Impacts of the PennEast and Adelphia Gateway Pipelines on Gas Drilling in Pennsylvania

An estimate of induced new gas wells and associated greenhouse gas emissions

Prepared for Delaware Riverkeeper Network

March 30, 2020

AUTHORS

Rachel Wilson
Erin Camp, PhD
Jason Frost

Synapse
Energy Economics, Inc.

485 Massachusetts Avenue, Suite 3
Cambridge, Massachusetts 02139

617.661.3248 | www.synapse-energy.com

CONTENTS

1. INTRODUCTION 1

2. BACKGROUND 1

2.1. Appalachian Basin Natural Gas Pipeline Constraints 1

2.2. PennEast and Adelphia Gateway Proposed Pipelines 4

3. POTENTIAL IMPACTS OF PENNEAST AND ADELPHIA GATEWAY 5

3.1. Unconventional Gas Wells in Pennsylvania 5

3.2. Impacts on Drilling Activity and Drilling-Related Emissions 7

3.3. Impacts on Climate Damages 9

APPENDIX A. PERMITTED WELLS IN PENNSYLVANIA A-1

1. INTRODUCTION

Economics dictate that expansion of natural gas pipeline infrastructure in constrained zones will cause an increase in the total production of natural gas. This is particularly likely in the constrained zones in Pennsylvania, where shale gas is being produced from the Marcellus and Utica Shales. Two proposed connected and interrelated pipeline projects in Pennsylvania—PennEast and Adelphia Gateway—would greatly expand the capacity of natural gas leaving the region, thereby leading to increased gas production and drilling. This report provides a background on the economic relationship between pipeline infrastructure and resource extraction, describes the two pipeline projects of interest, and estimates the number of new wells that would be drilled if the pipelines are built. Next, we provide an estimate of the increased emissions associated with the drilling and completion of these new wells. Finally, we calculate the climate damages associated with the drilling emissions and the increased utilization of natural gas using two values for the Social Cost of Carbon.

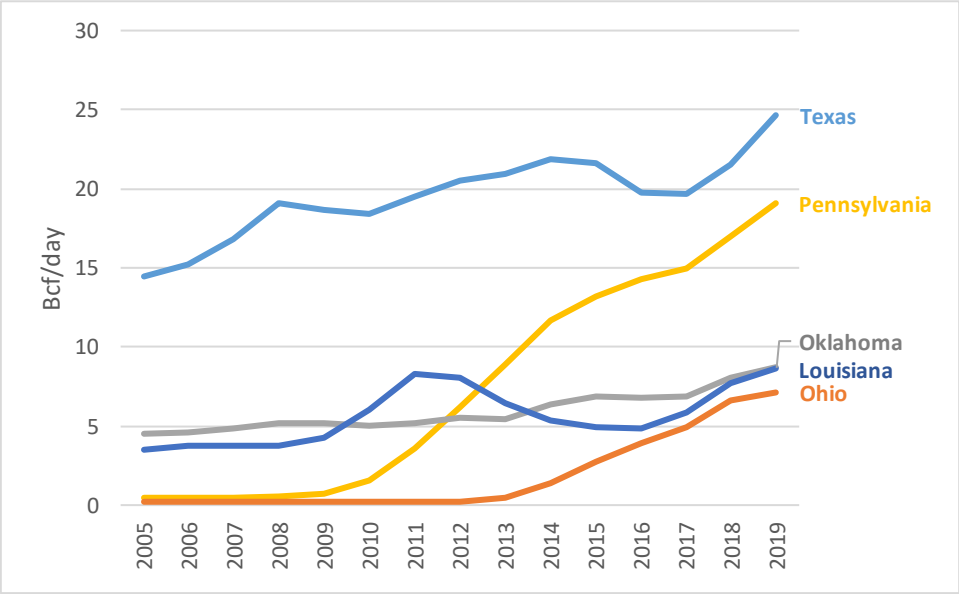
2. BACKGROUND

2.1. Appalachian Basin Natural Gas Pipeline Constraints

Natural gas prices are lowest in the regions in which gas is produced. For many years, the lowest natural gas prices in the East were found at Henry Hub, located near the Gulf of Mexico where much of the natural gas in the United States was produced. With the increase in shale gas production, however, the lowest natural gas prices in the country are now found at trading points in and around the Marcellus and Utica shale plays in Pennsylvania, West Virginia, and Ohio (i.e., the Appalachian Basin). The availability of pipeline infrastructure to send natural gas from the Appalachian Basin to other parts of the country has a direct impact on the price of natural gas in those regions. Greater gas take-away capacity allows more natural gas to be produced, and an increase in supply will lead to a decline in price in those regions that receive additional gas. The improved access to higher priced markets via additional pipeline infrastructure will raise the price of natural gas in the producing region, which also will increase production.

