EXHIBIT NO. _____

BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application Seeking Approval of Ohio Power Company's Proposal to Enter Into Renewable Energy Purchase Agreements for Inclusion in the Renewable Generation Rider	)))))	Case No. 18-1392-EL-RDR
In the Matter of the Application of Ohio Power Company to Amend its Tariffs	))	Case No. 18-1393-EL-ATA

DIRECT TESTIMONY OF
STEPHEN BUSER
ON BEHALF OF
OHIO POWER COMPANY

Filed: September 27, 2018

INDEX TO DIRECT TESTIMONY OF
STEPHEN BUSER

BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO
DIRECT TESTIMONY OF
STEPHEN BUSER
ON BEHALF OF
OHIO POWER COMPANY

PERSONAL DATA

Q. STATE YOUR NAME, TITLE, AND BUSINESS ADDRESS.

A. My name is Stephen Buser. I am an emeritus professor of finance in the Fisher College of Business at The Ohio State University. My business address is 2748 Andover Road, Columbus, Ohio 43221.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.

A. I received an undergraduate degree in economics from Princeton University, and a PhD in economics from Boston College.

Q. WHAT IS YOUR PROFESSIONAL BACKGROUND?

A. I joined College of Business at The Ohio State University in 1975, which was nearly 2 decades before the college was renamed in honor of a major donor, Max Fisher. I taught at OSU both before and after my formal retirement from OSU in 2003. Prior to my retirement I also served as chair of the OSU Finance Department and Associate Dean for the Fisher College. I have attached a copy of my CV which also notes that during sabbaticals from OSU, I taught at the University of Chicago on three occasions, and twice at the Massachusetts Institute of Technology. In addition, in 2007 I was chosen to serve on the transition team for President-elect Obama. I was assigned to a team that evaluated the FDIC, during what is widely regarded as the worst financial crisis since the great depression.

In terms of the specific issues addressed in this report, I provided a report on the economic impact of the Columbus Blue Jackets and Nationwide Arena on the Columbus region. I also completed a similar study of the economic impact of a local development firm known as TechColumbus. More recently, my colleague for the current study, Bill LaFayette, and I provided a regional economic analysis for the potential location for an expansion of the U.S. Major League Soccer team in one of three potential locations in the general area of Cincinnati, Ohio.

Q. ON WHOSE BEHALF ARE YOU OFFERING TESTIMONY?

A. I am testifying on behalf of AEP Ohio.

PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS CASE?

A. The purpose of my testimony is to provide a summary of an economic impact study ("the Study") that I co-authored with Bill LaFayette. The primary focus of the Study is the potential economic impact for plans to construct and maintain two sources of alternative energy that are referred to, respectively, as Highland Solar and Willowbrook Solar. Company witness Karrasch provides the details for each of the referenced facilities.

The Study also includes an evaluation of the social benefits of access to clean energy including issues relating to the health of energy workers, as well as a number of seemingly unrelated issues such as gender equality and opioid issues in the state of Ohio.

Q. ARE YOU SPONSORING ANY EXHIBITS?

A. I am sponsoring the following exhibit:

Exhibit SB-1: CV of Stephen Buser

I am co-sponsoring the following exhibit:

Exhibit SB/BL-1: Impacts of Solar Plant Construction and Operation on the Ohio Economy

ECONOMIC IMPACT ANALYSIS

Q. WHAT IS AN ECONOMIC IMPACT ANALYSIS?

A. The term, economic impact analysis, refers to the formal analysis of various measures of economic performance such as the impact on the value of goods and services produced, household earnings, employment, and value added, which is a formal measure for the impact on gross domestic production, or GDP. Our report also includes estimates for fiscal impacts, which in our case refers to taxes collected by Ohio and by various local communities.

Q. IS ECONOMIC IMPACT ANALYSIS WIDELY USED AND ACCEPTED?

A. Yes on both accounts. Economic impact analysis is widely used, and it is widely accepted. In addition, the specific methods employed in our report to measure the direct, indirect and induced economic effects are widely used, and they are also widely accepted.

