Ohio River Valley Institute response to:
U.S. Department of Energy
Office of Fossil Energy and Carbon Management
Request for Information: DE-FOA-0002660-RFI

Deployment and Demonstration Opportunities for Carbon Reduction and Removal Technologies

Submitted Electronically to: DeployDemoOppsRFI@netl.doe.gov by:

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Date: January 25, 2022

The Ohio River Valley Institute (ORVI) is a non-profit think tank whose mission is to help Northern and Central Appalachia develop public policies and initiatives that create economic prosperity and jobs, that improve quality of life and health for the region's residents, and that strengthen democratic institutions by increasing public participation in policymaking. ORVI reports are regularly covered by local, regional, and national news outlets and are cited by local, state, and national policymakers.

Because the energy sector has long played a major role in the region's economy and is transitioning in ways that have uncertain outcomes, it is a major focus of ORVI research. That work has produced three findings we believe should guide DOE in assessing, in the words of the RFI, ". . . the viability of technology demonstration and deployment projects to support the energy transition, eliminate greenhouse gas emissions, produce clean energy, create jobs, and enable a net-zero carbon emissions economy by 2050, all while prioritizing social justice."

The three findings that emerge from ORVI research are:

1. Expanding or perpetuating Appalachian coal and natural gas activity, even if successful, will contribute little or nothing to job growth and prosperity in the region and may even be counterproductive.
2. Because fossil fuel resources do not contribute to increased prosperity and improved quality of life in host communities, any carbon management project DOE considers must be justified purely on the basis of its market competitiveness and greenhouse gas

reduction, which, given the technologies' cost, precludes broad-based adoption in the electricity generating sector and narrows the viability window to niche applications and industries.

3. Because carbon management technology is viable in only niche applications and industries, massive infrastructure projects, such as region-wide pipeline networks and storage hubs for captured carbon and natural gas liquids, are not economically viable and cannot be cost-justified.

Given these findings, we believe the viability window for carbon capture and sequestration and related carbon management technologies is quite narrow. Therefore, we hope DOE's Office of Fossil Energy and Carbon Management (FECM) will include in the range of carbon management technologies and projects it considers ones that are devoted to remediating the impacts of past and ongoing fossil fuel activities, which have long saddled the region. These burdens include hundreds of thousands of orphaned and abandoned mines, wells, and toxic waste sites remediation of which would reduce greenhouse gas emissions, provide large numbers of jobs in areas that struggle most, encourage economic development, and enhance quality of life, making the region more attractive to both businesses and families.

In the following sections, we describe the research and facts upon which these findings and recommendations are based.

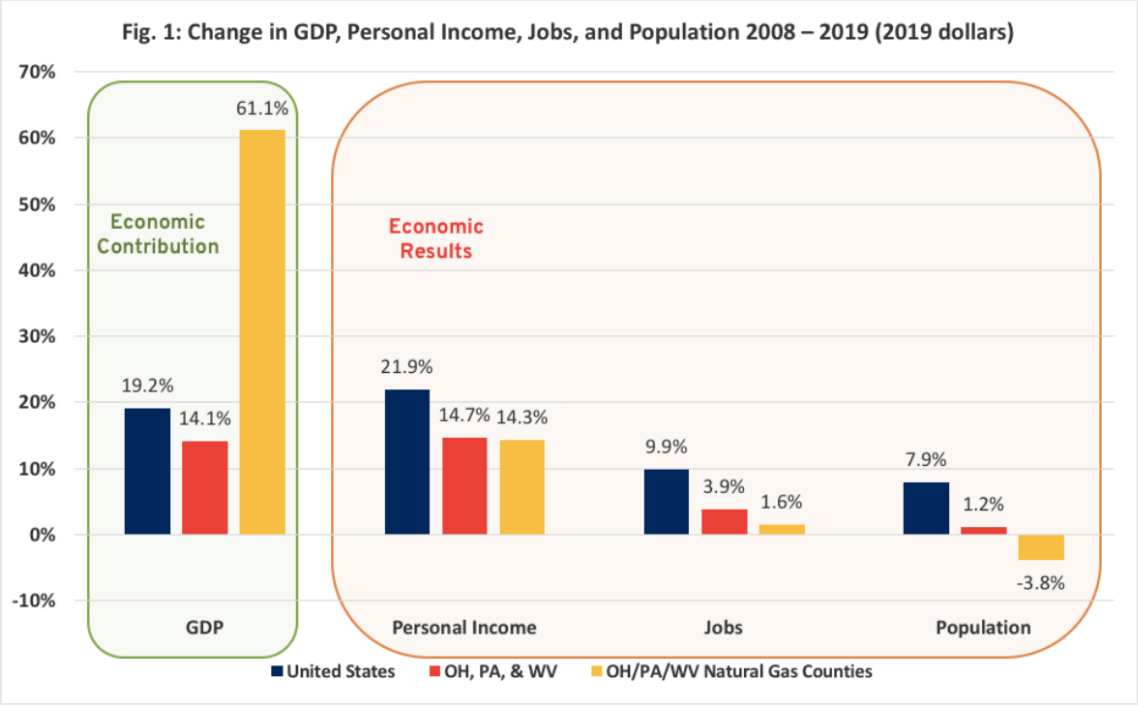
Growth Without Prosperity: Why Massive Natural Gas Expansion And Efforts to Perpetuate Coal Have Not and Cannot Deliver Job Growth or Stem Depopulation