Due to increased drilling in the Appalachian Basin, Pennsylvania is now the second largest gas-producing state behind Texas and accounted for 19 percent of total U.S. marketed gas production in 2017. Historical production for the top five gas-producing states is shown in Figure 1, below.

Figure 1. Natural gas production in selected states (2005-2019), billion cubic feet per day



Source: US EIA. Natural Gas Gross Withdrawals and Production. Available at: https://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGM_mmcf_a.htm.

The U.S. Energy Information Administration (EIA) notes that gas production in Pennsylvania has historically outpaced the growth in pipeline capacity to transport it out of the state. However, both permitting and gas drilling activity have increased in Pennsylvania as regional pipeline capacity has grown, enabling gas to be exported to market centers outside of production areas.[1] Two pipeline projects began operations in the fourth quarter of 2016: The Rockies Express Zone 3 expansion project moves gas west from southwest Pennsylvania and the Algonquin Incremental Market pipeline moves gas from northeastern Pennsylvania into New England. With the addition of the Rover Pipeline, the NEXUS Gas Transmission pipeline, and Phase II of the Atlantic Sunrise Pipeline, which entered service in 2018 with a combined capacity of more than five billion cubic feet per day (Bcf/d), EIA forecasted continued growth in gas production from the Appalachian Basin.[2]

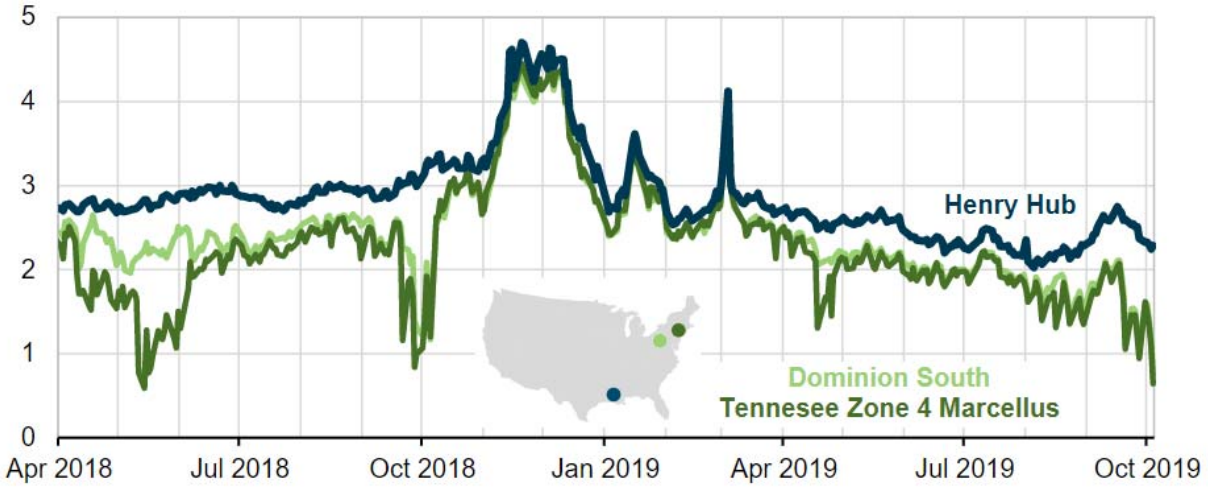
Towards the latter part of 2019, natural gas prices in the Appalachian Basin region dropped to $0.65 per million British thermal unit (MMBtu), while Henry Hub prices remained above $2 per MMBtu (Figure 2).[3] This price differential indicates that the pipelines transporting natural gas out of the Appalachian Basin region have been filling up, and less gas is able to reach other parts of the country.

[1] U.S. Energy Information Administration (EIA). 2018. *Pennsylvania's natural gas production continues to increase*. Available at: https://www.eia.gov/todayinenergy/detail.php?id=35892.