Q. PLEASE EXPLAIN THE DIRECT AND ADDITIONAL IMPACTS THAT ARE MEASURED IN AN ECONOMIC IMPACT ANALYSIS.

A. The term, direct effect, refers to the economic impacts of a specific action, such as the construction of a new facility to generate energy. The term, indirect effect, refers to additional economic impacts that are generated by firms that provide supplies needed to complete the project. And finally, the term, induced effect refers to additional benefits that are generated when employees of workers for the construction company and for the

companies providing supplies, spend part or all of their pay checks and thus generate additional demand for goods and services produced by seemingly unrelated parties.

Q. WHAT DATA AND INPUTS DID YOU USE FOR YOUR STUDY?

A. Estimates provided in the Study to assess regional economic impacts rely on multipliers provided by the U.S. Bureau of Economic Analysis. These multipliers are commonly referred to as the Regional Input-Output Modeling System (or RIMS II). The new system identifies different multipliers for different geographic areas as well as for different industries.

In addition to RIMS II multipliers obtained from the U.S. Bureau of Economic Analysis, our study relies on cost estimates provided by AEP Ohio as identified in the Study.

Q. PLEASE EXPLAIN THE ECONOMIC IMPACTS YOU HAVE ESTIMATED.

A. As noted in summary Table S-1 on page 3 of our report, if both solar construction plans are approved, we project the construction of the new facilities will create 3,870 new jobs. We also project that Ohio earnings for Ohio workers will grow by more than $250 million; output will grow by nearly $700 million; and the value added measure of the net effect on Ohio's GDP will grow by nearly $390 million.

As noted in summary Table S-2 on page 4, we also note that the post-construction annual operating economic effects are smaller in magnitude but will continue indefinitely. Specifically, we project that continuing Ohio employment will grow by roughly 50 jobs, earnings for Ohio workers will grow by more than $2.5 million; output will grow by more than $38 million; and the value added measure of the net contribution to the Ohio economy will grow by more than $33 million.

Q. WHARE ARE FISCAL IMPACTS AND HOW ARE THEY DIFFERENT FROM THE ECONOMIC IMPACTS?

A. The term, fiscal impacts, generally refers to the effects of a given proposal on either expenditures or tax revenues for one or more government entities. The focus of our study is on tax effects for the state of Ohio and for various local communities that will be generated by the construction and maintenance of the new facilities.

Q. WHAT ARE THE REGIONAL FISCAL IMPACTS YOU FIND?

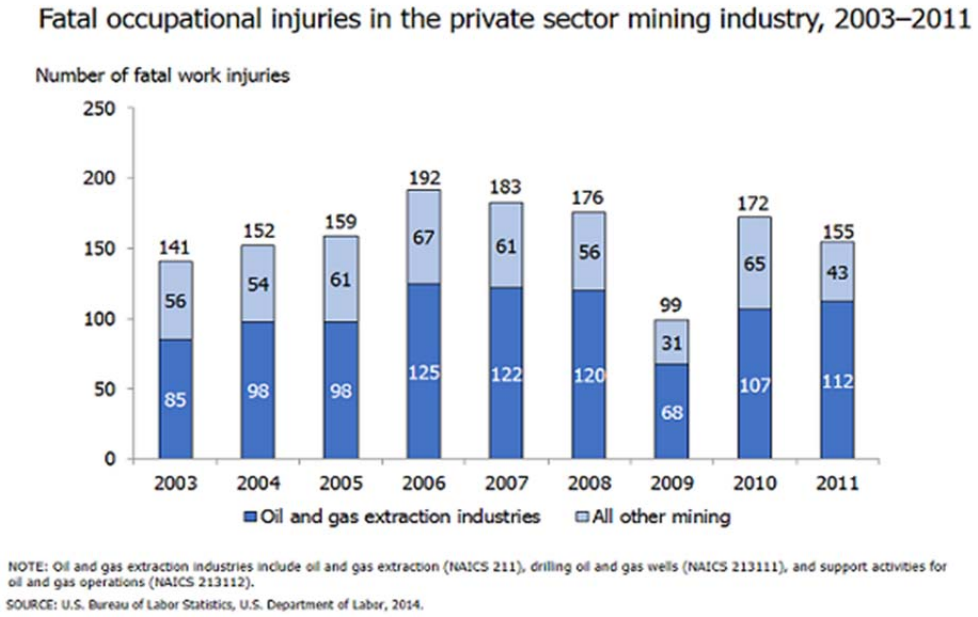
A. As identified in summary Table S-3 on page 4 of our report, we estimate that the construction of the new facilities will generate more than $24 million additional tax revenue for the state of Ohio. In addition, the construction of the facilities will generate more $8.4 million additional tax revenue for various local communities within Ohio. The increase in annual tax revenue from continuing operations is projected to be nearly $320,000 each year for the state of Ohio, and it is projected to add more than $50,000 per year for various localities within Ohio.

