufacturing. Many fluorinated gasses have very high global warming potentials (GWPs) compared to other greenhouse gasses. GWPs measure the heat-trapping ability of a gas over a specific time period, usually 100 years, relative to carbon dioxide. Some fluorinated gasses have GWPs thousands of times greater than carbon dioxide on a per-molecule basis. So small atmospheric concentrations can have disproportionately large effects on global temperatures. They can also have long atmospheric lifetimes. Among them, hydrofluorocarbons (HFCs) persist for approximately 270 years, perfluorocarbons (PFCs) exhibit astonishingly long lifetimes ranging from 2,600 to 50,000 years, nitrogen trifluoride (NF3) lingers for about 740 years, and sulfur hexafluoride (SF6) remains in the atmosphere for roughly 3,200 years. In contrast, about 65% to 80% of the CO_2 emitted into the atmosphere is absorbed by the ocean over a period of 20 to 200 years.

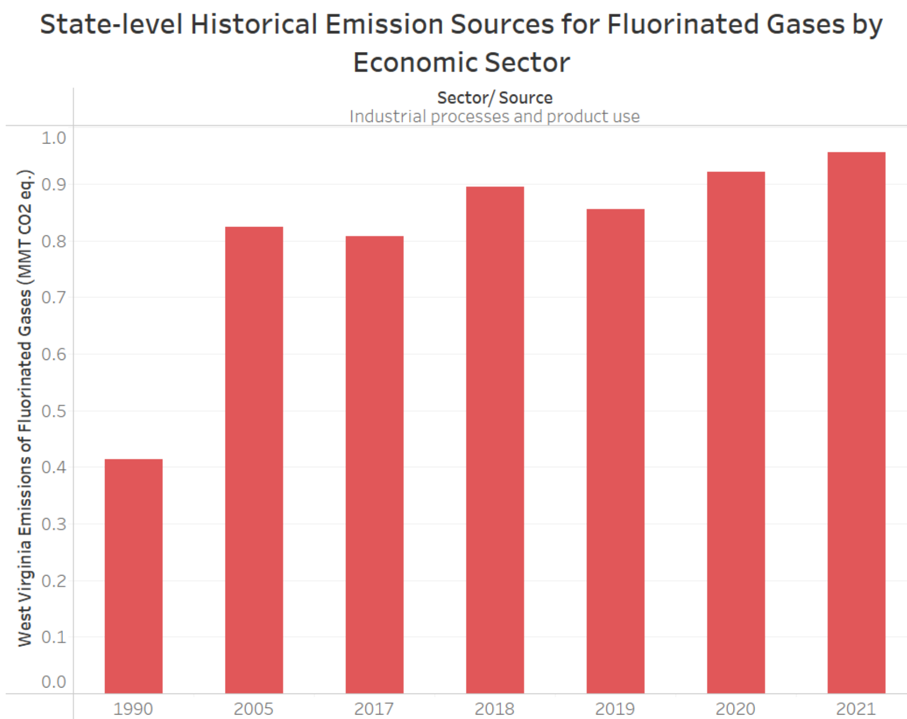

Figure 2.12. *Historic Data of Fluorinated Gas Emissions in WV Since 1990.*

Like other long-lived greenhouse gasses, most fluorinated gasses are well-mixed in the atmosphere, spreading around the world after they are emitted. Many fluorinated gasses are removed from the atmosphere only when they are destroyed by sunlight in the far upper atmosphere. In general, fluorinated gasses are the most potent and longest-lasting type of greenhouse gas emitted by human activities. Overall, fluorinated gas emissions in West Virginia have increased by about 130 % between 1990 and 2021 as shown in **Figure 2.12**. As a comparison, fluorinated gas emissions in the United States have increased by 105% between 1990 and 2021.

Figure 2.13 further details the contributions of each fluorinated gas in 2021. The emissions of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) have the biggest contribution to the total fluorinated gas emissions in West Virginia, which together account for about 96 % of total fluorinated gas emissions in 2021. They are used as refrigerants, aerosol propellants, foam-blowing agents, solvents, and fire retardants. Among them, almost all the emissions are HFCs, and the emission of PFCs is only about 0.013 %. The major emissions source of HFCs is their use as refrigerants. For example, they are used in air conditioning systems in both vehicles and buildings, which take 81.4 %.

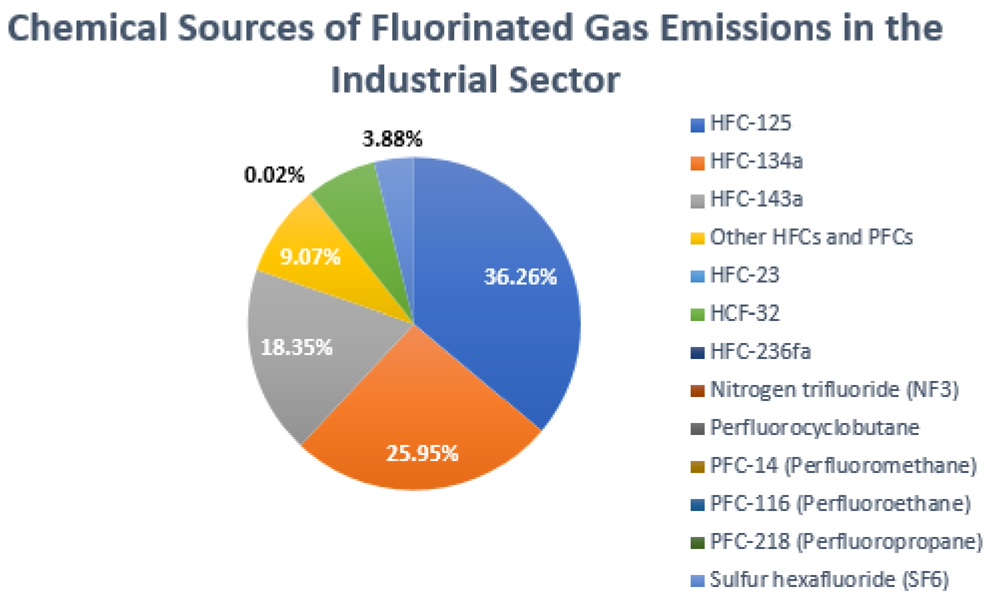

Figure 2.13. *Fluorinated Gas Contributions to GHG Emissions in 2021.*

Chemours Washington Works in Washington, WV is the only large facility reporting to the EPA of its fluorinated gas emissions in West Virginia. This factory produces chemicals used in semiconductors and in the manufacture of the non-stick product Teflon. **Figure 2.14** shows the fluorinated gas intensity map for WV which only shows the county where Chemours Washington Works is located.

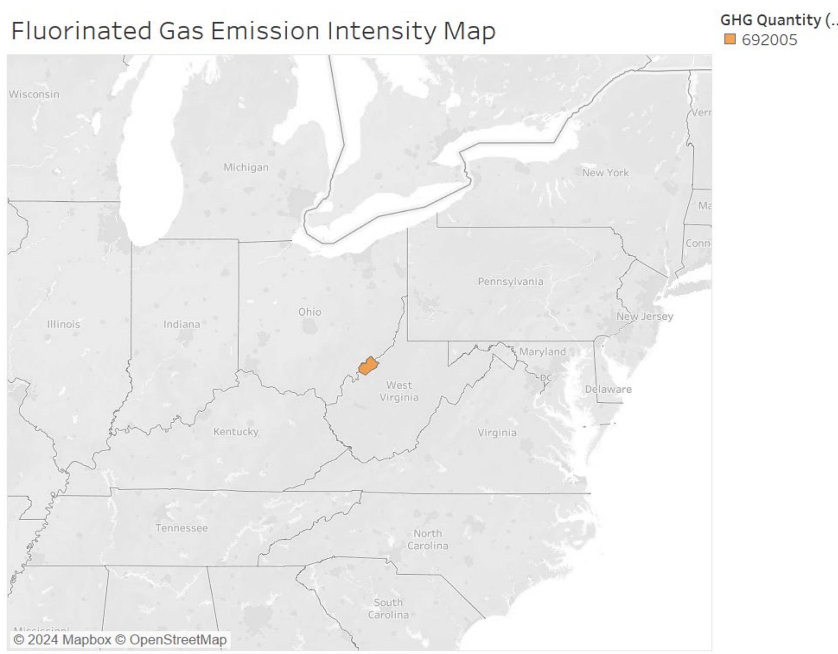

Figure 2.14. *WV Fluorinated Gas Emission Intensity Map.*

2.2 GHG Emissions Projections

This section provides a description of the priority policy, project, and program strategies and a prediction of the expected reduction in GHG emissions in West Virginia. The emission reduction forecast is a projection that will provide a directional overview from 2021 to 2050. In this PEAP, emphasis is placed on emissions reductions that will occur by 2030. Future emission reductions that will occur by 2050 will be built upon the work that will be completed prior to 2030. The initiatives that are described here will form the foundation for additional GHG reductions that will result from the implementation of the priority strategies defined in the priority initiatives. Further projected GHG reductions by 2050 will be provided in the Comprehensive Energy Action Plan (CEAP).

The GHG emissions projection begins with the calculation of a Business as Usual (BAU) case. This is the definition of emissions that would be expected absent any policy changes. The BAU is followed by the description of priority short-term actions on a per-sector basis and the calculation of emissions reductions that would result from each short-term policy action. The GHG emission reductions that are projected by 2030 are defined for each sector. A composite emission reduction projected for the State of West Virginia by 2030 is then compiled.

2.2.1 Business as Usual (BAU) Scenario

The GHG reduction quantification begins with the preparation of a BAU projection. The year 2021 is the base year for the emissions reduction calculation and 2021 is the first year in the BAU projection. The expected annual change in the emissions from each sector is based on projections from the Energy Policy Simulator (EPS) tool[13]. The EPS tool, developed by Energy Innovation and RMI, projects changes in GHG emissions within West Virginia through 2050 based on expected changes in the state's population, energy use, and fuel sources in the absence of policy actions. The shorter-term BAU projections through 2030 serve as the primary focus and the baseline for the PEAP.

The longer-term emissions in the BAU scenario through 2050 are shown in **Figure 2.15**. The projection for 2050 is that the emissions would decrease from 102.6 MMT CO2e to 99.0 MMT CO2e. The projection through 2030 is shown in **Figure 2.16**. This shows that by 2030, the emissions would decrease from 102.6 MMT CO2e to 94.6 MMT CO2e. This is due to economical adoption of emissions reducing technologies, like more efficient power generation, industrial, and commercial and residential building systems. Beyond 2030, the expected growth in the economy, population, and its energy use is expected to slightly increase emissions.

[13] West Virginia | Energy Policy Simulator, accessed 2-21-2024

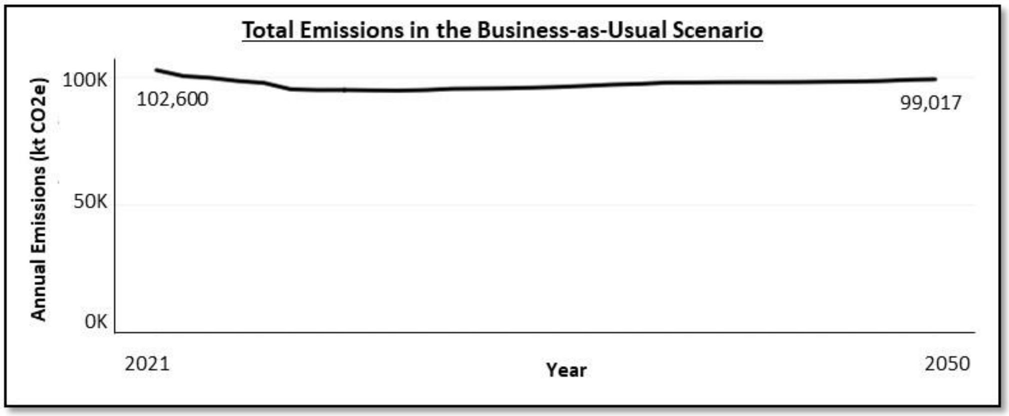

Figure 2.15. *Total WV GHG Emissions Through 2050 for the BAU Case*

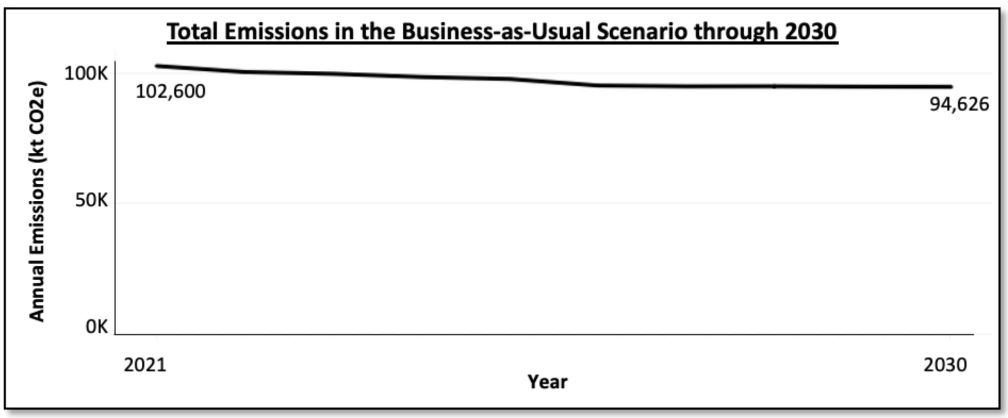

Figure 2.16. *Total WV GHG Emissions Through 2030 for the BAU Case*

The BAU scenario is also considered on a per-sector basis. The per-sector breakdown through 2030 is shown in **Figure 2.17**. Each BAU sector projection was developed individually in the EPS starting with that sector's 2021 emissions numbers. A description of the approach by sector is:

- **Electric Power Generation:** Projected based on EIA data on existing capacity, estimated demand, and expected electricity generation costs.
- **Industry:** Projections assume industrial energy use growth rate on an industry specific basis, based on an EIA energy outlook reference case . Industrial process emissions were forecasted based on the EPA's non-CO2 mitigation report .
- **Transportation:** Projections assume some expected fuel economy efficiency increases based on EPA standards and some economic adoption of EVs based on an NREL electrification study .
- **Commercial and Residential:** Projected based on a reference scenario from NREL and includes some electrification and efficiency improvements assumed in the BAU scenario.
- **Land Use and Agriculture:** Forecasted values are held constant, assuming land use and agricultural activities remain consistent.