In 2010, a frequently cited American Petroleum Institute economic impact study predicted that the then imminent Appalachian natural gas boom driven by hydraulic fracturing (fracking) would be "an economic game-changer" that would create over 250,000 new jobs in Pennsylvania and West Virginia. Another industry-sponsored study predicted the boom would generate 200,000 new jobs in Ohio as well. But, while natural gas production skyrocketed as the region went from being a bit player to producing nearly 40% of U.S. output, the predicted jobs boom never materialized.

A 2021 ORVI report examined the economic impacts of Appalachian natural gas development in the twenty-two Ohio, Pennsylvania, and West Virginia counties that are responsible for over 90% of the region's gas production. The report found that between 2008 and 2019, as gas production took off in the 22 counties, driving gross domestic product (GDP) growth at a rate three times that of the U.S. economy:

- The number of jobs grew by just 1.6% compared to 9.9% nationally. And half of the twenty-two counties experienced absolute job losses.
- Incomes grew by just 14% while the national figure was 22%.
- And, while the U.S. population grew by 8%,the resident population of the Appalachian natural gas counties actually declined by 4%.

In addition, the twenty-two natural gas counties, which we'll call "Frackalachia", lagged far behind the non-Frackalachian counties in Ohio, Pennsylvania, and West Virginia in job, income, and population growth.

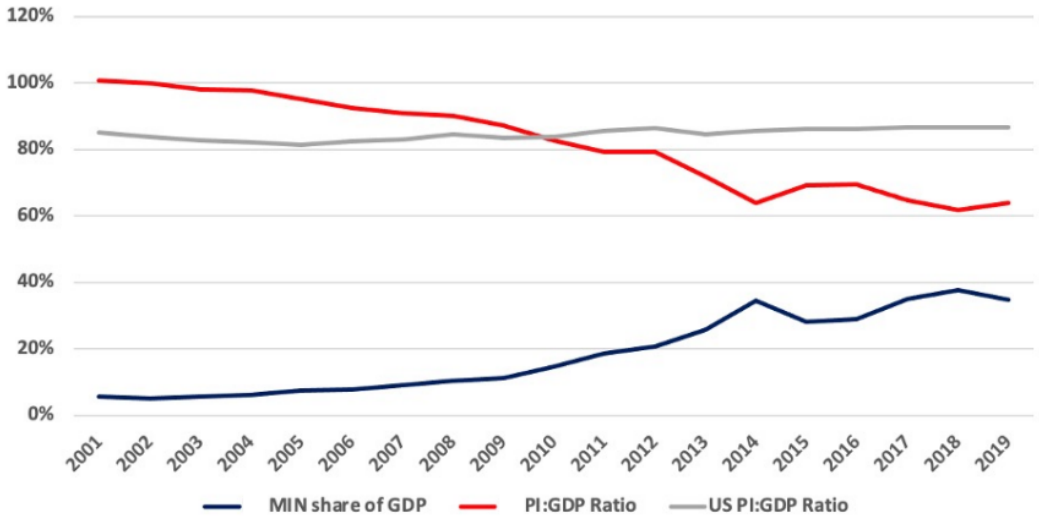


Sources: U.S. Bureau of Economic Analysis
QCEW Data: U.S. Bureau of Labor Statistics

These trends reflect an underlying disconnect between economic growth as measured by GDP and local prosperity. Put simply, very little of the investments made to extract natural gas and very little of the revenue earned when natural gas and its derivatives are sold ever enters local economies.