Q. WHAT ARE THE ADDITIONAL SOCIAL BENEFITS OF RENEWABLE ENERGY THAT ARE IDENTIFIED IN YOUR STUDY?

A. During a period of decreasing access to traditional sources of energy, such as coal, oil and gas, the development of renewable energy sources, such as solar and wind, is generally viewed as favorable both in the U.S. and in other countries. Despite this general approval, and despite significant advances that have occurred in the U.S., various studies report that the U.S. actually lags behind other countries, such as China and Brazil, with respect to the number of employees allocated to renewable energy sources.[1] The social benefits of renewable energy are also sometimes overlooked. A focus on social

benefits can encourage discussions among US citizens, which could in turn help promote access to renewable energy sources over time. This section of the Study seeks to encourage such discussions by considering examples of the social benefits for renewable energy such as: a) public health benefits; b) the development of transferable skills which can lead to enhanced gender equality in the energy industry; c) general benefits of improved standard of living; and d) potential ties to other issues such as strategies for addressing a growing opioid crisis.

Public Health Benefits. The authors of this Study acknowledge that in recent years, efforts to reduce risks for workers in traditional energy industries have been at least moderately successful. For example, a website maintained by the US Department of Labor (hereafter the DOL) claims the total number of mining related deaths reached an historic low of 35 deaths for the year 2009.[2] However, as shown in the following chart, a website maintained by the bureau of labors statistics (hereafter the BLS) identifies 99 mining deaths in the year 2009.[3] Despite this difference, the general patterns of mining deaths appear to be similar for reports by the BLS and the DOL.



According to a study conducted by the BLS, data provided by the Quarterly Census of Employment and Wages indicates that from 2003 to 2011, employment within the oil and gas industry increased by 71 percent and accounted for nearly 500,000 workers by the year 2011.[3] The same BLS study reports that the drilling of new oil and gas wells accounted for 17 percent of the oil and gas work force in 2011. Oil and gas extraction from existing wells accounted for an additional 34 percent of the 2011 oil and gas work force, and other forms of support for existing wells accounted for the remaining 48 percent of the oil and gas workforce as of 2011. These findings with respect job growth are generally viewed as favorable. However, there is also concern about health risks for a growing number of workers.

Despite the reduction in death rates, health risks continue to be substantial for workers in coal mines and in workers for oil and gas extraction. The BLS tracks these risks for workers in coal mines and workers in the gas and oil industries, and reports that

following a major coal mining disaster that occurred in 2006, there was a substantial reduction in the death rate for coal miners in subsequent years.[4] However, despite this improvement, in the year following the 2006 coal mining disaster, the number of fatal injuries for underground bituminous coal mine workers was still nearly six times the death rate for workers in private industries in general.[4] In addition, the BLS chart previously identified in this report also shows that for each of the years from 2003 to 2011, the number of fatal injuries was substantially higher for workers in the oil and gas industry than for workers in all other mining industries including coal mining.

With respect to nonfatal injuries and illnesses, the BLS estimates that for the year 2011, workers who either engaged in the drilling of new oil and gas wells or provided support for continuing operations for existing oil and gas wells suffered approximately 8,500 nonfatal injuries and illnesses.[3] The same report from the BLS also notes that nonfatal injuries and illnesses are more severe for oil and gas workers than for workers in other private industries. In support of this conclusion, the BLS notes that for the year 2011, the median number of days oil and gas employees were unable to work was 24, which was three times higher than the median number of days for injured workers were displaced in private industries in general. The BLS explains this pattern by observing that oil and gas injuries are frequently due to fracture bones that typically require extended periods of recovery.