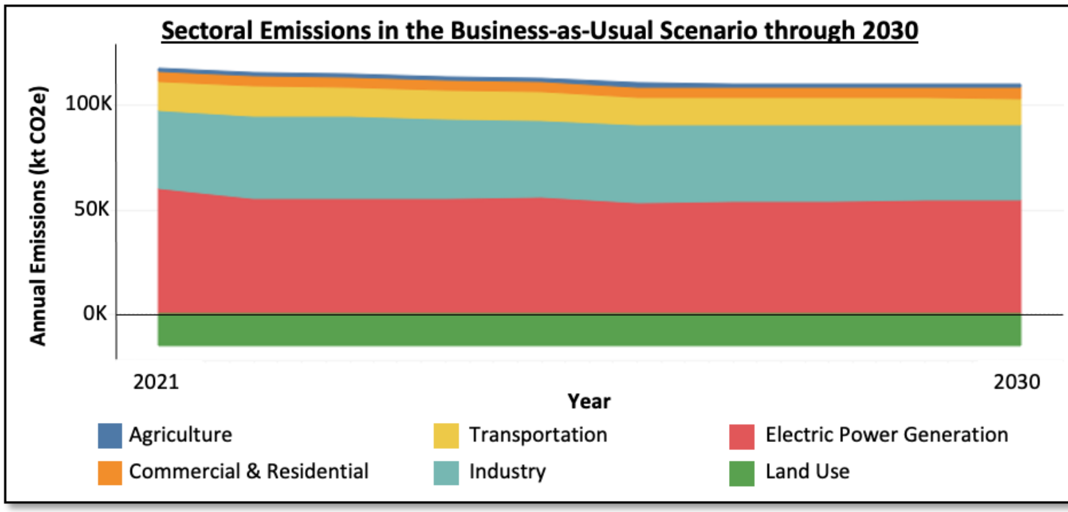

Figure 2.17. *WV GHG Emissions on a Per-Sector Basis through 2030 for the BAU Case*

2.2.2 Projected Reductions of GHG Emissions with Implementation of Priority Strategies

In 2021, the GHG emissions attributed to all sectors in WV, including the emissions reduction that result from Land Use, Land Use Change, and Forestry (LULUCF), were 102.6 MMT CO2e. The BAU case indicates that, absent policy intervention, the emissions would be expected to decrease to 94.6 MMT CO2e by 2030. With the incorporation of the GHG reduction measures described in **Section 2.4**, the emissions would be expected to be further reduced to 84.7 MMT CO2e by 2030. This is shown in **Figure 2.18.** This is a 10.5% reduction from the BAU and a 17.5% reduction from WV's total 2021 GHG emissions.

The priority strategies described in **Section 2.4** and others are expected to be implemented broadly in the state and are expected to continue to impact GHG emissions through 2050. A projection of these longer-term GHG reductions by 2050 will be provided in the Comprehensive Energy Action Plan (CEAP).

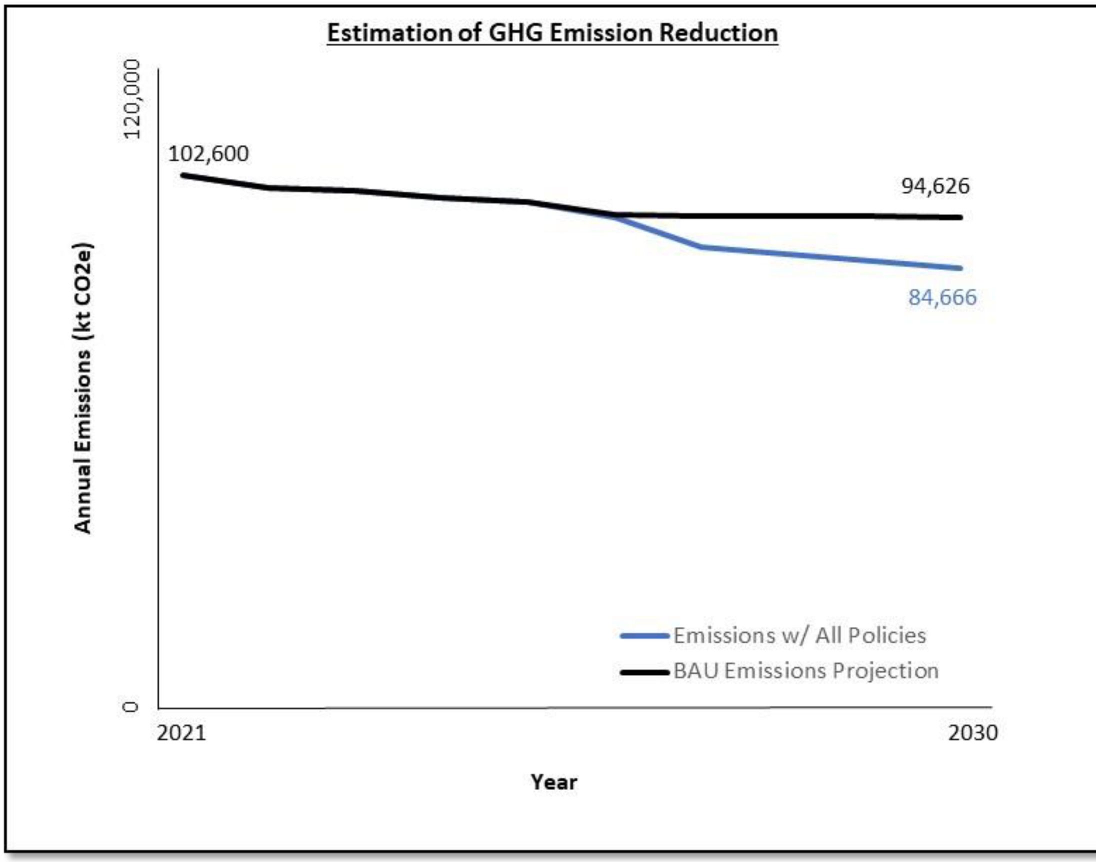

Figure 2.18. *Reduction in Overall GHG Emissions for West Virginia with Implementation of Priority Strategies*

2.3 GHG Reduction Measures

West Virginia's priority GHG Reduction Measures were developed in 2023-2024 through a process of public input through a series of statewide webinars and community feedback meetings. The priority GHG reduction measures seek to focus on the most significant sources of GHG emissions, while considering other relevant planning goals such as benefits to LIDACs, air pollution benefits, and other co-benefits.

2.3.1 Power Generation Sector Emissions Reduction Measures

As the largest source of statewide GHG emissions, WV's strategy seeks to implement three priority initiatives for the power generation sector. These are Efficiency Improvements of Existing Plants, New Base Load Generation, and Carbon Capture and Sequestration (CCS).

Efficiency Improvements in Existing Fossil Fuel-Fired Power Plants

The State's priority strategies include supporting projects that improve energy efficiency of existing coal-fired power plants. The goal of this strategy is to reduce the carbon intensity of coal-fired generation facilities within West Virginia. Potential examples of energy efficiency improvement opportunities may include (but are not limited to) neural network/intelligent soot blowers, boiler feed pumps, air heaters and duct leakage control, variable frequency drives, blade path upgrades, redesigned economizers, and others. The GHG reduction projections for the Power Generation sector illustrated in **Section 2.4.1.4** assume that such efficiency improvements will be implemented on two coal-fired plants.

Annual GHG emissions reduced in 2030:
463 kT CO2e

Implementing Agency:
West Virginia Office of Energy

Preliminary Funding Source:
CPRG Implementation Grant

Improving the efficiency of fossil-fuel fired power plants can decrease coal consumption, resulting in reduced emissions per unit of electricity compared to traditional plants. This approach mitigates CO_2 and other greenhouse gas (GHG) emissions linked with electricity generation and fuel combustion, like CH_4 and N_2O. It also diminishes gaseous and particulate emissions related to coal-fired combustion and electricity generation, including NOx, SOx, particulate matter (PM2.5), and volatile organic compounds (VOCs).

New Baseload Generation from Lower Carbon Sources including Nuclear, Geothermal, Hydrogen, Hydropower, and Combined Cycle Gas Turbine Plants

The State's GHG reduction strategy will support the development of new baseload power generation infrastructure sourced from lower-carbon technologies such as small modular nuclear reactors (SMRs), geothermal energy, hydrogen, hydropower, and combined cycle gas turbine (CCGT) plants. This initiative recognizes the importance of ensuring reliable energy supply while simultaneously addressing the need to mitigate greenhouse gas emissions. While the broader strategy includes developing multiple sources of baseload generation across all of these generation alternatives, for the purposes of the quantified impact of this policy, we assumed only that this program would fund one 200 MW SMR facility and one 1,300 MW CCGT facility. It is assumed that the SMR facility would be operational in 2032 and the CCGT facility in 2027.

Annual GHG emissions reduced in 2030:
4,237 kT CO2e

Implementing Agency:
West Virginia Office of Energy

Preliminary Funding Source:
CPRG Implementation Grant

By investing in these low-carbon technologies, the initiative anticipates significant reductions in emissions of various greenhouse gases. For instance, SMR facilities produce electricity without emitting CO_2 during operation, thus directly reducing carbon emissions associated with fossil fuel-based power generation. Similarly, CCGT, while still utilizing natural gas, operates more efficiently than traditional gas plants, resulting in lower CO_2, CH_4 and N_2O emissions per unit of electricity, when compared with coal-fired plants.

Carbon Capture and Sequestration Permitting and Geological Studies

The objective of this GHG reduction measure is to create and support a regulatory and technical environment that encourages the development of carbon capture and sequestration (CCS) projects within West Virginia. The development of CCS projects will be promoted in a variety of ways, such as support for geologic studies that identify promising sites for carbon sequestration and obtaining class VI well primacy to create a more streamlined permitting environment. This program will encourage CCS development through the reduction of risk associated with early exploration and consideration of carbon capture technologies, increased awareness and understanding of the potential benefits and challenges associated with carbon capture, and the creation of a supportive ecosystem for industry stakeholders to engage with carbon capture experts and resources as they consider investing in CCS facilities. This program will work in concert with other activities occurring in West Virginia around CCS including the development of the DOE's Clean Regional Hydrogen Hub.[14]

Annual GHG emissions reduced in 2030:
Not calculated because strategy will not directly result in CCS facility installation prior to 2030

Implementing Agency:
West Virginia Office of Energy

Preliminary Funding Source:
CPRG Implementation Grant

The implementation of this policy will encourage efforts to implement CCS facilities within the state through a more certain regulatory framework and identification of potential sites. The CCS program in the power generation sector will concentrate on reduction of emissions from fossil fuel fired power plants.

Given that this policy is exploratory and intended to incentivize installation of CCS technologies, no GHG reduction is included prior to 2030.

GHG Reduction Projections for the Power Generation Sector

In 2021, the GHG emissions attributed to power generation was 60.1 MMT CO2e. The BAU case indicated that the emissions would be 54.9 MMT CO2e in 2030. With the implementation of the GHG reduction measures described above, WV's Power Generation sector emissions are projected to be reduced to 52.2 MMT CO2e. This projection is shown in **Figure 2.19**. This is an 8.6% reduction from the BAU and a 16.3% reduction from 2021.

[14] DOE's Clean Regional Hydrogen Hub, [Regional Clean Hydrogen Hubs | Department of Energy], accessed 2-17-24.

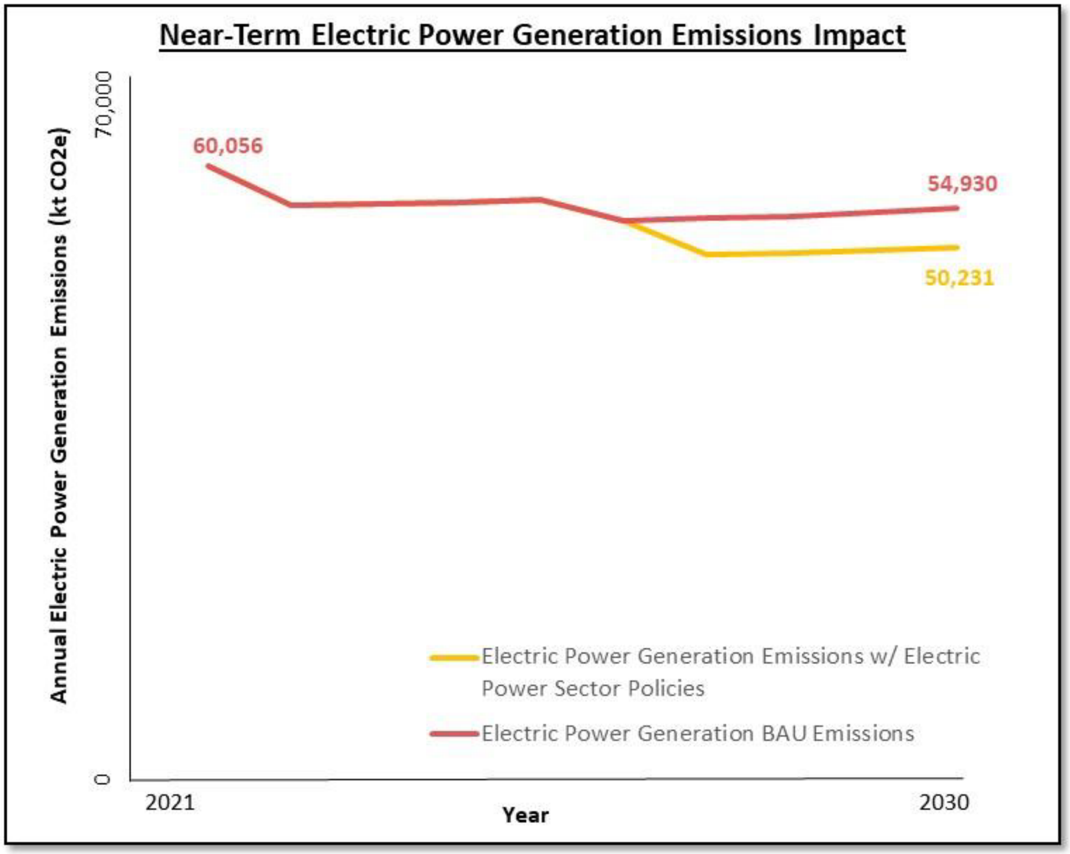

Figure 2.19. *Reduction in GHG Emissions for the Power Generation Sector*

2.3.2 Industrial GHG Emissions Reduction Measures

There are four priority initiatives for the Industrial sector. These are Carbon Capture and Sequestration Permitting and Geological Studies, Methane Leakage Reduction from Coal Mines, Methane Leakage Reduction from Oil and Gas, and Efficiency Improvements in Industrial Facilities.