This dynamic is reflected by the simultaneous rise of the mining sector, which includes natural gas production, and an almost lockstep decline in the ratio of personal income to GDP.

Fig. 6: Frackalachia Mining Share of GDP and PI:GDP, 2001-2019



Source: Author's calculation using Bureau of Economic Analysis data

The impact of this disconnect between GDP growth on the one hand and measures of prosperity on the other is best reflected in the fact that, although Frackalachia, if it were a state, would have had the ninth highest per capita GDP in the nation in 2019, its per capita personal income was among the nation's worst.

Fig. 5: Per Capita GDP and Personal Income by State, 2019

Per Capita GDP in 2019: Top 15 States		
1	District of Columbia	$ 203,173
2	New York	$ 91,102
3	Massachusetts	$ 86,557
4	Connecticut	$ 80,729
5	Washington	$ 80,500
6	California	$ 79,287
7	Delaware	$ 79,159
8	North Dakota	$ 75,034
	Frackalachia	**$ 74,828**
9	Alaska	$ 74,343
10	New Jersey	$ 71,467
11	Maryland	$ 70,587
12	Illinois	$ 69,886
13	Wyoming	$ 69,839
14	Colorado	$ 68,242
15	Minnesota	$ 68,050
	United States	$ 65,298

Per Capita Personal Income in 2019: Top 15 States		
1	District of Columbia	$ 83,406
2	Connecticut	$ 77,289
3	Massachusetts	$ 74,187
4	New York	$ 71,717
5	New Jersey	$ 70,471
6	California	$ 66,619
7	Washington	$ 64,758
8	Maryland	$ 64,640
9	New Hampshire	$ 63,502
10	Alaska	$ 62,806
11	Wyoming	$ 62,189
12	Colorado	$ 61,157
13	Virginia	$ 59,657
14	Minnesota	$ 58,834
15	Illinois	$ 58,764
	United States	$ 56,490
	⬇	
41	**Frackalachia**	**$ 49,820**

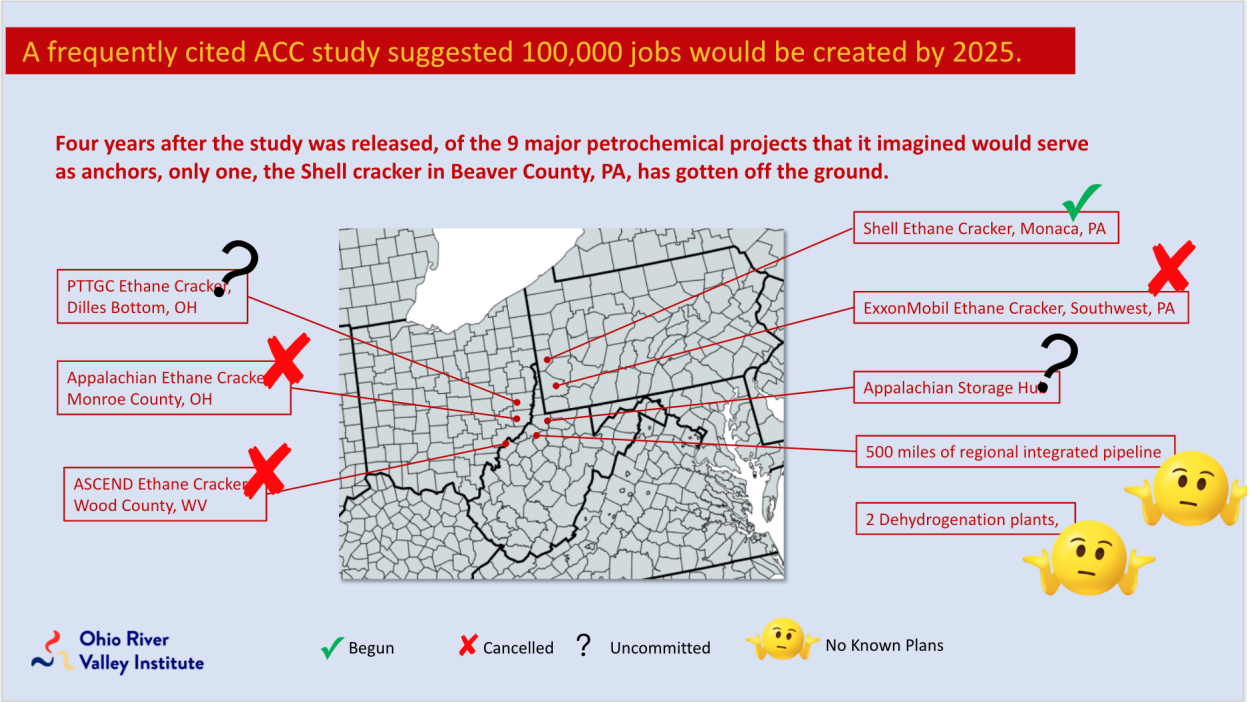
Source: Author's calculation using Bureau of Economic Analysis data