[2] EIA. October 18, 2018. *Natural Gas Weekly Update*. Available at: https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2018/10_18/.

[3] EIA. 2019. *Northeast natural gas spot prices fall as pipelines fill*. https://www.eia.gov/todayinenergy/detail.php?id=41673.

Figure 2. Marcellus shale gas spot prices relative to Henry Hub ($/MMBtu)



Source: EIA. "Northeast natural gas spot prices fall as pipelines fill." Today in Energy. *Daily natural gas prices for select trading hubs (Apr 1, 2018—Oct 4, 2019). Available at: https://www.eia.gov/todayinenergy/detail.php?id=41673.*

In response to the sustained low natural gas prices over the past year, the largest shale gas producers in the Appalachian Basin region have reported plans to slow production. EQT Corporation, Cabot Oil & Gas Corporation, and Range Resources Corporation all have planned to cut their drilling budgets and natural gas production for the year 2020.[4,5,6] Chesapeake Energy Corporation halted drilling in late 2019 and has been experiencing financial losses due to low gas prices.[7] Cabot Oil & Gas stated that it and other regional operators have been eagerly seeking opportunities for transport of their produced gas, given that pipeline buildout has slowed in recent years. Should pipeline construction move forward, much of the overproduced natural gas would be able to hit the regional market, and drilling in the Appalachian Basin would likely resume its original pace.

[4] Gough, P. January 2020. BizJournals.com. https://www.bizjournals.com/pittsburgh/news/2020/01/07/range-resources-cuts-drilling-budget-drops.html.

[5] Gough, P. October 2019. BizJournals.com. https://www.bizjournals.com/pittsburgh/news/2019/10/31/eqt-cuts-spending-on-natural-gas-drilling-in-2019.html.

[6] Cocklin, J. July 2019. Natural Gas Intel. https://www.naturalgasintel.com/articles/119092-cabot-to-cut-spending-production-in-2020-as-natural-gas-market-weakens.

[7] Hiller, J. October 2019. Reuters. https://www.reuters.com/article/us-usa-naturalgas-chesapeake-energy-idUSKBN1X92AN.

2.2. PennEast and Adelphia Gateway Proposed Pipelines

In 2018 and 2019, the Federal Energy Regulatory Commission (FERC) approved eight pipeline projects to transport gas coming out of the Appalachian Basin, with six others still pending.[8,9] Of the approved projects, two of the largest pipelines are the PennEast Pipeline and the Adelphia Gateway Pipeline. The remainder of this report focuses on these two pipelines.

PennEast

The PennEast pipeline received its Certificate of Public Convenience and Necessity (CPCN) from the FERC in January 2018. The project has a proposed capacity of 1,107,000 dekatherms per day (Dth/d) over 116 miles of 36-inch diameter pipeline across Pennsylvania and New Jersey. At the time of FERC approval, the pipeline had 990,000 Dth/d of service commitments for gas transport. Since receiving regulatory approval, the project has encountered delays in obtaining permits and property rights in New Jersey. As a result, PennEast is now requesting approval from the FERC to split the project into two phases. Phase 1 includes only facilities in Pennsylvania, including an interconnection with the Adelphia Gateway pipeline and the Columbia Gas Transmission pipeline in Northampton County, while Phase 2 includes the remaining facilities in New Jersey. Dividing the project into two phases would allow pipeline construction in Pennsylvania to move forward while the company awaits receipt of the necessary permits in New Jersey.

Table 1. Capacity and service commitments for the proposed phases of the PennEast pipeline

PennEast Phase	Gas Capacity (Dth/d)	Service Commitments (Dth/d)
Phase 1	650,000	340,000
Phase 2	457,000	-

Source: Abbreviated Application for Amendment to Certificate of Public Convenience and Necessity of PennEast Pipeline Company, LLC. Available at: https://elibrary.ferc.gov/IDMWS/file_list.asp?document_id=14832180.