Carbon Capture and Sequestration Permitting and Geological Studies

The policy will extend to the industrial sector the CCS policy initiatives that were described above for the power generation sector. This will extend to industrial facilities the regulatory and technical policies that encourage the development and use of CCS projects in West Virginia. This will address the many sources of CO_2 emissions that could be reduced through carbon capture from industrial facilities, such as those from refineries, chemical plants, and steel mills.

Given that this policy is exploratory and intended to incentivize installation of CCS technologies, the projections for industrial GHG emission reductions do not include impacts from this measure prior to 2030.

Annual GHG emissions reduced in 2030:
Not calculated because strategy will not directly result in CCS facility installation prior to 2030

Implementing Agency:
West Virginia Office of Energy

Preliminary Funding Source:
CPRG Implementation Grant

Methane Leakage Reduction and Use from Coal Mines

This policy will provide support to projects that reduce methane emissions at West Virginia's active and abandoned coal mines. Projects that both reduce methane emissions and make waste methane available for economic use, such as in power generation or for use in place of natural gas, will be particularly encouraged. The program is expected to be structured as a competitive process within the State, and projects that represent the most cost-effective opportunities for methane emissions reduction and use will be prioritized through the competitive process.

Annual GHG emissions reduced in 2030:
2,465 kT CO2e

Implementing Agency:
West Virginia Office of Energy

Preliminary Funding Source:
CPRG Implementation Grant

Methane is a potent greenhouse gas, and reduction of methane emissions from active and abandoned coal mines will be critical to reducing the state's overall GHG emissions. West Virginia's coal mines accounted for 14.3 MMT CO2e in 2021. Reducing methane emissions from coal mines will also improve air quality, as these emissions contribute to harmful air pollutants in communities that have historically been associated with mining activities.

Methane Leakage Reduction from Oil and Gas Systems

Under the Methane Emissions Reduction Program (MERP)[15], supported by the US EPA and DOE, the WV Department of Environmental Protection (DEP) is developing a program that aims to reduce methane emissions from marginal conventional oil and gas wells. The program will provide financial and technical assistance to owners and operators to voluntarily and permanently plug these wells, monitor and quantify methane emissions before and after the plugging activities, and facilitate well site restoration in accordance with state rules and regulations.

Annual GHG emissions reduced in 2030:
Not calculated as there are research measurements required in order to reliably estimate expected impact

Implementing Agency:
West Virginia Department of Environmental Protection

Preliminary Funding Source:
Financial and Technical Assistance from MERP

The implementation of this policy will encourage industry efforts to cut methane emissions from oil and gas wells and support environmental restoration of these sites. This initiative will result in a direct reduction in greenhouse gas emissions, support healthier ecosystems, and promote cleaner air for communities across West Virginia.

Efficiency Improvements in Industrial Facilities

This policy is designed to support energy and emissions audits of industrial facilities across the state to identify economically viable energy efficiency improvements for those facilities. This program seeks to make implementable recommendations to facilities to help them modernize their systems and processes, thereby reducing emissions of various harmful pollutants. Through this initiative, industrial facilities can access support for audits that identify a wide range of economically and technically feasible emissions reduction projects, such as energy efficiency

[15] Methane Emissions Reduction Program | US EPA, accessed 2-17-24.

upgrades, electrification of operations, process optimization, waste-heat recovery, conversion to low-carbon fuels, emission control technologies, and others.

Annual GHG emissions reduced in 2030:
2,652 kt CO2e

Implementing Agency:
West Virginia Office of Energy

Preliminary Funding Source:
Existing WVOE allocations

Transitioning from fossil fuel combustion to electric-powered machinery reduces emissions of CO_2, NOx, SOx, and particulate matter. Implementing energy-efficient technologies reduces overall energy consumption and, consequently, emissions of CO_2 and other pollutants associated with delivering the facility's energy.

GHG Reduction Projections for the Industrial Sector

In 2021, the Industrial Sector GHG emissions were 37.5 MMT CO2e. The BAU case projects that the emissions would be 35.8 MMT CO2e in 2030. With the incorporation of the industrial sector GHG reduction measures, the emissions would be reduced to 30.7 MMT CO2e. As shown in **Figure 2.20**, implementation of the State's priority strategies for the industrial sector is projected to result in a 14.3% reduction from the BAU and an 18.1% reduction from 2021.

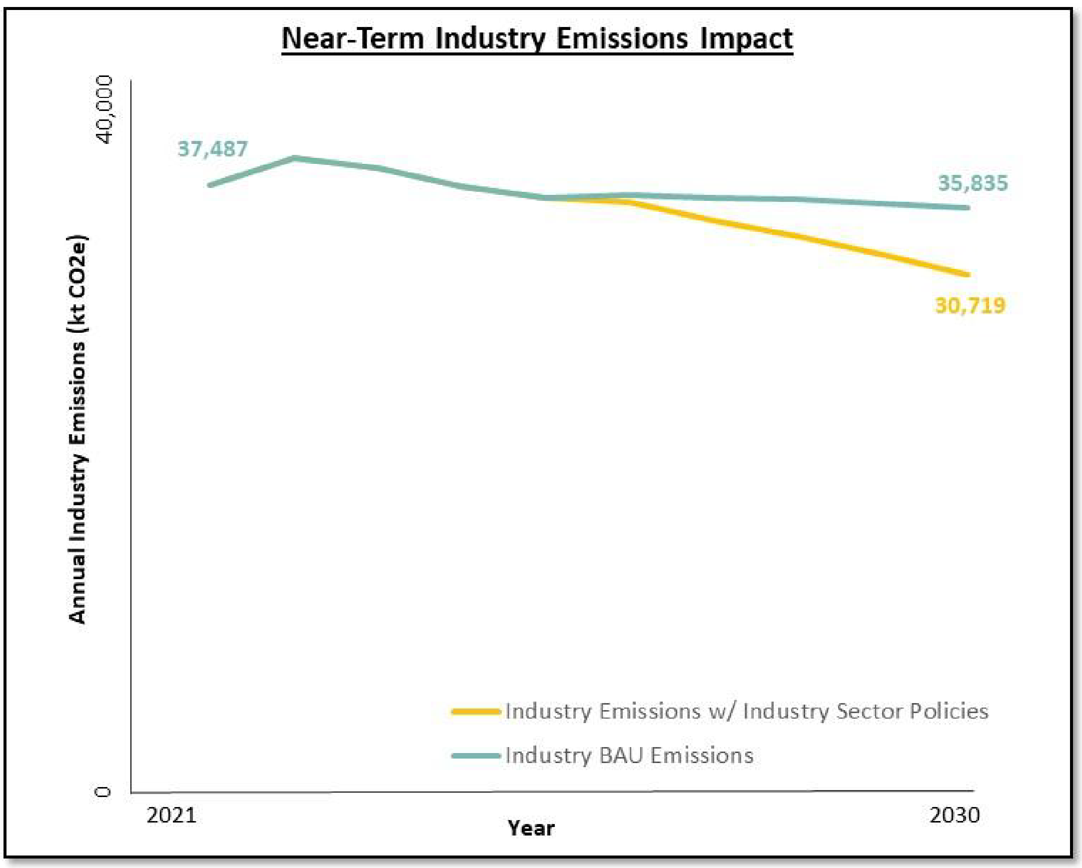

Figure 2.20. *Reduction in GHG Emissions for the Industrial Sector*

2.3.3 Residential and Commercial Emissions Reduction Measures

West Virginia's priority GHG emission reduction strategies for the Residential and Commercial sector include: conducting energy audits of state, county, and local government buildings; implementing GHG reduction programs for state government buildings; and broadly encouraging energy efficiency initiatives in the Residential and Commercial building sector.

Energy Audits for State, County, and Local Government Buildings

This policy has two major components. First, it will support the addition of automated energy use tracking software on state owned buildings. This software will be used to identify buildings with disproportionately high energy usage that may have cost-effective energy efficiency improvement opportunities. This energy use tracking software will additionally be made available to county and local governments for implementation on their buildings.

The second major component of this policy measure will be energy audits on the government owned buildings that have been identified to have disproportionately high energy use. These audits will analyze the building's current energy consumption trends and identify opportunities to reduce energy losses. The prioritized list of these opportunities will serve as the input to the policy "GHG Reduction Programs for State Government Buildings."

Annual GHG emissions reduced in 2030:
Not calculated because expected emissions impact comes from *GHG reduction Programs* strategy

Implementing Agency:
West Virginia Office of Energy

Preliminary Funding Source:
CPRG Implementation Grant

The addition of monitoring software and performing energy audits, on their own, will not reduce carbon emissions, but is a necessary precursor to the policy "GHG Reduction Programs for State Government Buildings" that will implement projects that reduce emissions on state owned buildings. Doing this analysis of energy usage first allows for the most cost-effective energy efficiency improvement projects at the system-wide level to be selected for implementation, striving for the maximal GHG emissions reductions possible with the funding.

GHG Reduction Programs for State Government Buildings

This policy measure includes the enactment of projects identified in the policy "Energy Audits for State, County, and Local Government Buildings" aimed at improving energy efficiency and reducing carbon emissions in a multitude of ways in state-owned commercial buildings. The state will prioritize the state-owned buildings to enact these projects based on the audits' identification of the most cost-effective pathways to emissions reduction. The programs will fund efficiency improvement projects such as (but not limited to) energy efficiency and green roofing on state universities, lighting upgrades, water conservation, HVAC system optimization, energy efficient appliances and equipment, building automation systems, and solar paneling to offset energy use.

Annual GHG emissions reduced in 2030:
143 kt CO2e

Implementing Agency:
West Virginia Office of Energy

Preliminary Funding Source:
CPRG Implementation Grant

By making improvements to the energy efficiency of buildings, CO_2 emissions associated with energy consumption can be reduced. This will result in lower carbon emission per unit of electricity produced compared to the buildings without the energy efficiency improvements.

Energy Efficiency in the Residential and Commercial Building and Construction Sector

The state's climate pollution reduction strategy also broadly encourages energy efficiency initiatives in the residential and commercial building sector, including encouraging individual counties to submit proposals for energy efficiency initiatives in residential and commercial construction.

Annual GHG emissions reduced in 2030:
Not calculated as no specific WV government policy is planned

Implementing Agency:
Individual Counties and Municipalities

GHG Reduction Projections for the Residential and Commercial Sector

In 2021, the GHG emissions attributed to the residential and commercial sector were 4.9 MMT CO2e. The BAU case indicated that the emissions would be 5.0 MMT CO2e in 2030. With the implementation of the priority strategies for the residential and commercial sector, the emissions would be reduced to 4.8 MMT CO2e. As shown in **Figure 2.21**, these priority measures are projected to result in a 2.8% reduction from the BAU and a 1.5% reduction from 2021.

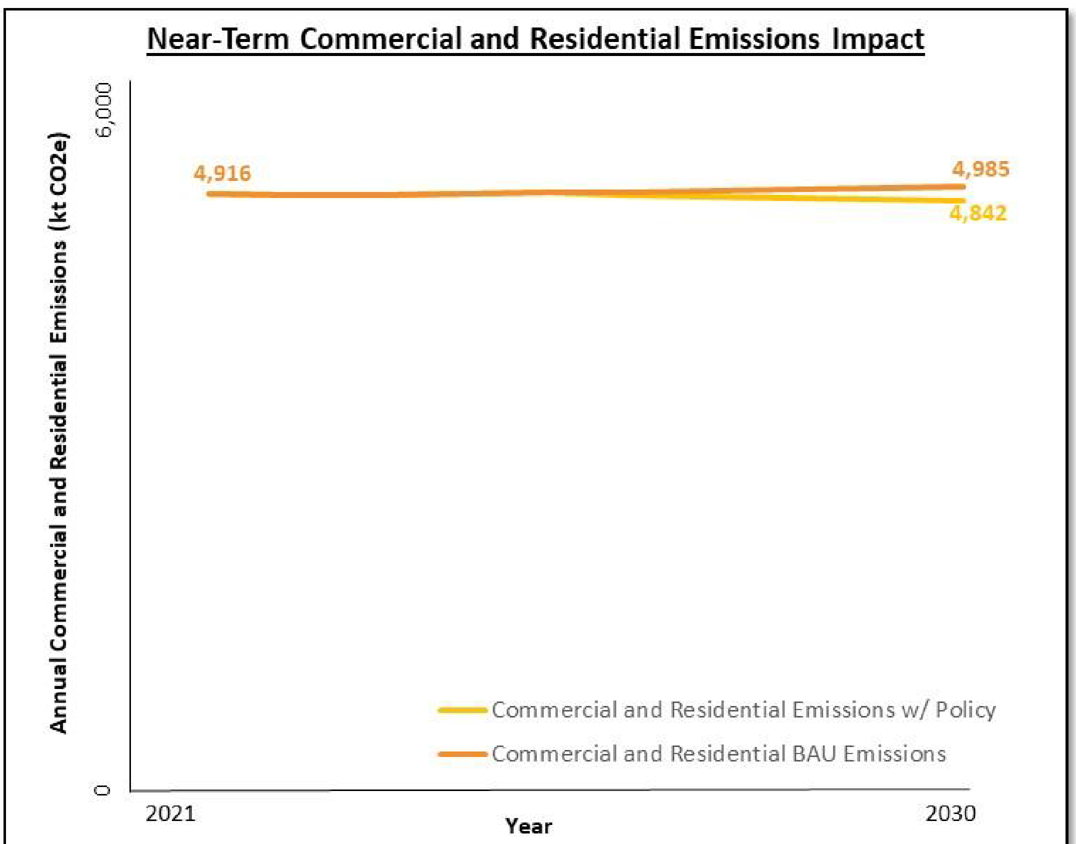

Figure 2.21. *Reduction in GHG Emissions for the Residential and Commercial Sector*

2.3.4 Transportation GHG Emissions Reduction Measures

Annual GHG emissions reduced in 2030:
Not calculated because implementation of specific strategies is dependent on prioritization of broader DOT projects

Implementing Agency:
West Virginia Department of Transportation

Preliminary Funding Source:
Federal Highway Administration Carbon Reduction Program

The State's strategies for the Transportation Sector have been developed as part of West Virginia's Carbon Reduction Strategy (WVCRS) which seeks to align with federal requirements and guidance to reduce carbon emissions produced by the transportation sector. These requirements were established as part of the Carbon Reduction Program (CRP)[16], authorized by the Infrastructure Investment and Jobs Act (IIJA).