A subsequent ORVI report, which was cited by Nobel Prize-winning economist, Paul Krugman, found that the reasons for the disconnect are structural, meaning that significant growth in jobs and income is unlikely to take place regardless of continued expansion either of natural gas production or of the closely related petrochemical and electric generating industries. That's because these are among the least labor-intensive industries in the American economy and because much of the upstream and downstream economic activity associated with these industries is based outside the region.

Another factor in the failure of major fossil fuel investments to deliver economic prosperity in Appalachia is that markets have not supported and will not support massive expansions of upstream and downstream industries – a point which ORVI as well as prominent economists and analysts in the region have tried to make only to be drowned out by industry propaganda, which has at times unfortunately been supported by DOE. The most prominent examples are two major projects the federal government and the Department of Energy have worked assiduously to bring to fruition without success. The first is a proposed Appalachian ethane storage hub, which has been the subject of extensive promotion and legislative efforts. The second is the creation of a second (to the Gulf Coast) American petrochemical cluster in Appalachia.

In its efforts to promote these projects, DOE has frequently referenced deeply flawed and misleading industry-sponsored research and economic impact studies that, like the American Petroleum Institute study on the economic impacts of Appalachian shale gas development cited earlier in this letter, offer up grandiose job creation claims, which are used to distort policymaking processes and divert attention from other, more effective strategies for economic development and decarbonization.

The most recent example is DOE's citation of a 2017 American Chemistry Council economic impact study, which proclaimed that by 2025 "a second center of U.S. petrochemical and plastic resin manufacturing, similar to the Gulf Coast" could produce "100,000 permanent new jobs" in the region. The fate of that vision is neatly summarized in this slide from a 2021 webinar that was sponsored by ORVI.



Of the 9 major petrochemical projects envisioned by the American Chemistry Council and endorsed by DOE, only one has gotten off the ground. That project, the Royal Dutch Shell ethane cracker in Beaver County, PA, was initiated in 2014. In the eight years since, no other new projects have begun. And, it should be noted that even the Shell project has so far produced disappointing economic outcomes.

A recent ORVI report found that, since the announcement of the Shell cracker, which is scheduled to begin operation in 2022, Beaver County:

- Experienced modest GDP growth at a rate below that of the state and the nation.
- Lost population while state and national populations grew.
- Lost jobs while the state and nation were adding jobs.
- Failed to reduce poverty, despite significant declines at the state and the national levels.
- Experienced income growth at the same rate as the state and the nation.
- Lost businesses while the state and the nation were adding them.

These outcomes speak to another fatal flaw in the notion that perpetuating or expanding fossil fuel industries can counter economic decline or induce prosperity. Nearly all of the upstream and downstream economic activities they are purported to help bring about – storage facilities, ethane crackers, methanol plants, pipeline networks, etc. – suffer from some of the same drawbacks as fossil fuel extraction and power generation. Notably, they are not labor intensive and they impose major environmental and health costs on the communities that host them.

The DOE RFI states that, “An estimated $10 billion dollars could become available for carbon capture, direct air capture and industrial emissions reduction”. That figure is paltry compared to the over $200 billion the oil and gas industry has already invested in the Appalachian natural gas boom without delivering any measurable economic benefit to the region. Indeed, when the Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization delivered its “Initial Report To The President on Empowering Workers Through Revitalizing Energy Communities”, it ranked as third-neediest the Wheeling, WV - OH metropolitan area which falls wholly within Frackalachia and which has already been the recipient of tens of billions of dollars in fossil fuel investment.