Adelphia Gateway

The Adelphia Gateway pipeline project would purchase two existing oil and gas pipelines (currently owned by Interstate Energy Company) and build new natural gas pipeline infrastructure in southeastern Pennsylvania. The project is organized into three zones: Zone North A, Zone North B, and Zone South. Zones North A and B only include existing natural gas pipeline infrastructure—34.5 miles of 18-inch diameter pipeline and 4.4 miles of 20-inch diameter pipeline. Zone South would repurpose 50 miles of

[8] Federal Energy Regulatory Commission. Approved Major Pipeline Projects. https://www.ferc.gov/industries/gas/indus-act/pipelines/approved-projects.asp.

[9] Federal Energy Regulatory Commission. Major Pipeline Projects Pending. https://www.ferc.gov/industries/gas/indus-act/pipelines/pending-projects.asp.

an 18-inch diameter oil pipeline to instead transport natural gas.[10] This newly converted Zone South pipeline would have a capacity of 250,000 Dth/d with a service commitment of 100,000 Dth/d.[11] All Adelphia Gateway calculations following in this memo include only the Zone South project, since the Zone North project would not develop additional pipeline capacity for natural gas.

3. POTENTIAL IMPACTS OF PENNEAST AND ADELPHIA GATEWAY

Given current pipeline capacity limitations to deliver gas to high-value markets, the economics do not favor increased drilling for natural gas. With additional transport capacity from pipelines like the PennEast and Adelphia Gateway, gas producers will again have an economic incentive to drill additional wells in the Appalachian Basin region. In addition to advancing new drilling, additional pipeline infrastructure will advance gas production in wells that have been drilled but from which the industry has not yet extracted gas due to a lack of available pipeline infrastructure.

3.1. Unconventional Gas Wells in Pennsylvania

As of early 2020, the state of Pennsylvania has 11,744 unconventional natural gas wells that have received a permit and are producing gas. Those wells are found largely in the counties located in the northeast and southwest regions of the state, which contain 85 percent of active wells. In the northeast region, near the start of the PennEast pipeline, four counties contain large volumes of producing gas wells: Bradford County (12 percent of producing wells in the state), Lycoming County (8 percent), Susquehanna County (15 percent), and Tioga County (7 percent). Figure 3 shows the distribution of the actively producing wells across the state.

Table 2. Unconventional gas wells in Pennsylvania by region

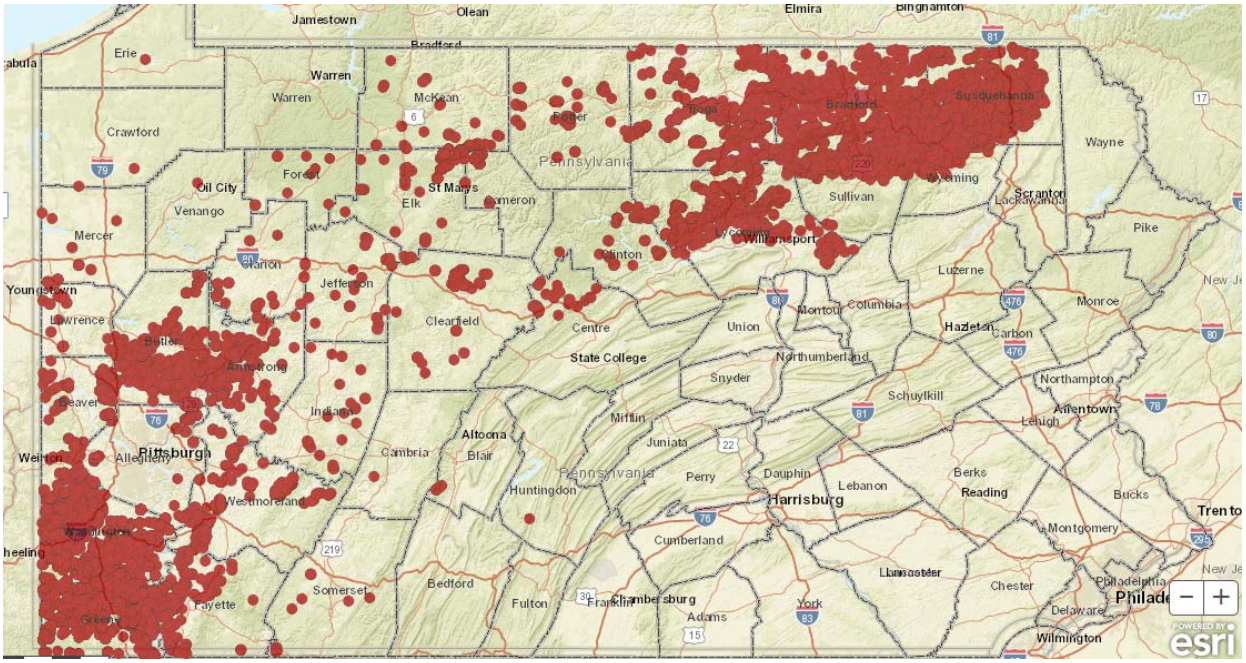
Region	Drilled	Proposed But Never Materialized	Operator Reported Not Drilled
Northeast	5,416	728	3,813
Southwest	4,575	1,120	1,258
Northwest	1,001	302	353
Central	752	315	649
Capital	0	0	0
Southeast	0	0	0
Total	11,744	2,465	6,073