The program employs strategies aimed at reducing the vehicle miles traveled (VMT) within the state through programs that promote the use of alternative transportation technologies like bicycle and pedestrian facilities, increasing the availability of transit that provide an alternative to single user vehicles, and micromobility support that provides facilities that makes the use of e-bikes and scooters easier.

The program also seeks to make improvements of the GHG impacts of the State's transportation network through low/zero carbon emission road construction equipment, sustainable pavement practices, and energy efficient streetlights. These infrastructure changes will improve energy efficiency and reduce carbon-emitting production. In addition, the program will incorporate the use of alternative fuel vehicles by incentivizing lower carbon vehicle types and building charging stations for electric vehicles, further reducing the carbon emissions from VMT.

This policy is aimed at reducing the state's transportation related emissions, which were 13.7 MMT CO2e in 2021. It will reduce the number of vehicle miles traveled with transit improvements and bike facilities, which in turn will reduce carbon emissions produced.

3 Low Income Disadvantaged Communities Benefits Analysis

The greenhouse gas reduction measures described in **Section 2.4** have the potential to provide significant economic benefits to low-income and disadvantaged communities (LIDACs) in the state of West Virginia. In this section, we define what we mean by LIDACs and discuss some of the climate risks associated with these communities in West Virginia. We then provide an overview of current economic conditions in LIDAC and non-LIDAC counties, followed by a discussion of how some of the GHG reduction measures may affect these communities.

3.1 Identifying LIDACs and EnvironmentalImpacts and Risks

The first step in assessing the environmental and economic impacts of GHG reduction to local communities is to identify which areas are considered low-income and disadvantaged communities (LIDACs). The project team decided to adopt the definition of LIDAC from the CEJST[17] provided by the Council on Environmental Quality, part of the Executive Office of the President. The CEJST identifies disadvantaged census tracts across eight risk categories related to the environment, energy, health, and socioeconomics. Within each disadvantaged category there are a number of individual criteria that are

[16] Bipartisan Infrastructure Law - Carbon Reduction Program | Federal Highway Administration, accessed 2-21-24
[17] Climate and Economic Justice Screening Tool. The CEJST is available at https://screeningtool.geoplatform.gov/

used to assess the level of disadvantage, such as projected flood risk, air pollution, and heart disease rates, among others. In general, the census tract would be considered disadvantaged if it meets or exceeds the 90th percentile of each criterion compared with the nation and if the tract has a low-income burden above 65%.[18] In addition, if a tract is surrounded by disadvantaged communities, and it meets an adjusted low-income threshold that is greater than or equal to the 50th percentile, that tract is also considered disadvantaged.

The EPA considers the CEJST tool the preferred measure for establishing economic disadvantage across communities for the CPRG process. The CEJST provides data on disadvantaged communities at the level of census tracts. To create our list, we downloaded the CEJST Version 1.0 communities list and filtered it for tracts in West Virginia. We then compiled these data in a spreadsheet that is included with this report. The census tracts identified as disadvantaged by the CEJST tool are shown in **Figure 3.1**.

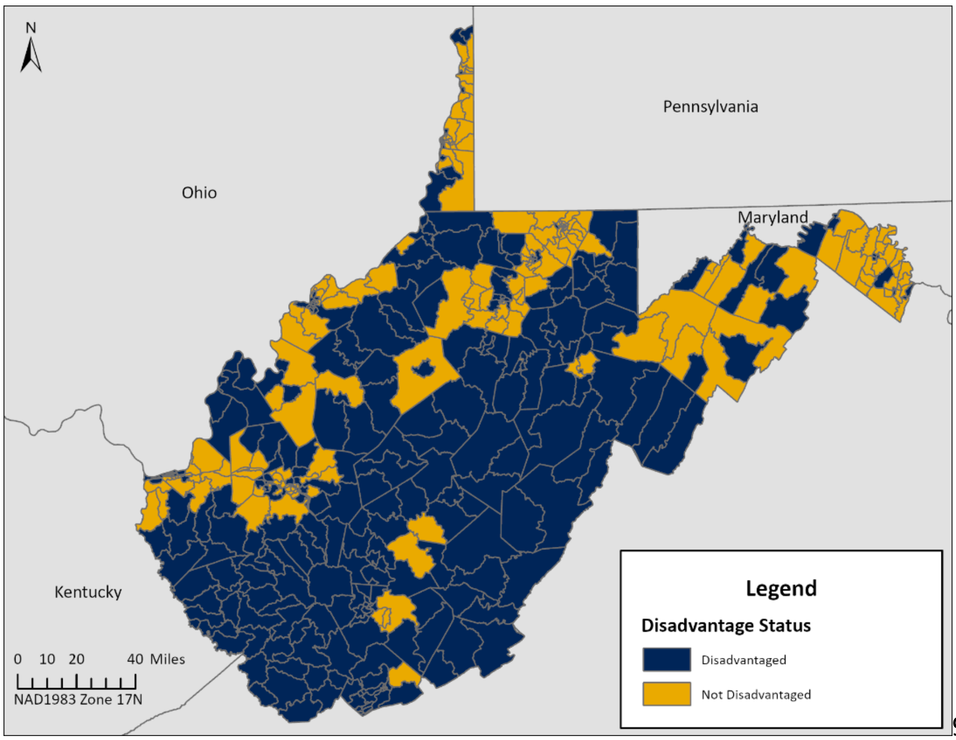

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Figure 3.1. *Disadvantaged Census Tracts Identified by the CEJST are Shown in Blue. The CEJST identifies disadvantaged census tracts across eight categories related to environmental risk, energy, health, and socioeconomics.*

While we consider the CEJST tract-level data the official measure of disadvantaged communities, we also require measurements of disadvantage at different levels of geography. Much of the economic data

[18] CEQ. 2022. "Climate and Economic Justice Screening Tool Technical Support Document." White House Council on Environmental Quality. https://static-data-screeningtool.geoplatform.gov/data-versions/1.0/data/score/downloadable/1.0-cejst-technical-support-document.pdf.

we use is available only on a county level, for example. Also, zip codes may be more understandable to community members than their census tract. Thus, we created measures of disadvantage at the county and zip code levels, which are listed in the second and third tab of the attached spreadsheet.

For the county measure we calculated the ratio of census tracts listed as disadvantaged in the CEJST data to the total number of tracts in the county. We then broke the counties into three categories:

1. Entirely Disadvantaged;
2. Majority Disadvantaged;
3. Zero to Minimal Disadvantage.

The first category is for those counties where all the census tracts in the county are identified as disadvantaged in the CEJST dataset. These counties would likely have significant economic and environmental hardship across the entire county. Majority Disadvantaged counties are those where more than 50% of the census tracts are identified as disadvantaged. We would consider these counties to also face considerable disadvantages. The last classification is for counties that have less than 50% of their census tracts, including zero, identified as disadvantaged. These counties would face a lesser degree of hardship from the various impacts identified in the CEJST tool.

Measuring disadvantage at the zip code level may be useful as the EnergyWise West Virginia program moves forward. However, zip code boundaries do not fit neatly within the boundaries of census tracts and thus are not as easily calculated. To establish whether a zip code should be considered disadvantaged, we mapped the CEJST census tract data in GIS software (ArcGIS Pro) and then superimposed that data on a map of postal zip codes provided by ESRI, [19] which approximates the geographical boundaries of US Postal Service zip codes. We then calculated the percentage of the geographical area of each zip code that fell within a disadvantaged census tract. This is reported in the "Percent Disadvantaged" column of the spreadsheet. Using this percentage, we divided the zip codes into the same three categories as the county data. A description of the data follows in **Tables 3.1 through 3.3.**

Table 3.1. *Disadvantaged Census Tracts Description*

Field	Description
FIPS	The Census Bureau FIPS code for the tract
County Name	Name of the County in which the tract is located
Identified as Disadvantaged	Identifier for whether the tract is disadvantaged in the CEJST dataset

Table 3.2. *Disadvantaged County Description*

Field	Description
FIPS	US Census County FIPS code
County Name	Name of the county

[19] The zip code shapefile is available at https://www.arcgis.com/home/item.html?id=8d2012a2016e484dafaac0451f9aea24

Percent Disadvantaged	Percentage of the tracts in the county that are disadvantaged
Disadvantage Code	Numeric code identifying the disadvantage category
Disadvantage Category	The category of disadvantage defined above

Table 3.3. *Disadvantaged Zip Codes Description*

Field	**Description**
Zip Code	US Postal Service Zip Code
Post Office Name	Name of the US Post Office serving this Zip Code
Percent Disadvantaged	Percentage of the tracts in the zip code that are disadvantaged
Disadvantage Code	Numeric code identifying the disadvantage category
Disadvantage Category	The category of disadvantage defined above

3.2 Environmental Risks, Impacts, and Vulnerabilities

Most disadvantaged tracts in West Virginia are low-income and have low educational attainment. According to the EPA's CCSVUS Report,[20] the populations in these areas have greater environmental risks, especially related to air pollution, resulting in increased vulnerability to premature death and childhood asthma. Additionally, West Virginia has higher populations of those ages 65 and older and those with diabetes who are also exposed to air pollution which can also lead to pulmonary and heart diseases, premature deaths, and other complications from diabetes. Additionally, the report shows that West Virginia's disadvantaged tracts are also at high risk to inland flooding especially those tracts with lower educational attainment and a higher percentage of residents ages 65 and older. In all cases, as shown in the report, these vulnerabilities are expected to increase. These environmental risks are reflected by the criteria the CEJST uses to define disadvantaged communities, and defined above. In **Table 3.4** we show the criteria with the largest number of census tracts in West Virginia that meet the CEJST definition of disadvantage.

[20] EPA. 2021. *Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts*. US Environmental Protection Agency, EPA 430-R-21-003. https://www.epa.gov/cira/social-vulnerability-report.

Table 3.4. *Top 10 Criteria Associated with Disadvantage in West Virginia*

Criterion	**Census Tracts Meeting this Criterion**	**Percent of Total**
Greater than or equal to the 90th percentile for heart disease and is low income?	266	55%
Greater than or equal to the 90th percentile for share of properties at risk of flood in 30 years and is low income?	160	33%
Greater than or equal to the 90th percentile for diabetes and is low income?	119	25%
Greater than or equal to the 90th percentile for asthma and is low income?	111	23%
Greater than or equal to the 90th percentile for DOT transit barriers and is low income?	105	22%
Greater than or equal to the 90th percentile for wastewater discharge and is low income?	85	18%
Greater than or equal to the 90th percentile for low life expectancy and is low income?	83	17%
Greater than or equal to the 90th percentile for unemployment and has low HS attainment?	68	14%
Greater than or equal to the 90th percentile for energy burden and is low income?	60	12%
Greater than or equal to the 90th percentile for households at or below 100% federal poverty level and has low HS attainment?	51	11%

The most prevalent disadvantage criterion in West Virginia is the heart disease rate. Approximately 55% of census tracts in West Virginia have a heart disease rate higher than the 90th percentile compared with tracts nationally (**Figure 3.2**) and are low income. Flood risk is also an extensive problem in West Virginia, particularly in the central and southern regions of the state (**Figure 3.3**). More than one-third of census tracts in the state have an elevated risk of inland flooding.