So, as DOE considers applications for grants to fund carbon management projects, it should reject any suggestion that investments that perpetuate or expand fossil fuel extraction, either natural gas or coal, will contribute to job growth or economic prosperity in northern and north-central Appalachia. And DOE should also keep in mind that natural gas and coal extraction are highly polluting activities that harm peoples’ health and significantly reduce quality of life – issues that carbon capture technologies can do little or nothing to address and might even exacerbate.

Decarbonizing our energy system and economy is an absolute imperative and to some extent fossil fuels may be with us for some time to come. So the search for effective carbon management technologies is important, but it should be done with the understanding that these technologies impose economic costs, not benefits, and they should only be adopted when other more effective, less costly solutions are not available.

Because fossil fuel resources do not contribute to economic prosperity and improved quality of life, projects that DOE considers for funding must be justified purely on the basis of market competitiveness, their effectiveness in reducing greenhouses, and their avoidance of externalized costs such as localized pollution.

The RFI indicates that DOE anticipates funding demonstration projects and deployments in the areas of carbon capture, transportation, storage, and conversion. In addition to considering projects’ technical feasibility, potential effectiveness in reducing greenhouse gas emissions, and their ability to minimize externalized costs, DOE must also consider whether projects are likely to succeed in a marketplace populated by competing clean energy technologies that are more effective at reducing GHG emissions and impose fewer negative externalities. And, if they do not offer a clear competitive advantage, DOE risks squandering public money on projects that may succeed according to technical criteria, but which are stillborn in a marketplace that has no need for them.

That has been a problem for DOE grantmaking for years and even decades with regard to carbon management projects, particularly those in the coal industry.

In December 2021, the General Accounting Office (GAO) released an analysis which found that, of eight coal carbon capture projects for which DOE provided $684 million in funding between 2010 and 2017, “Three projects were withdrawn—two prior to receiving funding—and one was built and entered operations, but halted operations in 2020 due to changing economic conditions.” Also, “DOE terminated funding agreements with the other four projects prior to construction.”

Of the eight projects, none is currently active, “largely due to external factors that affected their economic viability,” according to the GAO report. The GAO report’s findings are a stark reminder of the need to rigorously assess the market potential of prospective projects and to refuse to fund those that cannot quantitatively demonstrate a high likelihood of commercial viability.

So, what kinds of projects are likely to meet a market viability criterion and which are not? Some industries, such as steel making and cement making, are widely recognized as being amenable to carbon capture because, in addition to being major greenhouse gas emitters, their manufacturing processes are notoriously difficult to electrify and, therefore, offer few options for decarbonization.

But, according to the International Energy Administration, these and other industrial applications generate less than a third of the carbon that would be available for capture. The largest single source of carbon that could potentially be captured is the power generating system. But capturing carbon from natural gas-fired and coal-fired power plants poses a problem. It can’t be done at a cost that would allow electricity from those sources to be cost-competitive except perhaps in the case of a relatively small number of gas-fired plants that might be required to balance energy load.

A recent study by researchers at Rutgers University examined the “Total Cost of Carbon Capture and Storage Implemented at a Regional Scale: Northeastern and Midwestern United States”. The study found that implementing CCS in the power generating sector would cost between $52 and $60 per ton of captured carbon in coal-fired operations and $80 to $90 per ton in gas-fired power plants. These figures imply that CCUS would add at least 6.19 cents/kWh to the cost of coal-fired power and 3.87 cents/kWh (or $38.70/MWh) to power from natural gas.