[10] The Zone South portion of the Adelphia Gateway pipeline project also includes the construction of two new laterals (total of 4.65 miles), which would not increase the total gas capacity leaving Pennsylvania.

[11] Abbreviated Application of Adelphia Gateway, LLC for Certificates of Public Convenience and Necessity. Available at: https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=14796855.

Source: PA Geospatial Data Clearinghouse. Oil Gas Locations 2020. Dataset available online at: http://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=1088.

Figure 3. Map of producing unconventional gas wells in Pennsylvania



Source: PA Department of Environmental Protection, Oil and Gas Mapping. Available at: http://www.depgis.state.pa.us/PaOilAndGasMapping/OilGasWellsStrayGasMap.html.

The state of Pennsylvania also tracks natural gas wells that are Proposed but Never Materialized (PBNM), in which a permit was issued but expired prior to the commencement of drilling, as well as Operator Reported Not Drilled (ORND), in which a permit was issued but the operator reported that the well was never drilled. These sites are logical and likely candidates for new drilling in Pennsylvania. A total of 2,465 wells are classified as PBNM and 6,073 wells are classified as ORND (Table 2). Like active wells, most of these undrilled well permits are in the northeast (53 percent) and southwest (28 percent) regions of Pennsylvania.

Given the large number of wells that have been permitted but not drilled, one can reasonably expect that new natural gas wells drilled as a result of the construction of the PennEast and Adelphia pipelines would most likely be in the northeast and southwest regions of Pennsylvania. Those counties with the highest number of wells that received permits but were never drilled are Bradford, Susquehanna, Greene, Washington, Tioga, and Lycoming. Bradford County contains the greatest percentage of undrilled permitted wells in the state—21 percent.

Complete counts of producing, PBNM, and ORND wells by county and region in Pennsylvania can be found in the Appendix.

Table 3. PBNM and ORND wells by county in Northeast and Southwest Pennsylvania.

Region/County	Proposed but Never Materialized (PBNM)	Operator Reported Not Drilled (ORND)
Northeast	**728**	**3,813**
Bradford	102	1,731
Carbon	0	0
Lackawanna	0	27
Luzerne	1	12
Lycoming	139	447
Monroe	0	0
Pike	0	0
Sullivan	21	226
Susquehanna	199	661
Tioga	236	484
Wayne	5	4
Wyoming	25	221
Southwest	**1,120**	**1,258**
Allegheny	54	66
Beaver	45	101
Bedford	1	0
Blair	2	0
Cambria	4	15
Fayette	86	38
Greene	404	292
Indiana	23	32
Somerset	3	15
Washington	375	537
Westmoreland	123	162

Source: PA Geospatial Data Clearinghouse. Oil Gas Locations 2020. Dataset available online at: http://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=1088.

3.2. Impacts on Drilling Activity and Drilling-Related Emissions

If the PennEast and Adelphia Gateway pipelines move forward, a significant amount of existing shale gas production that has been curtailed would come online thereafter. At a minimum, permitted wells that were not previously completed would start producing gas for transport to New Jersey and Pennsylvania. This section of the memo estimates how many wells would likely come online as a result of each of the following pipeline projects: PennEast Phase 1, PennEast Phase 2, and the Adelphia Gateway Zone South. We also present results for the two following combinations of pipeline development: PennEast Phase 1 and Adelphia Zone South; PennEast Phases 1 and 2 and Adelphia Zone South.