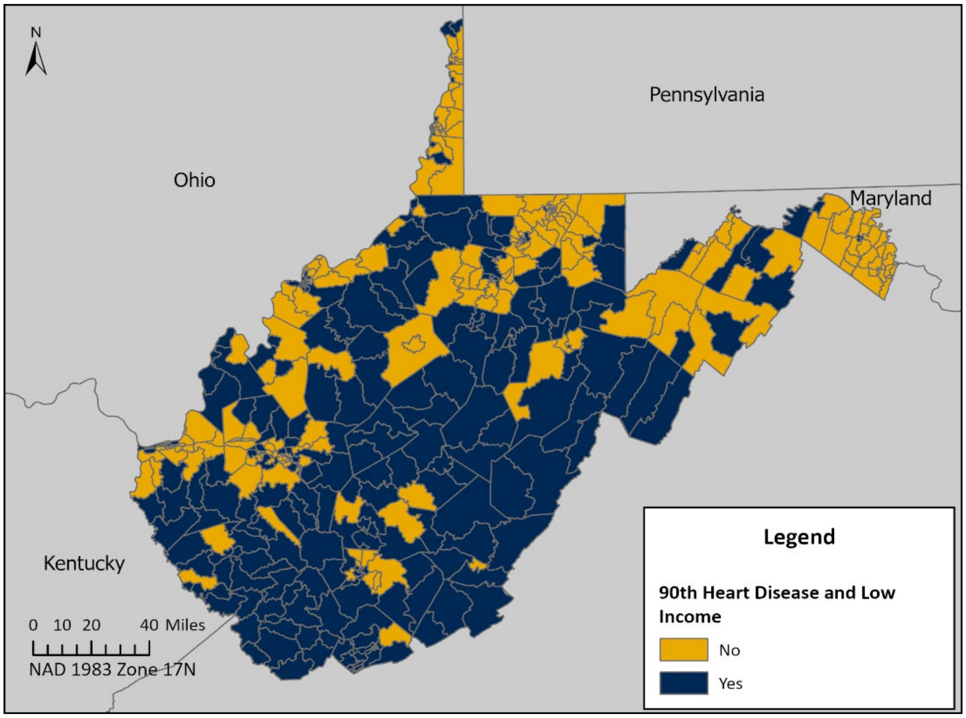

Figure 3.2. *West Virginia Counties with Heart Disease Levels Greater Than 90th Percentile Nationally. More than half of West Virginia Counties meet this criterion.*

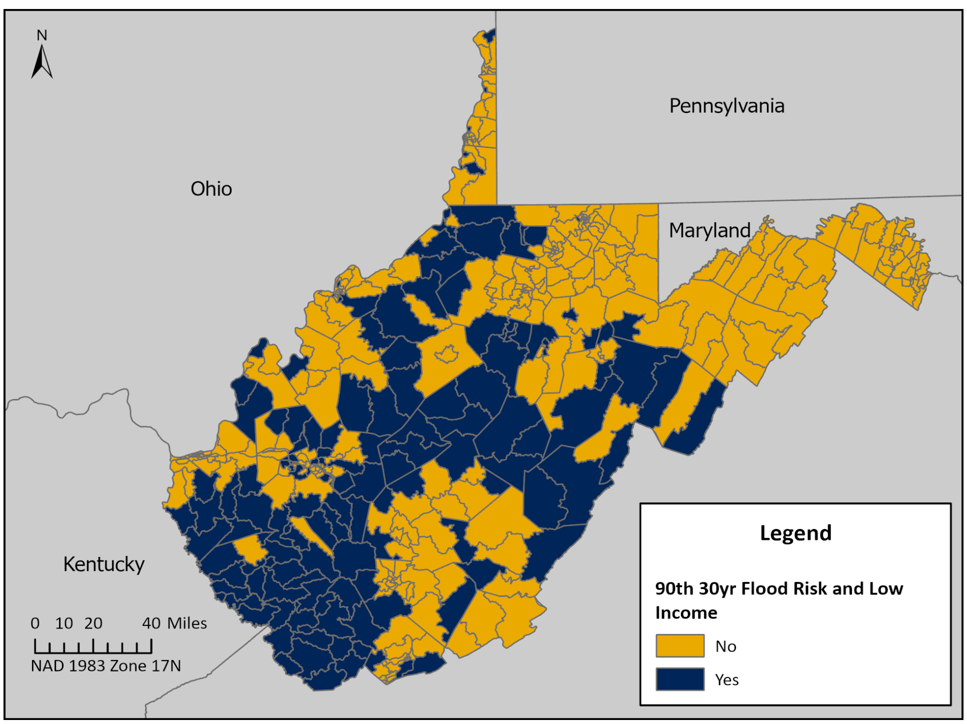

Figure 3.3. *West Virginia Counties with a 30-Year Flood Risk Above the 90th Percentile Nationally. About one-third of census tracts in West Virginia are at risk for inland flooding.*

3.3 Engaging with LIDACs to Understand Community Priorities

Throughout the PEAP process, the EnergyWise West Virginia project team has had meaningful engagement with stakeholders in LIDACs to ensure that their existing needs and desired outcomes are integrated into the emissions reduction measure identification and implementation processes. Through these engagements, the project team has recognized the knowledge of community values, concerns, practices, and local norms and history that LIDAC members are uniquely able to provide.

To incorporate feedback from these communities, the project team has done the following:

- Conducted virtual meetings with stakeholders;
- Communicated transparently with LIDAC and non-LIDAC stakeholders throughout the PEAP planning process;
- Had various and frequent engagement with these stakeholders;
- Received and implemented feedback from stakeholders and;
- Considered the impact on LIDAC residents of proposing potential priority areas for greenhouse gas emissions reductions.

More specifically, in January 2024, the project team conducted a series of three public stakeholder focus groups to better understand community needs for greenhouse gas reduction programs. The agency invited nearly 750 stakeholders from energy and manufacturing industries, labor groups, government, and environmental organizations, among others. Of these, 65 individuals participated in the public meetings. As shown in **Table 3.5**, 22 of these participants either did not provide their location or were from outside the state. Of the remaining group, a little more than half of the participants are located in communities with significant disadvantage, according to the CEJST definitions (at the county level). The project team has also received written communications from other stakeholders.

Table 3.5: *Number of Participants in Stakeholder Forums*

Disadvantaged County Category	Participants
Entirely Disadvantaged	3
Majority Disadvantaged	20
Zero to Minimal Disadvantage	20
Other	22
Total	**65**

3.3.1 Overview of LIDAC Counties

As may be expected, LIDAC counties in West Virginia have lower economic vitality than non-disadvantaged communities. As shown in **Figure 3.4**, the large majority of West Virginia counties have some measure of disadvantage. Of the 55 counties in the state, 20 are entirely disadvantaged, meaning that all census tracts in the county are identified as disadvantaged in the CEJST dataset. Another 22 counties have more than half of their tracts in the disadvantaged category, while 13 have fewer than half or no disadvantaged tracts. The disadvantaged counties are spread fairly evenly across the state.

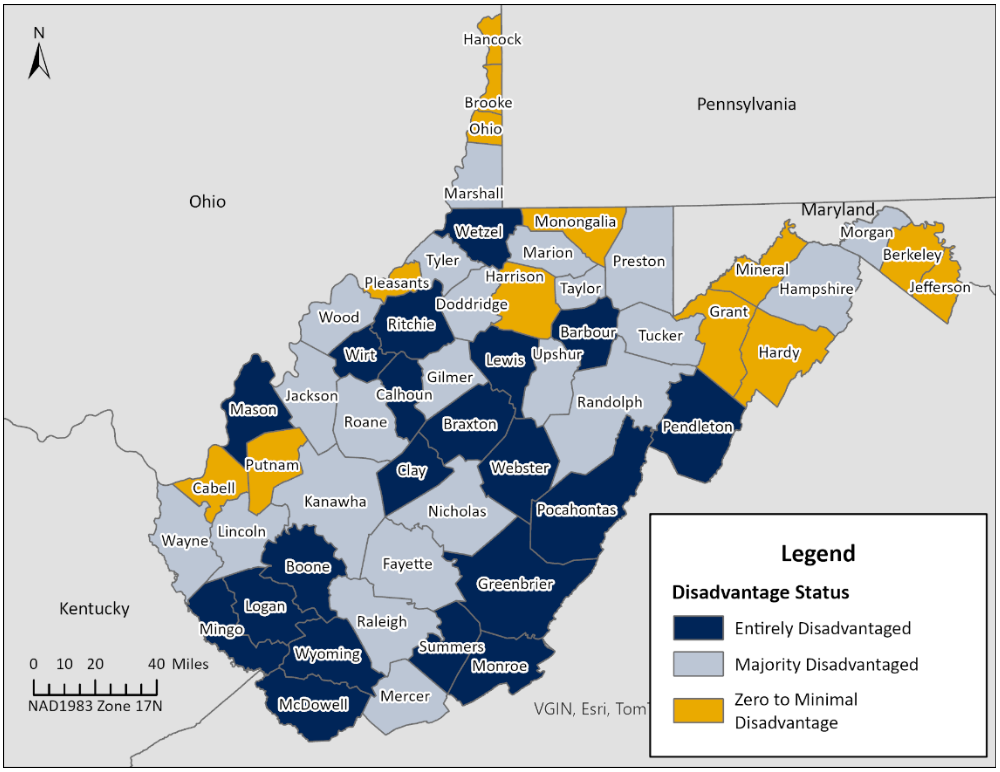

Figure 3.4. *Disadvantage Status Category for West Virginia Counties. Approximately three-quarters of West Virginia counties are either entirely or majority disadvantaged.*

As shown in **Figure 3.5**,[21] entirely disadvantaged counties tend to be more rural with lower population than counties with lower disadvantaged status. The 20 entirely disadvantaged counties make up more than a third of the number of counties in the state but contained just over 17% of total population in 2022. Minimal disadvantaged counties contained nearly 37% of the state's population, and this is the only category where population increased over the previous decade.

Employment follows a similar pattern as population over the previous decade. In **Figure 3.6**,[22] we show the ratio of employment to population. Prior to the effects of the COVID-19 pandemic in 2020, the share of people employed declined in both entirely and majority-disadvantaged counties by 3 and 2 percentage points, respectively. In contrast, the share of people employed in minimally disadvantaged counties grew by 1 percentage point over this period. All counties experienced significant job losses during the COVID-19 pandemic, but the entirely disadvantaged counties have recovered more quickly to pre-pandemic levels.

[21] Source: US Census Bureau ACS 5-Year Estimates
[22] Source: ACS 5-Year Estimates

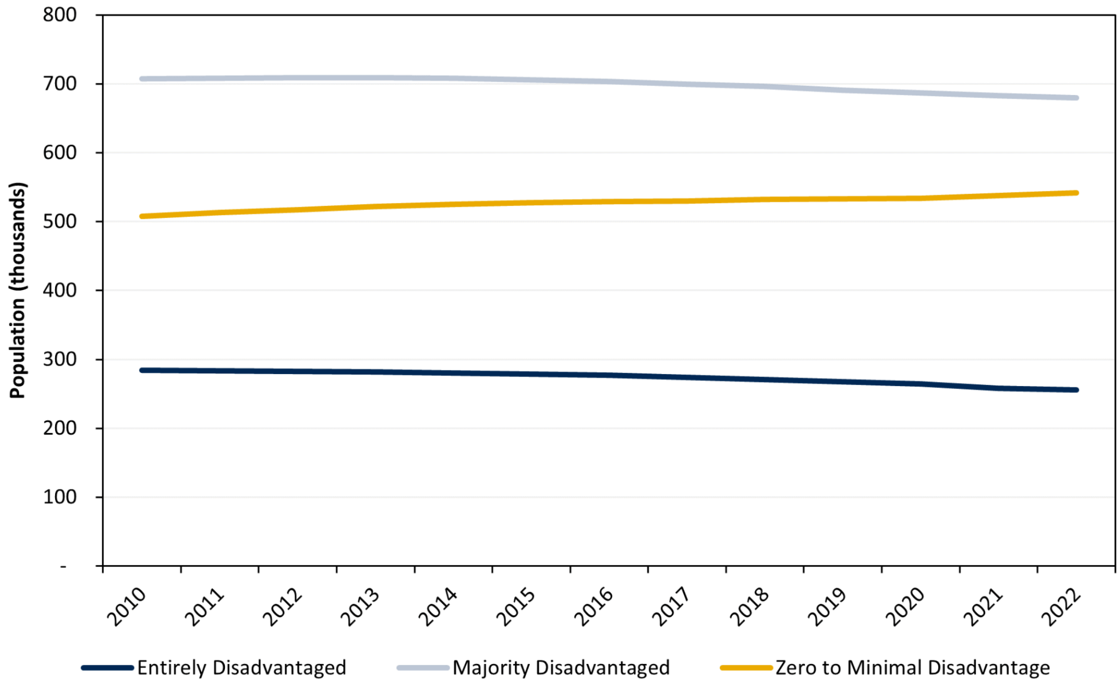

Figure 3.5. *Population Broken Down by Disadvantage Category. Population growth occurred only in minimally disadvantaged counties between 2010 and 2022.*

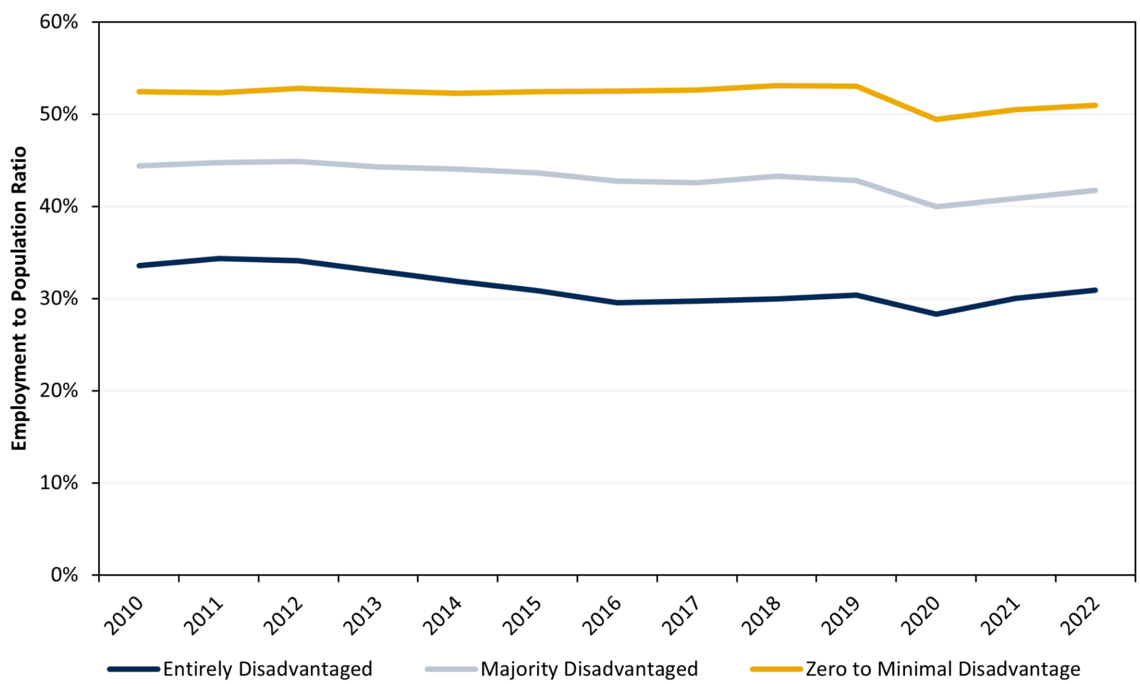

Figure 3.6. *West Virginia Employment to Population Ratio by Disadvantage Type. The ratio of workers to population is significantly lower for disadvantaged counties.*

Consistent with the employment to population ratio, **Figure 3.7**[23] shows that disadvantaged counties have significantly higher unemployment rates than those with lesser disadvantages. As of 2022, counties identified as disadvantaged had an unemployment rate of 4.83%, compared with 3.8% in counties with minimal disadvantage. During 2020, unemployment shot up to nearly 10% for disadvantaged counties, while remaining relatively modest at 7.72 percent in those with minimal disadvantage.