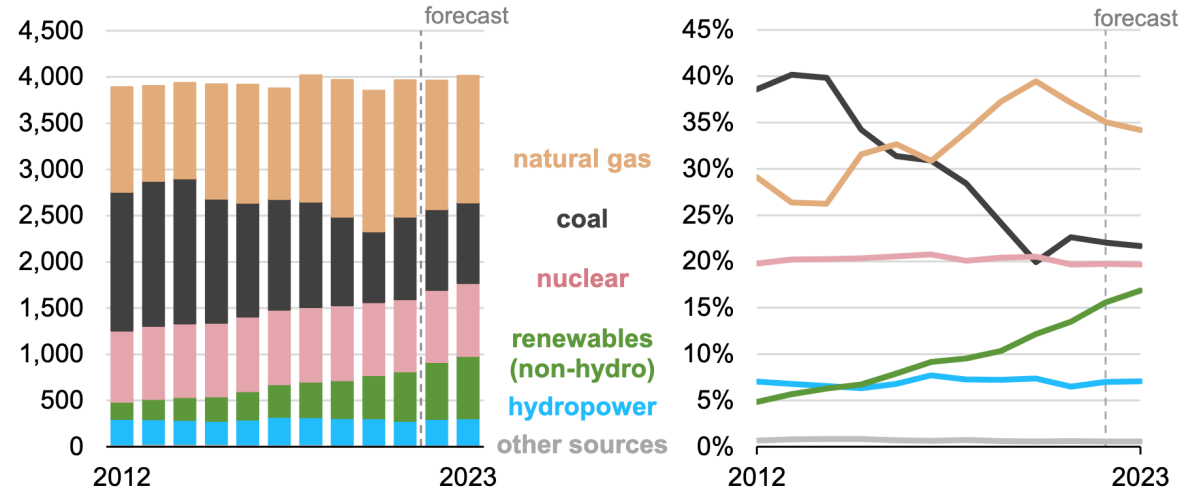
In the Energy Information Administration’s “Annual Energy Outlook 2021”, the levelized cost of energy from combined cycle natural gas power plants entering service in 2026 is $34.51/MWh, which means an added cost of $38.70/MWh to capture and store carbon dioxide would more than double the cost of electricity from new plants. Meanwhile, the percent increase in costs for existing plants that would have to be retrofitted for CCS would need to be even greater since, in the first half of 2020, the average wholesale price of energy in the PJM market was a mere $30.62/MWh. The economics for implementing CCS in coal-fired power plants are even worse.

In summary, the ORVI report found that, if CCS were implemented in the nation's remaining natural gas and coal-fired power plants, retail electric prices would have to rise nationally by 25% or $100 billion per year to cover the cost.

At the same time, electric generation from renewable resources is growing rapidly and often at a cost below that of natural gas and coal without CCS.

New renewable power plants are reducing U.S. electricity generation from natural gas

Annual U.S. electric power sector generation by energy source (2012–2023)



Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, January 2022

These facts suggest that the economic viability criterion for funding will pose a major barrier to prospective carbon capture and management projects in the power generation sector. And proposed projects that clear the barrier should do so only because of their effectiveness in other industries in which they are cost competitive.

Because carbon management technology is viable in only niche applications and industries, massive infrastructure projects, such as region-wide pipeline networks and storage hubs for captured carbon and natural gas liquids, are not economically viable and cannot be cost-justified.

In July 2021, an alliance called the Labor Energy Partnership issued a report titled, "Building to Net-Zero: A U.S. Policy Blueprint for Gigaton-Scale CO^2 Transport and Storage Infrastructure", which calls for the creation of networks of CO2 pipelines or "hubs" in the Ohio River Valley, Wyoming, and along the Gulf Coast. The concept was embraced by The White House Council on Environmental Quality in a "Council on Environmental Quality Report to Congress on Carbon

Capture, Utilization,and Sequestration". And it has been hailed by Deputy Secretary of Energy, David Turk, who was quoted as saying of the Labor Energy Partnership, "I think the report that you all have put together is incredibly helpful to show that we need to do more from the DOE side, other agencies, and Congress."

The problem with the CO2 hubs, each of which would cost tens of billions of dollars to construct, nearly all of which would come from taxpayers, is that, given the economics of carbon capture and storage, it is far from obvious that the industries in which carbon capture may be financially feasible would produce enough of the stuff to make efficient use of the immense transportation and storage capacity envisioned in the Labor Energy Partnership report.

In a section of the report titled, "Modeling a CO2 Infrastructure Hub in The Ohio River Valley", the report says, "The Ohio River Valley is home to more than 50 facilities that emit a total of at least 123 MtCO2e per year, the equivalent of roughly 27 million passenger vehicles. Coal-fired power plants contribute 90 percent of that total. The region has plentiful CO2 storage capacity in saline reservoirs. Geospatial analysis using SimCCS found that as few as eight CO2 injection wells and 855 miles of CO2 pipeline could permanently dispose of emissions from all the facilities analyzed in this study."

As noted earlier, the economics of carbon capture for natural gas-fired power are nearly impossible, but for coal they are absurd. According to data from the Energy Information Administration, PJM, and various analyses of carbon capture and storage costs, the incremental cost in coal-fired power plants would be approximately $62/MWh which, even in fully depreciated coal plants, would drive the total levelized cost of electricity to $104/MWh, more than three times the average cost of energy in the PJM market during the first half of 2020.