The total number of wells induced by any given pipeline depends on the lifetime production, or estimated ultimate recovery (EUR), from a given well. EUR is typically measured in billion cubic feet (Bcf) per well. There is significant variability in EUR across wells in the state of Pennsylvania. As such, we have only included data from the counties where future drilling is most likely, based on the analysis above (Bradford, Susquehanna, Greene, Washington, Lycoming, and Tioga Counties). Further, there is additional variability due to increasing lateral lengths of horizontal wells in recent years, which have steadily been increasing average well EURs in the region.[12]

Our analysis begins with average EUR data by county in Pennsylvania and assumes each pipeline will have a lifetime of 40 years.[13] Given that the EUR data is only available through 2014 and the amount that EURs have increased since then is uncertain, we present a low and high estimate of likely well additions (Table 4). The low estimate assumes that average EURs have not changed from 2008 to 2014, whereas the high estimate assumes that average EURs have increased about 60 percent from 2015 to 2018.[14] The low and high estimates are both calculated using a weighted average based on the number of wells in each county. The resulting weighted average EURs (low and high) are 6.47 and 10.35 Bcf per well. Using this EUR range, we calculate the estimated number of new wells that will come online for each pipeline project in Table 4 below.

Table 4. Estimated number of future wells and drilling-related emissions (metric tons CO_2e), as a result of PennEast and Adelphia Gateway pipeline construction

Pipeline Project	Low Estimate of New Wells	High Estimate of New Wells	Low Estimate of Drilling-Related Emissions (mt CO_2e)	High Estimate of Drilling-Related Emissions (mt CO_2e)
PennEast Phase 1	917	1,466	1,254,641	2,007,425
PennEast Phase 2	644	1,031	882,109	1,411,374
Adelphia Zone South	353	564	482,554	772,086
PennEast Phase 1 + Adelphia Zone South	1,269	2,030	1,737,195	2,779,511
PennEast Phases 1 and 2 + Adelphia Zone South	1,913	3,061	2,619,303	4,190,885

If both the PennEast and Adelphia Gateway pipelines are constructed, between 1,900 and 3,100 new wells are likely to be drilled to fill the new capacity. These new wells will most likely be located in

[12] Westwood Energy. 2018. Super Laterals Trending in the US Northeast. Available at: https://www.westwoodenergy.com/blog/super-laterals-trending-in-the-us-northeast.

[13] Swindell, G. 2018. Estimated Ultimate Recovery (EUR) Study of 5,000 Marcellus shale wells in Pennsylvania (February 2018 Update). Available at: http://www.gswindell.com/marcellus_eur_study.pdf.

[14] Synapse communications.

northeast Pennsylvania (Bradford, Susquehanna, Tioga, and Lycoming Counties) and southwest Pennsylvania (Greene and Washington Counties).

The drilling and completion of these anticipated new wells will contribute to increased greenhouse gas emissions. Unconventional gas wells release CO_2 and CH_4 (methane) through combustion emissions, equipment leaks, and vented emissions from the wells themselves. To calculate the associated emissions from drilling these wells, we utilized an assessment from the U.S. EPA that reports the average emissions, in CO_2 equivalent (CO2e), associated with unconventional natural gas drilling well pads, at 4,927 metric tons (Mt) per well pad.[15] We converted this value into emissions per well[16] using the total number of active unconventional gas well pads in Pennsylvania, reported at 3,263.[17] This yields an average unconventional drilling emissions value for Pennsylvania of 1,369 Mt per well. This value was applied to the low and high estimates for new wells associated with each pipeline project. Results are shown in the fourth and fifth columns of Table 4. If both the PennEast and Adelphia Gateway pipelines are constructed, between 2.6 and 4.2 million Mt of CO_2e will be emitted into the atmosphere as a result of drilling and completion alone. The following section describes the CO_2e emissions associated with the combustion of the produced natural gas and the emissions associated with pipeline operations.

3.3. Impacts on Climate Damages

Climate damages associated with increasing greenhouse gas emissions can include, but are not limited to, property damage from floods, changes in agricultural productivity, extinction of endangered species, and loss of unique environments. These damages translate to increased health care costs, destruction of property, and increased food prices, which cost families and businesses billions of dollars. We calculated the social cost of the greenhouse gas emissions associated with the PennEast and Adelphia pipelines using the Social Cost of Carbon (SCC), as estimated by both the Obama and Trump administrations. The SCC is a value used to measure the climate damages—the monetized value of the net impacts—associated with carbon dioxide (CO_2) emissions. It values the incremental damages done by an additional ton of emitted CO_2 and discounts the sum of the total damages to the present value. These SCC estimates vary substantially because the Obama administration value (roughly \$50/ton of CO_2) includes global damages, while the Trump administration value (about \$7/ton of CO_2) only includes damages that occur within the United States.