Labor force participation varies significantly by disadvantage type as well (**Figure 3.8**).[24] In 2022, the labor force participation rate for entirely disadvantaged counties was 44%, 18 percentage points below the national average of 62% in that year. In the same year, labor force participation in minimally disadvantaged counties was 60%, nearly equaling the US average.

The COVID-19 pandemic had different effects on labor force participation in the state. For entirely disadvantaged counties, labor force participation fell from 46% in 2020 to 43% in 2021. In contrast, minimally disadvantaged counties experienced a slight increase in labor force participation, moving from 59% in 2019 to 60% in 2020.

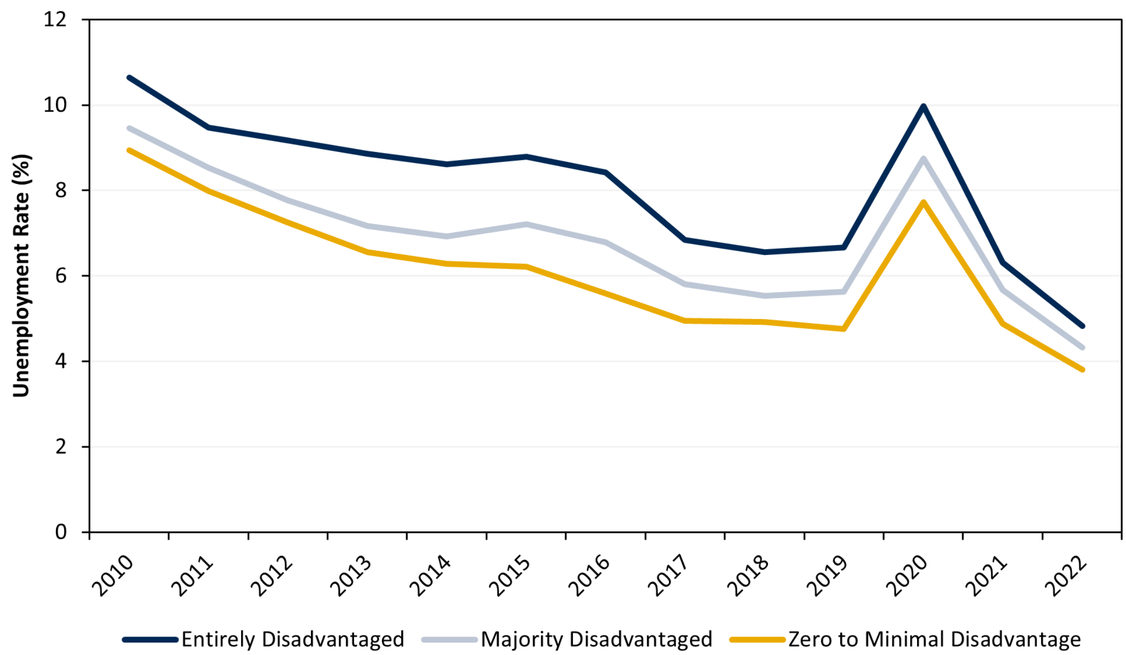

Figure 3.7. *West Virginia Unemployment Rate. The unemployment rate for entirely disadvantaged counties rose to nearly 10% in 2020 during the COVID-19 pandemic.*

[23] Source: US Bureau of Labor Statistics, US Census Bureau ACS 5-Year Estimates
[24] Source: US Census Bureau ACS 5-Year Estimates

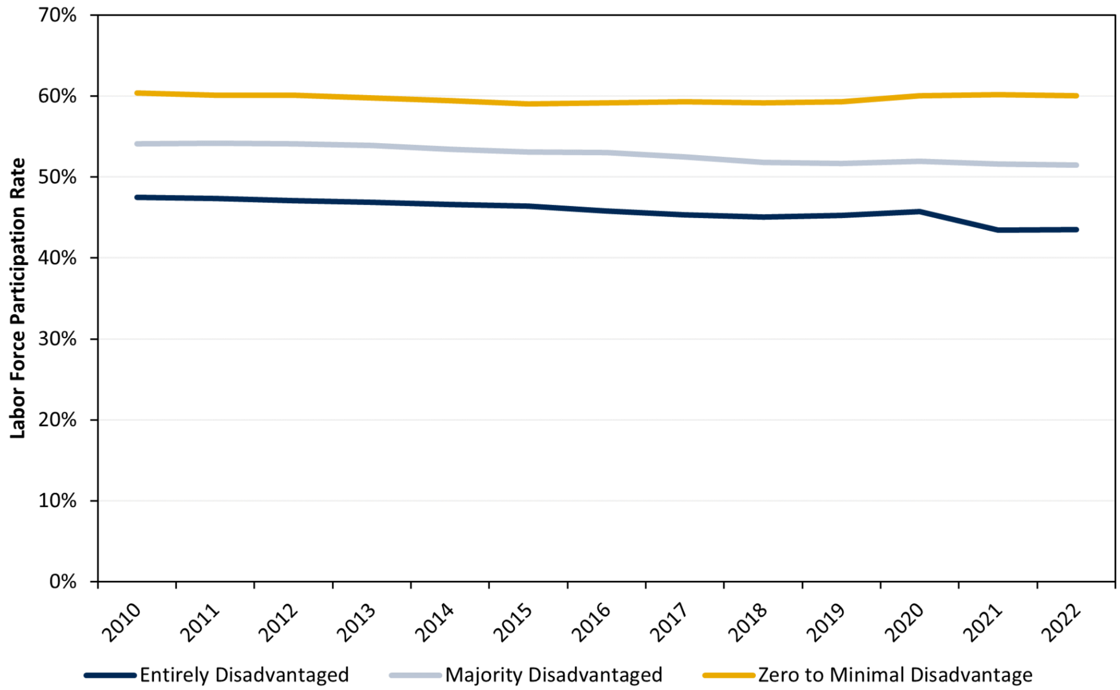

Figure 3.8. *West Virginia Labor Force Participation Rate. For the period between 2010 and 2022, entirely disadvantaged counties had an average labor force participation lower than 50%.*

Per capita personal income (PCPI) is also substantially higher in counties with low disadvantage (**Figure 3.9),**[25] perhaps not surprisingly. PCPI in entirely disadvantaged counties was approximately $42,000 in 2022, compared with more than $51,000 in minimally disadvantaged counties, a difference of more than 21%. However, there is some evidence that the gap has been closing, as incomes rose the fastest between 2010 and 2022 in majority disadvantaged counties at a rate of 4% per year, compared with about 3.8% for other categories.

Finally, residents in minimally disadvantaged counties have a higher level of educational attainment on average than those in other areas. As shown in **Figure 3.10**,[26] 24% of residents in minimally disadvantaged counties had a bachelor's degree or higher in 2021, compared with 18% in majority disadvantaged counties, and 13% in entirely disadvantaged counties. The gap in educational attainment has been widening over time, as well. In 2010, 11% of residents in entirely disadvantaged counties had a bachelor's degree or higher, compared with 19% of those in minimally disadvantaged counties, a gap of 8 percentage points.

[25] Source: US Bureau of Economic Analysis
[26] Source: US Census ACS 5-Year Estimates

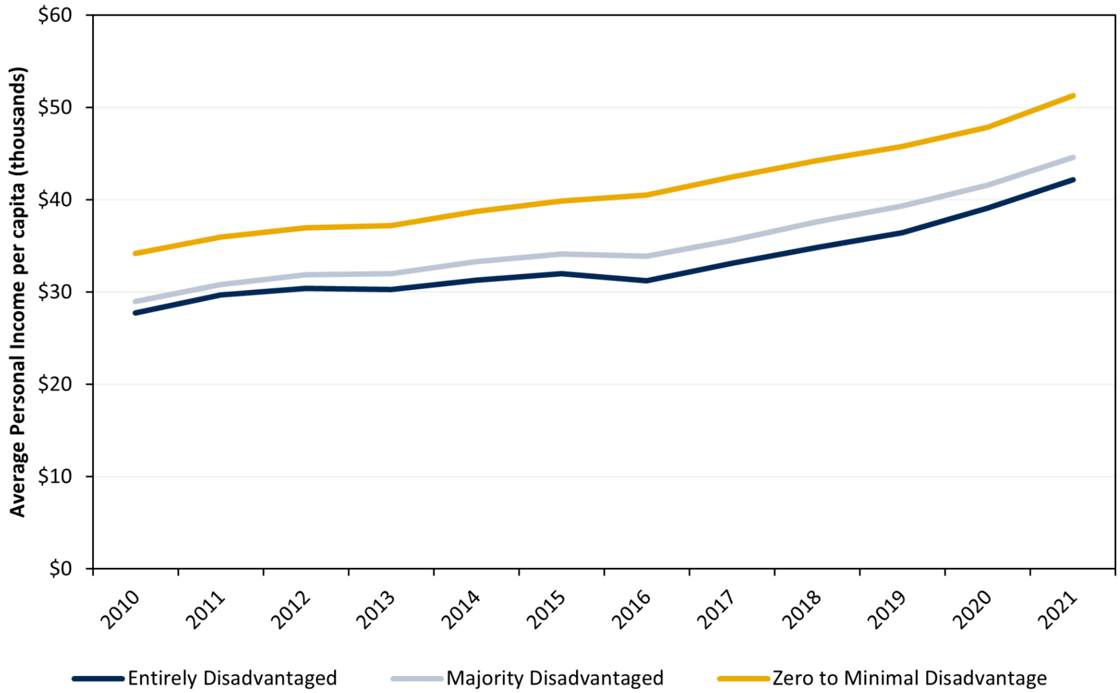

Figure 3.9. *West Virginia Per Capita Personal Income. Both entirely and majority disadvantaged counties have lower PCPI than minimally disadvantaged counties.*

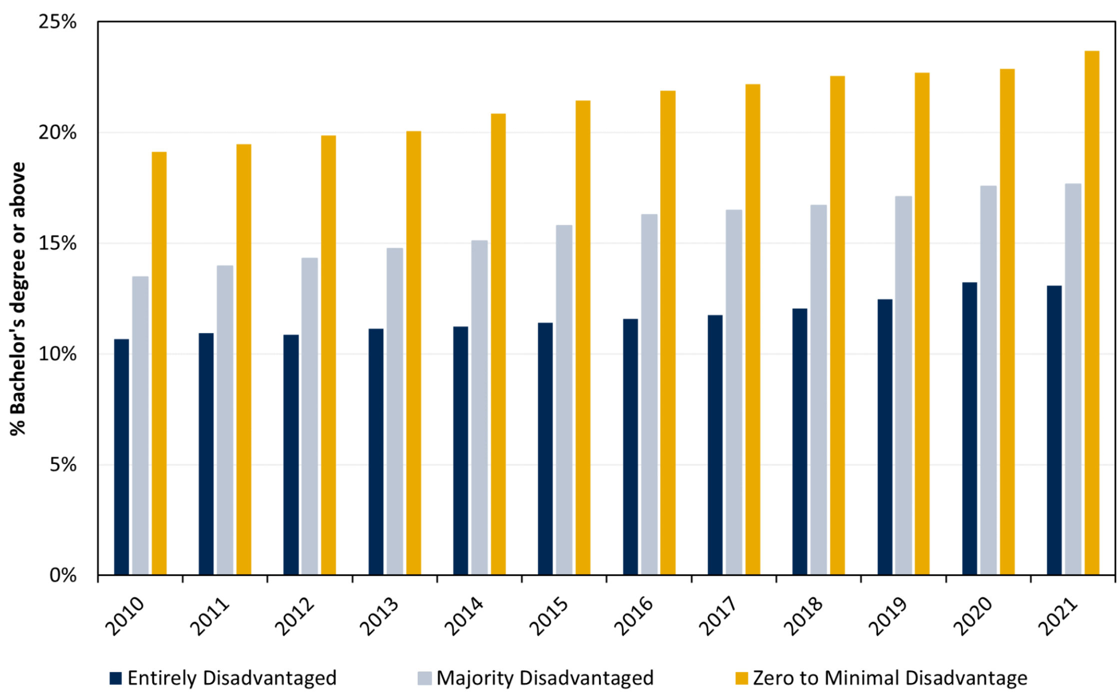

Figure 3.10. *West Virginia Higher Educational Attainment. The percentage of residents with a bachelor's degree has risen in all three categories, but remains lower in those counties with higher disadvantage.*

3.3.2 Potential Benefits of Selected Greenhouse Gas Reduction Strategies

As mentioned above, West Virginia has proposed a number of greenhouse gas reduction measures that would affect power generation, industry, residential and commercial construction, transportation, and other sectors. At this stage, we do not have specific projects under consideration for funding and thus cannot provide precise estimates of the economic impacts of these programs. However, we can describe in a qualitative way how projects in two of these areas may affect local communities.

Carbon Capture and Sequestration

One of the primary strategies the state has proposed to reduce GHGs in the power sector is the use of carbon capture and sequestration technologies in the power generation sector. As of 2023, West Virginia had nine operating coal-fired power plants, generating more than 85% of the state's power. Since coal-fired power generation is one of the largest sources of GHG emissions in the state, these power plants provide one of the largest opportunities for carbon reduction.

As shown in **Figure 3.11**, currently two of the coal-fired power plants in West Virginia—Mountaineer Power Plant in Mason County, and the Mitchell Power Plant in Marshall County—are located in census tracts considered disadvantaged by the CEJST criteria. These two plants represent nearly a quarter of the total coal-fired generating capacity in the state and are estimated to employ more than 500 workers. These two plants, along with the John Amos Power Plant in Putnam County, had been considered for retirement as early as 2028 but were recently approved by the state Public Service Commission to install environmental upgrades that are expected to keep the plants in operation through 2040.[27] The remaining seven power plants are located in tracts adjacent to disadvantaged communities and likely have significant economic ties to neighboring communities. Installing carbon capture technologies at the state's coal-fired power plants could significantly reduce carbon output and reduce the environmental risks to LIDACs in West Virginia, while extending the life of these power plants that provide significant economic value to the LIDACs and surrounding communities.