After being confronted with the cost of carbon capture during a September 2021 meeting with the chairman of the West Virginia Public Service Commission and the CEO of American Electric Power, West Virginia Senator Joe Manchin said to reporters, "I'd love to have carbon capture, but we don't have the technology because we really haven't gotten to that point," Manchin added. "And it's so darn expensive that it makes it almost impossible."

Moreover, the cost to construct just the pipelines for the recommended CCS hubs was estimated by Princeton University's Net-Zero project to be between $170 and $230 billion. For a quarter of that amount, the federal government could give every coal mining and every coal-fired power plant worker in the nation a severance package of a million dollars, retire the plants, and move on to cleaner, more efficient sources of electricity. Finally, it should not be forgotten that carbon capture would do little to mitigate localized pollution from coal and gas-fired plants, which are major contributors to highly elevated cancer rates in counties surrounding the plants, a fact that was actually noted in the Labor Energy Partnership report.

In summary, if the electric generating sector cannot sustain the cost increases required by CCS and, therefore, cannot participate in the CCS enterprise, then any rationale for construction of a CO2 hub in Appalachia is swept away. That fact is sufficient cause for DOE to reject as economically infeasible any funding proposals for related projects.

Conclusions and Recommendations: Carbon Management Projects DOE Should Consider for Funding

The reality is that, in Appalachia, the coal and natural gas industries and the downstream electric generating sector have long since ceased to be (and in many counties have never been) engines for job growth and economic prosperity. Therefore, efforts to prop up these industries by forcing federal taxpayers to absorb the risks and massive cost they impose serves no public good. And, when localized pollution and health impacts are taken into account, such efforts may actually do harm.

However, there is hope. Fossil fuel industries have bestowed and continue to bestow on Appalachia carbon management challenges that can be turned into opportunities for increased employment and an improved quality of life for communities that suffer from some of the nation's highest rates of toxic pollution. These challenges include:

- The measurement, prevention, and remediation of methane leaks during natural gas extraction.
- The effective capping of abandoned and orphan natural gas wells.
- Remediation of the vast volumes of coal ash, coal waste, and acid drainage from abandoned mines.
- The reclamation and reforestation of abandoned surface and underground mining operations, which are major sources of CO2 and methane emissions.

Each of these enterprises requires manpower, which translates into potential job opportunities in areas that are among the most challenged as we transition to a clean energy economy. And many of them require the development of new and improved technologies. To some degree the federal government has started down that path. But current efforts in the areas of coal ash and abandoned mine remediation and the remediation of orphaned and abandoned wells pale when compared to the immensity of the task.

There is little that the federal government can do that would provide greater economic stimulus and job growth in Appalachia than to provide funding commensurate with the seriousness of these problems. Because, beyond providing jobs, measures to address these problems would address a major barrier to economic growth and prosperity – a quality of life that is seriously compromised by polluted air and water and that contributes to some of the highest cancer rates and shortest lifespans in America. Unless that problem is addressed and peoples' most fundamental needs are successfully met, Appalachia risks becoming a place suitable only for extractive industries and the shrinking number of people required to support them.

Carbon capture and other carbon management technologies may be the best available means of reducing greenhouse gas emissions in some niche industries and sectors. But their role in large-scale sectors such as electricity generation will be at best extremely limited and will not be sufficiently large to justify major investments in massive infrastructure projects to store captured carbon. Nor can such investments be justified on economic development grounds or on demonstrably false claims that job growth or economic prosperity will ensue. The best hope for Appalachia economically and environmentally is to join the rest of the nation in transitioning as rapidly as possible to a clean energy economy. This can be done by addressing the challenges listed above and by making investments in energy efficiency, grid modernization, and renewable generation and storage. The Ohio River Valley Institute has proposed a model for clean energy transition in the region that would create jobs, increase incomes, and reduce pollution and greenhouse gases.

Therefore, we ask DOE to require of all requests to fund carbon capture and other carbon management projects that they be able to demonstrate a likely prospect of successfully competing in an unsubsidized marketplace with clean energy alternatives that have far greater potential for triggering and supporting job growth and sustained prosperity.

Thank you.
Sean O'Leary