---

[15] The EPA assumed that drilling and completion of an unconventional gas well takes place early in the year with the well producing gas the remainder of the year with a full complement of common, higher process emissions equipment on the well pad, including a compressor, glycol dehydrator, gas pneumatic controllers, and condensate tank without vapor recovery. Furthermore, the EPA assumed that unconventional well completion does not employ "Reduced Emissions Completion" practices. Data taken from page 32 of https://www.epa.gov/sites/production/files/2015-05/documents/subpart-w_tsd.pdf.

[16] A single well pad is a location which houses the wellheads for a number of horizontally drilled wells. The EPA reports average emissions per well pad, and here we estimate emissions per well.

[17] Pennsylvania Department of Environmental Protection. Available at: http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/Well_Pads.

First, we calculate the social cost of the carbon value, on a net present value basis, associated with the High and Low estimates of the drilling of new wells presented in Table 4, above. We make the conservative assumption that the drilling of new wells is evenly distributed over the 40-year assumed lifetime of the pipeline projects. The costs are shown in Table 5, below, for both the Low and High estimates of new wells drilled as a result of the pipeline projects under both Social Cost of Carbon values.

Table 5. Social cost of emissions of CO_2e associated with the drilling of new wells as a result of the pipeline projects

Pipeline Project	Total Costs (2019$, Obama SCC)		Total Costs (2019$, Trump SCC)	
	Low Wells	High Wells	Low Wells	High Wells
PennEast Phase 1	$46,012,770	$73,620,432	$6,300,293	$10,080,470
PennEast Phase 2	$32,350,517	$51,760,827	$4,429,591	$7,087,346
Adelphia Zone South	$17,697,219	$28,315,551	$2,423,190	$3,877,104
PennEast Phase 1 + Adelphia Zone South	$63,709,989	$101,935,982	$8,723,483	$13,957,573
PennEast Phases 1 and 2 + Adelphia Zone South	$96,060,506	$153,696,809	$13,153,074	$21,044,919

We find that the total climate damages resulting from the drilling of new gas wells using the Trump administration's values range from $13 million to $21 million, on a net present value basis. Total climate damages using the values from the Obama administration range from $96 million to $153 million.[18]

The new capacity of the various components of this pipeline project could carry large quantities of natural gas, resulting in the potential release of enormous quantities of greenhouse gas emissions. In addition to emissions generated by combustion of the gas that flows through the pipeline, additional emissions result from pipeline operations (including gas consumed by compressor stations, leaks, and other sources). The results are shown in Table 6.

Table 6. Social cost of maximum potential carbon emissions associated with PennEast pipeline project

		PennEast Phase 1	PennEast Phase 2	Adelphia	Total
Total Costs (million 2019$)	Obama Administration SCC	$20,473	$14,582	$7,960	$43,016
	Trump Administration SCC	$2,803	$1,997	$1,090	$5,890

[18] According to the Institute for Policy Integrity, experts agree that the Obama administration's central estimate of the social cost of carbon does not yet include all of the accepted economic impacts of climate change and is lower than the true cost of climate damages from greenhouse gases. Available at: https://www.edf.org/sites/default/files/expertconsensusreport.pdf

The present value cost over a projected lifetime of 40 years, discounted at 3 percent each year, ranges from a low of almost $6 billion using the Trump administration's values to a high of just over $43 billion using the estimates developed by the Obama administration. These numbers are likely conservative, as studies have found that emissions leakage is up to 60 percent higher than U.S. EPA estimates.[19] Valuation of increased leakage would increase the climate damages.

[19] Alvarez, R., et al. Assessment of methane emissions from the U.S. Oil and gas supply chain. Science 361, 186-188 (2018).