[27] Tate, Curtis. 2021. "W.Va. Customers Will Pay for Upgrades To 3 Coal Plants, PSC Rules." October 12, 2021. https://wvpublic.org/w-va-customers-will-pay-for-upgrades-to-3-coal-plants-psc-rules/

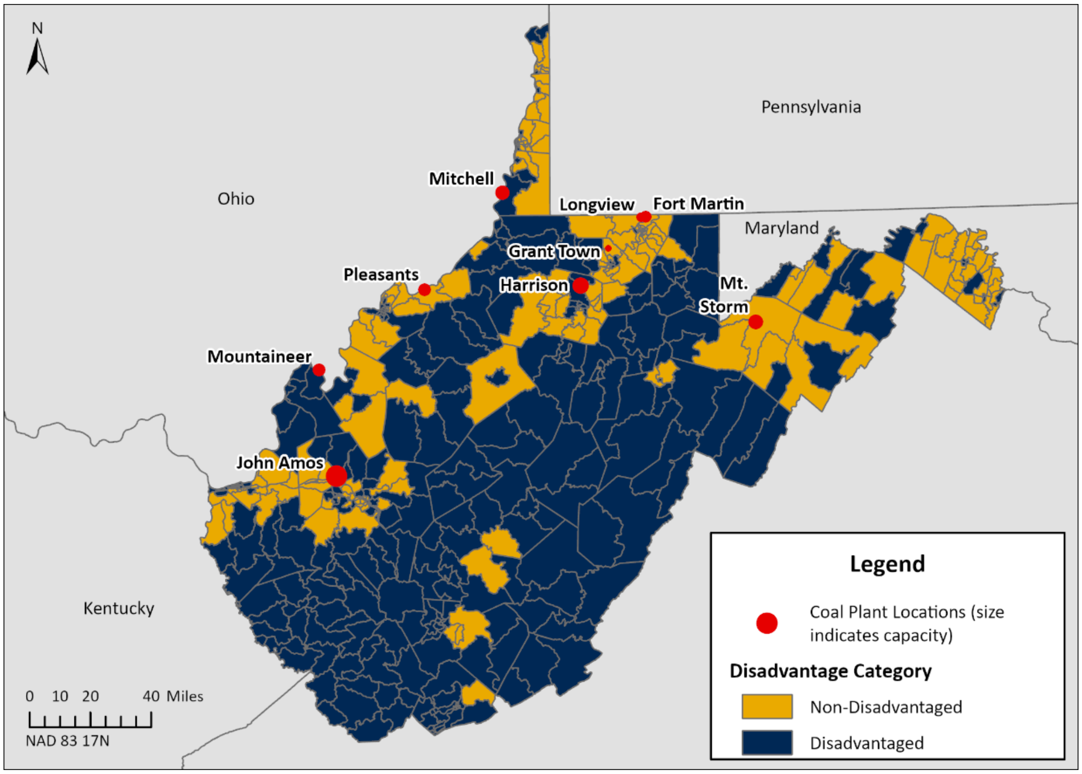

Figure 3.11. *Coal-Fired Power Plant Locations. Two large-scale power plants are located in disadvantaged census tracts, representing approximately one-quarter of the state's coal-fired generating capacity.*

Methane Reduction in the Natural Gas Industry

Another source of GHG emissions in West Virginia is methane leakage at the state's natural gas infrastructure, including wells and pipelines. Since the development of hydraulic fracturing and horizontal drilling techniques to drill for natural gas in shale deposits, West Virginia has grown to become the fourth-largest producer of natural gas in the United States. As shown in **Figure 3.12**, natural gas production is clustered in the northern part of the state.

One of the state's primary GHG reduction strategies would identify and provide funding to reduce or capture methane emissions from the state's natural gas industry. Four of the top five natural gas producing counties in West Virginia are designated as either majority or entirely disadvantaged by our criteria defined above. Limiting methane emissions in this sector would allow the economic benefits of natural gas production to continue to flow to LIDAC communities, while reducing harmful methane emissions from this industry.

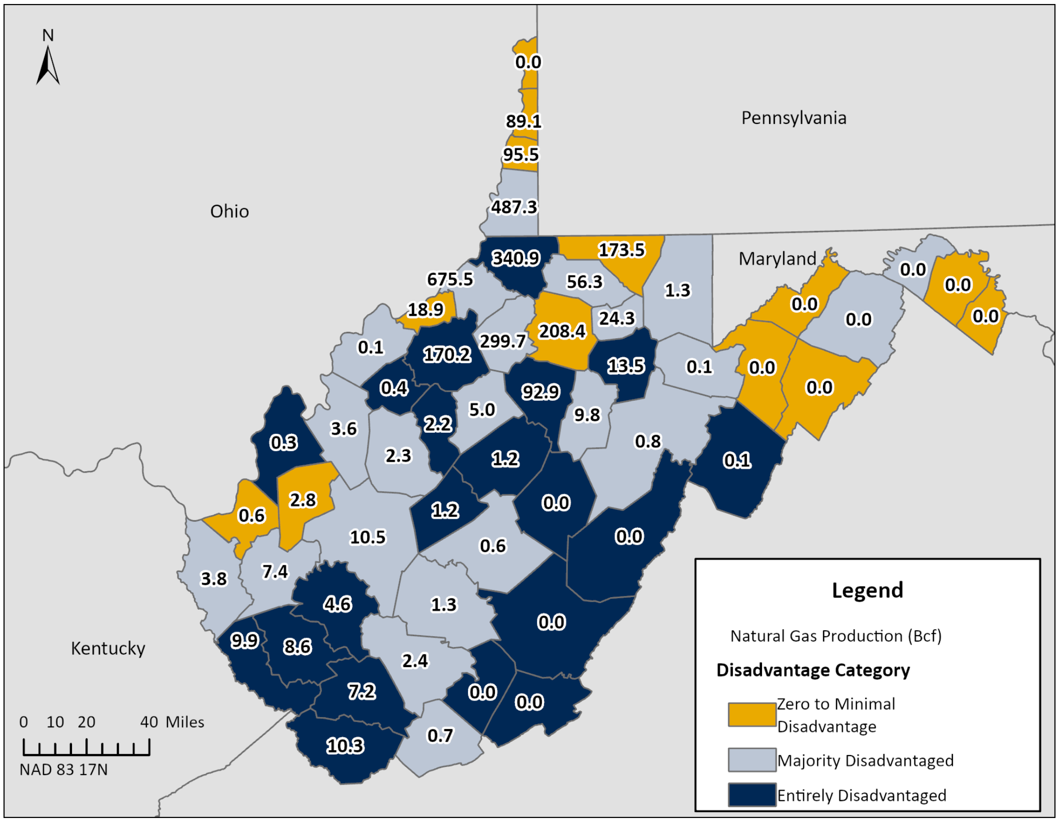

Figure 3.12. *Natural Gas Production (Bcf) and Disadvantaged Counties. Natural gas production is clustered in the northern part of the state, and thus the greatest potential for methane reduction comes in this region.*

4 Review of Authority to Implement

The West Virginia Legislature passed a bill related to the administration of the West Virginia Water Pollution Control Act as it pertains to Class VI wells. Class VI wells are to be utilized for underground carbon dioxide sequestration and storage by injecting carbon dioxide into deep rock formations for long-term storage in an effort to reduce carbon dioxide emissions. This action will ultimately allow the state to obtain primary enforcement authority from the United States Environmental Protection Agency (U.S. EPA) over Class VI wells. This is in response to the U.S. EPA requiring the state to make changes to the code in pursuit of that regulatory authority. Once approved, West Virginia will be the fourth state to have primacy over Class VI wells, joining North Dakota, Wyoming and Louisiana.

5 Workforce Planning Analysis

To implement priority measures described in this PEAP, the EnergyWise West Virginia team has conducted a preliminary analysis of necessary workforce development activities at the statewide level. This analysis serves as a baseline for future efforts as strategies are more clearly defined, projects are scoped, and localities are identified.

5.1 Discussion

5.1.1. Labor Force and Unemployment

U.S. Bureau of Labor Statistics data indicate that the civilian non-institutionalized population in West Virginia has declined by roughly 1.2% from 2019 to 2022. Effects from the COVID-19 pandemic for 2020 and 2021 are evident in labor force participation rate, total labor force, employment, unemployment, and unemployment rates. While labor force participation rates for 2019 and 2022 are equivalent, the labor force declined by more than 10,000 participants over that same period. Despite a significant increase in 2020, the number of unemployed individuals in the state declined from 39,390 in 2019 to 30,662 in 2022 (or roughly 22.2%). This suggests a declining number of potential applicants for open positions and may place additional pressures on firms filling roles.

Table 5.1. *West Virginia Labor Force and Employment Summary*[28]

	Civilian Non-institutionalized Population	Labor Force	Labor Force Participation Rate	Unemployment	Unemployment Rate
2019	1,452,860	795,299	54.7%	39,390	5.0%
2020	1,446,494	779,913	53.9%	64,276	8.2%
2021	1,442,066	778,747	54.0%	39,744	5.1%
2022	1,435,928	785,115	54.7%	30,662	3.9%
Change 2019 to 2022	-16,932	-10,184		-8,728	

A potential challenge for the development of both priority programs and site-level projects may arise from the geographic distribution of the labor force. The size of the civilian labor force in West Virginia counties varies significantly. In 2022, three of the state's fifty-five counties (Berkeley, Monongalia, and Kanawha) had labor forces in excess of 50,000, while fifteen counties reported a labor force smaller than 5,000 in 2022. Locations with a smaller labor pool may have difficulties supplying workers to larger projects. This is further impacted by rurality, geographic isolation, a lack of transportation and/or housing infrastructure, and the presence of fewer amenities to recruit or retain workers. **Figure 5.1** presents the size of the labor force by county in 2022.

[28] Source: U.S. Bureau of Labor Statistics, Local Area Unemployment Statistics (LAUS)

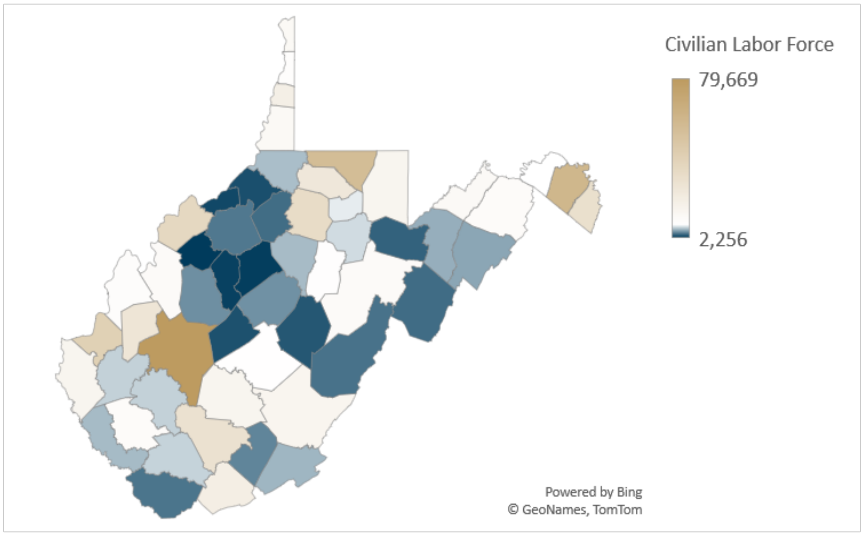

Figure 5.1. *Civilian Labor Force by West Virginia County, 2022*[29]

This is further exacerbated by the makeup of these counties. Roughly 15% of the state's labor force resides in counties identified as "Entirely Disadvantaged" as part of the LIDAC analysis undertaken during the PEAP process. These areas, characterized by lower incomes and health challenges, may have fewer resources available to support workforce development and retention.

Table 5.2. *West Virginia Labor Force by County LIDAC Status, October 2023*[30]

West Virginia	Total Labor Force	Average County Labor Force	Minimum County Labor Force	Maximum County Labor Force
Minimally disadvantaged counties	322,515	24,809	2,646	60,047
Majority disadvantaged counties	350,189	15,198	2,413	80,086
Entirely disadvantaged counties	120,918	6,046	2,256	14,988

[29] Source: WorkForce West Virginia. Annual Report on the Civilian labor Force, Employment and Unemployment.
[30] Source: U.S. Bureau of Labor Statistics, study team calculations

5.1.2. Selected Industry Employment

In the twelve selected industries under examination, U.S Bureau of Labor Statistics data indicate a loss of roughly 7.1% or 7,942 jobs from 2019 to 2022, while total employment in the state fell by approximately 3.5% over the same period. The largest declines were in the Construction industry (3,826 jobs) and Mining, quarrying, and oil and gas extraction (2,212 jobs). Both in 2019 and 2022, the identified grouping made up about one-fifth of total private employment, in all industries. These figures suggest a tightening of labor markets and that there may not be a sufficient pool of unemployed or under-employed workers to support significant expansion activities in industries that require specialized skills.

Table 5.3. *West Virginia Selected Industry Employment, 2019 and 2022*[31]

West Virginia Private Employment, Selected Industries		**2019**	**2022**
NAICS 21	Mining, quarrying, and oil and gas extraction	21,564	19,352
NAICS 23	Construction	35,459	31,633
NAICS 324	Petroleum and coal products manufacturing	714	554
NAICS 325	Chemical manufacturing	9,039	8,155
NAICS 326	Plastics and rubber products manufacturing	3,521	4,202
NAICS 331	Primary metal manufacturing	4,350	4,129
NAICS 332	Fabricated metal product manufacturing	4,561	4,237
NAICS 221	Utilities	5,278	5,370
NAICS 48-49	Transportation and warehousing	19,527	18,837
NAICS 5413	Architectural, engineering, and related services	4,824	4,577
NAICS 54162	Environmental consulting services	414	350
NAICS 562	Waste management and remediation services	2,931	2,844
	Subtotal	**112,182**	**104,240**
	Total, all industries	**559,118**	**539,694**

5.1.3. Selected Occupational Employment

[31] Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages (QCEW)

WorkForce West Virginia projections for selected occupations associated with these industries indicate that each of the occupation codes, for which data is provided, forecast "moderate demand" over the 2016-2026 time period.[32] The data also suggest relatively high wages, with annual mean wages for many of these specific occupation codes also exceeding the state's annual mean wage ($52,895) by as much as 84%. Additionally, Location Quotients (LQ)[33] for multiple occupations (particularly for Mining and Geological Engineers, Including Mining Safety Engineers) point to significant areas of concentrated occupational employment. This indicates that West Virginia's workforce is made up of a higher percentage of these workers than the national average and highlights the (higher) relative contribution to the economic base. These combine to suggest that the state derives substantive, and growing, wage impacts from workers in these occupations.

Table 5.4. *West Virginia Selected Occupational Summary*[34]

Occupation (SOC code)	May 2022 Employment	Annual mean wage	Location Quotient	2016-26 Demand
Architecture and Engineering Occupations (17-0000)	9,540	$83,100	0.84	
Environmental Engineers (17-2081)	650	$90,720	3.12	Moderate demand
Mining and Geological Engineers, Including Mining Safety Engineers (17-2151)	290	$97,100	8.69	Moderate demand
Environmental Engineering Technologists and Technicians (17-3025)	100	$57,320	1.58	Moderate Demand
Life, Physical, and Social Science Occupations (19-0000)	6,550	$66,770	1.09	
Environmental Scientists and Specialists, Including Health (19-2041)	230	$71,200	0.66	Moderate demand
Environmental Science and Protection Technicians, Including Health (19-4042)	700	$50,750	4.52	Moderate demand
Construction and Extraction Occupations (47-0000)	40,910	$52,740	1.47	
Production Occupations (51-0000)	33,870	$43,830	0.85	

[32] It should be noted that these projections were developed prior to the COVID-19 pandemic, and as such, cannot account for its impacts.
[33] See also https://www.bls.gov/cew/about-data/location-quotients-explained.htm. Location Quotient (LQ) is a measure of an industry's concentration in a given geography compared to the nation as a whole.Numbers higher than 1.0 indicate a higher concentration, those lower than 1.0 less of a concentration.
[34] Source: U.S. Bureau of Labor Statistics, Occupational Employment and Wage Statistics (OEWS) and WorkForce West Virginia LMI

Power Distributors and Dispatchers (51-8012)	190	$92,720	4.32	(No info)
Power Plant Operators (51-8013)	290	$83,570	2.02	Moderate demand
Gas Plant Operators (51-8092)	Not disclosed	$76,510	Not disclosed	(No info)

5.1.4. Workforce Education and Training

The West Virginia Labor Force ecosystem is well-positioned to support the development of high-quality jobs like those already described, and those arising from technological advancement. Focusing on academic programs closely tied to the industries and occupations identified in the PEAP process, the study team identified 145 academic programs at state Public Four-Year (Higher Education Policy Commission, HEPC) and Community and Technical College (CTC) system institutions (**see Table 5.5**) aligned with Architecture, Engineering, Construction, and Transportation industries. Of those 145 programs, those in Engineering and Engineering Technologies make up nearly 85%. The extent to which these certification and degree programs have the potential to address skills gaps in the energy an industrial sector[35] will be an important area of focus for ensuring that future workforce efforts align with industry needs.

Table 5.5. *Selected Academic Programs at West Virginia HEPC and CTC Institutions*[36]

NCES CIP Cluster	West Virginia Degree Programs count		
	Associate's/Baccalaureate Degrees	**Master's/Doctoral Degrees**	**Certificate Programs**
04 Architecture and Related Services	1	2	0
14 Engineering	30	18	1
15 Engineering Technologies/Technicians	51	4	19
46 Construction Trades	4	0	2
49 Transportation and Materials Moving	6	3	4

5.2 Preliminary Conclusions

Based on this analysis, the study team identified broad impacts to the West Virginia workforce as a result of the EnergyWise West Virginia Plan, especially in regard to effects upon skilled labor, existing industries, existing jobs, the creation of high-quality jobs, and expanding economic opportunities.

[35] "What's Needed To Close The Skills Gap In The Power Industry" - Forbes.com. https://www.forbes.com/sites/forbestechcouncil/2022/04/08/whats-needed-to-close-the-skills-gap-in-the-power-industry/?sh=7873707a138e

[36] Source: West Virginia Higher Education Policy Commission, internal calculations

5.2.1 Skilled Labor

The energy sector has had well-documented skilled labor shortages on a national scale for several years, exacerbated by the increasing need for data analytics and software manipulation skills among energy workers in both the fossil and renewable sectors. In West Virginia, where these trends are mirrored, the enactment of the PEAP measures will likely place additional pressures on labor markets to supply workers with sufficient skills.

5.2.2 Existing Industries

Private employment in the industries most directly tied to expected PEAP/CEAP activities make up roughly one-fifth of total private employment in the state. Despite declines in overall employment in the aftermath of the COVID-19 pandemic, these industries are significant contributors to the state's economy. Some of the identified industries have seen growth beyond their 2019 employment levels (notably NAICS 326 - Plastics and rubber products manufacturing and NAICS 221 – Utilities).

5.2.3 Existing Jobs

A brief review of occupations tied to PEAP/CEAP-related activities suggests a higher concentration of these jobs in the state as measured by Location Quotient (LQ)[37] – a measure of an industry's concentration in a given geography compared to the nation as a whole. This is particularly true for Mining and Geological Engineers, Including Mining Safety Engineers (SOC 17-2151), Environmental Science and Protection Technicians, Including Health (SOC 19-4042), and Power Distributors and Dispatchers (SOC 51-8012) that each have LQs over 4.0. These occupations also report average wages well above that of the state average and are forecasted to be in moderate demand in the latest set of employment projections.

5.2.4 High-Quality Job Creation

The West Virginia Labor Force ecosystem is well-positioned to support the development of high-quality jobs like those already described, and those arising from technological advancement through substantive academic programs at state institutions, with a sizable number in Engineering and Engineering Technologies. Geographic distribution of labor pools may impact availability of necessary labor to adequately contribute to potential job creation resulting from PEAP/CEAP-related programs and projects.

5.2.5 Data Sources

Resources employed as part of the initial analysis include a variety of state, federal, and industry data sources centered around labor market information, demographics, and education and training.

At the state level, these include:

- WorkForce WV Labor Market Information, at the West Virginia Department of Commerce http://lmi.workforcewv.org/default.html
- West Virginia Higher Education Policy Commission https://www.wvhepc.edu/resources/data-and-publication-center/

At the federal and industry level, these include:

- U.S. Bureau of Labor Statistics

[37] See also https://www.bls.gov/cew/about-data/location-quotients-explained.htm.

   - Occupational Employment and Wage Statistics (OEWS) https://www.bls.gov/oes/tables.htm
   - Local Area Unemployment Statistics (LAUS) https://www.bls.gov/lau/
   - Quarterly Census of Employment and Wages (QCEW) https://www.bls.gov/cew/
- U.S. Bureau of Economic Analysis - RIMS II Multipliers https://apps.bea.gov/regional/rims/rimsii/
- Projections Central, sponsored by the US Department of Labor https://projectionscentral.org/
- O*Net Online https://www.onetonline.org/
- National Center for Education Statistics – Classification of Instructional Programs (CIP) https://nces.ed.gov/ipeds/cipcode

5.2.6 Time Scale

With a lag in the reporting of several data sources, some of the baseline estimates reference periods during or immediately following the COVID-19 pandemic. In an effort to provide additional context for the baselines, the study team chose to focus its analysis on the 2019 reference year to the latest available monthly or annual figures. In the case of total employment for the counties by LIDAC classification, the latest available monthly data was for October 2023, with all other published estimates noted as "preliminary." For annual data, the most recently published data was for calendar year 2022.

5.2.7 Geographic Focus

Although the Low-Income Disadvantaged Communities Benefits Analysis in Section 3.6 makes use of information at the Census Tract level, the vast majority of workforce-related data at that level are subject to heavy data withholding protections, to the extent that data is even reported at all. As such, the study team chose to focus its energies in the PEAP at the county, Workforce Investment Area (WIA), or state level as appropriate.

5.2.8 Industries

A brief review of industry relationships, using RIMS II Multipliers from the U.S. Bureau of Economic Analysis, provided twelve industries with expected workforce impacts from PEAP strategies covering power generation, industrial, transportation, and commercial and residential buildings. While it is almost certain that the list will change during in-depth analysis produced during the CEAP process, the following set serves as the initial tranche of industries analyzed.

Table 5.6. *Primary Industry NAICS Code Summary*

NAICS Code	Description
21	Mining, quarrying, and oil and gas extraction
221	Utilities
23	Construction
324	Petroleum and coal products manufacturing
325	Chemical manufacturing

326	Plastics and rubber products manufacturing
331	Primary metal manufacturing
332	Fabricated metal product manufacturing
48-49	Transportation and warehousing
5413	Architectural, engineering, and related services
54162	Environmental consulting services
562	Waste management and remediation services

5.2.9 Occupations

Much like for the selected industries above, refinement in the particular occupations analyzed during PEAP activities will occur once priority programs are implemented and project-level activities are identified as part of CEAP activities. For illustration purposes, the study team examined both broad occupational groupings, as well as a sampling of likely impacted occupation codes to establish a better understanding of their relative contributions to the state's economy. These include:

- **Architecture and Engineering Occupations (17-0000)**
  - Environmental Engineers (17-2081)
  - Mining and Geological Engineers, Including Mining Safety Engineers (17-2151)
- **Life, Physical, and Social Science Occupations (19-0000)**
  - Environmental Scientists and Specialists, Including Health (19-2041)
  - Environmental Science and Protection Technicians, Including Health (19-4042)
- **Construction and Extraction Occupations (47-0000)**
- **Production Occupations (51-0000)**
  - Power Distributors and Dispatchers (51-8012)
  - Power Plant Operators (51-8013)
  - Gas Plant Operators (51-8092)

6 Intersections with Other Funding Availability

During a preliminary review of available sources, the EnergyWise West Virginia Project Team identified federal funding opportunities which may support—but not fully facilitate—the implementation of the State's PEAP measures.

The table below outlines the name and amount of each funding opportunity and which PEAP measure(s) it supports.

Table 6.1. *Summary of Other Available Funding Sources*

Funding Opportunity	Funding Type	Applicable PEAP Measure(s)	Percent of Implementation Covered	Award Amount (USD) and Duration
Abandoned Mine Land Economic Revitalization (AMLER) Program	Grant	**Power Generation** - New Generation, SMRs, Geothermal, Hydro, NG **Industrial**- Coal Mine Methane Leakage Reduction, Use	Only certain project costs are eligible	Available: $29.347 million; project awards vary. 5 Years
Advanced Energy Project Credit – 26 U.S. Code § 48C	Tax Credit	**Power Generation** - Efficiency in Existing Fossil Powerplants **Industrial** - Efficiency and Electrification in Existing Industrial Facilities	N/A	Base Tax Credit: 6%; with available 30% bonus.
Appalachian Regional Commission - Energy Projects Funding	Grant	**Power Generation** - New Generation, SMRs, Geothermal, Hydro, NG **Industrial** - Efficiency and Electrification in Existing Industrial Facilities	Max. ARC Share: 30-80%	$500k - $3M. Up to 3 Years
Assistance for Latest and Zero Building Energy Code Adoption	Grant	**Commercial & Residential Bldgs**. - Energy Audits for State, County, and Local Gov't Bldgs.	N/A	Varies
Carbon Storage Assurance Facility Enterprise: Phases II, III, III.5, IV	Funding Opp. Announcement (FOA)	**Power Generation & Industrial** - CCS on Existing Facilities	50-80%	Varies by Area of Interest. 24-36 Months

USDA Loan Guarantees	Loan Guarantee	**Power Generation** - Efficiency in Existing Fossil Power plants **Industrial** - Efficiency and Electrification in Existing Industrial Facilities	N/A	Provides loans up to 80% guarantee. Duration varies.
DOE Industrial Assessment Centers (IAC) Implementation Grant Program	Grant	**Industrial** - Efficiency and Electrification in Existing Industrial Facilities	50%	$300,000. N/A
Energy Auditor Training (EAT) Grant	Grant	**Commercial & Residential Buildings** - Energy Audits for State, County, and Local Gov't Bldgs.	N/A	$200,000. 36 Months
Energy Efficiency and Conservation Block Grant (EECBG)	Grant	**Commercial & Residential Buildings** - Energy Audits for State, County, and Local Gov't Bldgs.	N/A	Varies. 2 years
Environmental and Climate Justice Community Change Grants Program	Grant	**Commercial & Residential Buildings** - Energy Audits for State, County, and Local Gov't Bldgs.; GHG Reduction Programs for State Gov't Bldgs.	N/A	Track I: $10-20M each; Track II: $1-3M. 3 years
Inflation Reduction Act (IRA): Methane Emissions Reduction Program Oil and Gas Methane Monitoring and Mitigation (OGM3)	Notice of Intent (NOI)	**Industrial** - NG and Petroleum Systems Methane Leakage Reduction, Use	TBD	Up to $1B total funding pool. TBD
Innovative Clean Energy: Nuclear Loan Guarantees	Loan Guarantee	**Power Generation** - New Generation, SMRs, Geothermal, Hydro, NG	N/A	Loan varies

Technical Assistance for the Adoption of Building Energy Codes	Grant	**Commercial & Residential Buildings** - Energy Audits for State, County, & Local Gov't Bldgs; GHG Reduction Programs for State Gov't Bldgs.	100%	Varies
Title 17 Innovative Energy Loan Guarantee Program: Advanced Fossil Energy Projects	Loan Guarantee	**Power Generation** - New Generation, SMRs, Geothermal, Hydro, NG **Industrial** - Efficiency and Electrification in Existing Industrial Facilities	Up to 80%	Varies