Appendix A. PERMITTED WELLS IN PENNSYLVANIA

Region/ County	Drilled and Producing	PBNM	ORND	% Drilled and Producing	% PBNM	% ORND
Capital	**0**	**0**	**0**	**0%**	**0%**	**0%**
Adams	0	0	0	0%	0%	0%
Cumberland	0	0	0	0%	0%	0%
Dauphin	0	0	0	0%	0%	0%
Franklin	0	0	0	0%	0%	0%
Fulton	0	0	0	0%	0%	0%
Lancaster	0	0	0	0%	0%	0%
Lebanon	0	0	0	0%	0%	0%
Perry	0	0	0	0%	0%	0%
York	0	0	0	0%	0%	0%
Central	**752**	**315**	**649**	**6%**	**13%**	**11%**
Cameron	73	3	46	1%	0%	1%
Centre	31	19	110	0%	1%	2%
Clearfield	101	85	127	1%	3%	2%
Clinton	85	12	50	1%	0%	1%
Columbia	0	8	2	0%	0%	0%
Elk	202	26	132	2%	1%	2%
Huntingdon	1	1	1	0%	0%	0%
Jefferson	47	49	31	0%	2%	1%
Juniata	0	0	0	0%	0%	0%
McKean	119	51	55	1%	2%	1%
Mifflin	0	0	0	0%	0%	0%
Montour	0	0	0	0%	0%	0%
Northumberland	0	0	0	0%	0%	0%
Potter	93	61	95	1%	2%	2%
Snyder	0	0	0	0%	0%	0%
Union	0	0	0	0%	0%	0%
Northeast	**5,416**	**728**	**3,813**	**46%**	**30%**	**63%**
Bradford	1,414	102	1,731	12%	4%	29%
Carbon	0	0	0	0%	0%	0%
Lackawanna	0	0	27	0%	0%	0%
Luzerne	0	1	12	0%	0%	0%
Lycoming	968	139	447	8%	6%	7%
Monroe	0	0	0	0%	0%	0%
Pike	0	0	0	0%	0%	0%
Sullivan	149	21	226	1%	1%	4%
Susquehanna	1,753	199	661	15%	8%	11%

Region/ County	Drilled and Producing	PBNM	ORND	% Drilled and Producing	% PBNM	% ORND
Tioga	816	236	484	7%	10%	8%
Wayne	0	5	4	0%	0%	0%
Wyoming	316	25	221	3%	1%	4%
Northwest	**1,001**	**302**	**353**	**9%**	**12%**	**6%**
Armstrong	301	62	48	3%	3%	1%
Butler	591	110	258	5%	4%	4%
Clarion	38	22	25	0%	1%	0%
Crawford	2	3	0	0%	0%	0%
Erie	1	0	0	0%	0%	0%
Forest	12	14	13	0%	1%	0%
Lawrence	28	57	5	0%	2%	0%
Mercer	27	25	1	0%	1%	0%
Venango	1	3	3	0%	0%	0%
Warren	0	6	0	0%	0%	0%
Southeast	**0**	**0**	**0**	**0%**	**0%**	**0%**
Berks	0	0	0	0%	0%	0%
Bucks	0	0	0	0%	0%	0%
Chester	0	0	0	0%	0%	0%
Delaware	0	0	0	0%	0%	0%
Lehigh	0	0	0	0%	0%	0%
Montgomery	0	0	0	0%	0%	0%
Northampton	0	0	0	0%	0%	0%
Philadelphia	0	0	0	0%	0%	0%
Schuylkill	0	0	0	0%	0%	0%
Southwest	**4,575**	**1,120**	**1,258**	**39%**	**45%**	**21%**
Allegheny	183	54	66	2%	2%	1%
Beaver	157	45	101	1%	2%	2%
Bedford	0	1	0	0%	0%	0%
Blair	6	2	0	0%	0%	0%
Cambria	1	4	15	0%	0%	0%
Fayette	335	86	38	3%	3%	1%
Greene	1,539	404	292	13%	16%	5%
Indiana	36	23	32	0%	1%	1%
Somerset	16	3	15	0%	0%	0%
Washington	1,961	375	537	17%	15%	9%
Westmoreland	341	123	162	3%	5%	3%
Grand Total	**11,744**	**2,465**	**6,073**	**100%**	**100%**	**100%**

Source: PA Geospatial Data Clearinghouse. Oil Gas Locations 2020. Dataset available online at: http://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=1088.