A complete list of health issues related to traditional energy sources would be extensive, and researchers generally agree that the list continues to grow. For example, the World Health Organization estimates that worldwide air pollution generated by combustible energy sources could have accounted for as many as 7 million premature deaths in 2012.[5]

Researchers at MIT estimate that within the U.S., air pollution from combustible energy sources could account for as many as 200,000 additional premature deaths each year.[6]

Transferable Skills. The energy sector has traditionally been a heavily male-dominated field. When viewed from this perspective, a finding reported by the International Renewable Energy Agency (hereafter IRENA) is highly significant in so far as, on average, females account for roughly 35% of the labor force in the modern renewable energy sector.[1] Despite these gains, females continue to face difficult barriers in the energy field, and additional support is needed to provide essential tools such as: a) mentorship and training; b) policies to facilitate the raising of children; and c) and greater flexibility in the workplace. To provide additional benefits in the transfer from conventional to renewed energy, ideally, one would continue to draw on the local workforce, offer skills training programming, and promote gender fairness and equality.

Social Benefits of Improved Standard of Living. The United Nations Millenium Development program has identified a variety of measures of well-being such as health, personal security and subjective well-being. Each of these measures is believed to be highly correlated with disposable household income. For example, the International Organization for Economic Co-operation and Development, has identified links between living conditions and jobs, income, wealth, and housing conditions.[7] The organization also identifies additional dimensions related to quality of life, such as education and skills, health status, work life balance, civic engagement and governance, social connections, personal security, environmental quality and subjective well-being. Such interactions highlight he need for policies and programs that would benefit all

constituents and help close the income gaps among social groups. Economic development that is truly inclusive must take into account the security and well-being of all community members in all situations. In addition, social protections can lead to growing tax revenues that can be recycled into health, education, and infrastructure improvements, all of which can help advance human development.

Combatting the Opioid Crisis. Ohio has been described as "ground zero" for the nation's ongoing drug overdose epidemic.[8] According to the Center for Disease Control (hereafter the CDC), opioids - whether prescribed or illicit – are a major contributor to deaths due to drug overdose. The CDC has identified 63,632 drug overdose deaths for the year 2016.[9] For those deaths, the CDC found that opioids were involved in 42,249 of the cases. The CDC also reports that more than 10 percent of all opioid deaths in the U.S. occur in the state of Ohio. As a result of the general opioid problem, both human and financial resources are subject to increasing stress in a variety of fields including public health, social services, addiction treatment, and law enforcement.

Concluding Observation. After formally declaring a public health crisis in October of 2017, in March of 2018 President Trump said he would work with Congress to find $6 billion in new funding to fight the crisis in 2018 and 2019. Various studies suggest that for low income workers, increased income and enhanced standard of living can reduce the dependence on opioids. By virtue of these findings there might very well be an indirect link between improved standard of living and a reduction in the nature and extent of the opioid problem for the state of Ohio as well as for other states.

Q. DOES THIS COMPLETE YOUR DIRECT TESTIMONY?

A. Yes.

ENDNOTES:

[1] Source: IRENA. Renewable Energy Benefits: Understanding the Socio-economics. November 2017.

[2] Source: https://arlweb.msha.gov/mshainfo/factsheets/mshafct2.htm

[3] Source: https://www.bls.gov/iif/oshwc/cfoi/osar0018.htm

[4] Source: https://www.bls.gov/iif/oshwc/osh/os/osar0012.htm

[5] Source: World Health Organization, March 25, 2014.
http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/

[6] Source: Fabio Caiazzo, Akshay Ashok, Ian A. Waitz, Steve H.L. Yim, Steven R.H. Barrett Air pollution and early deaths in the United States. Part I: Quantifying the impact of major sectors in 2005. Atmospheric Environment, 79, November 2013, Pages 198-208.

[7] Source: IRENA. The Socio-economic Benefits of Solar and Wind Energy. May 2014

[8] Sources: Soboroff, Jacob. NBC News. Opioid addiction: How Ohio has become the epicenter. 2017. https://www.nbcnews.com/nightly-news/video/opioid-addiction-how-ohio-has-become-the-epicenter-971802691633, and Garrett, Amanda. How much has the opioid crisis cost Ohio? Akron Beacon Journal/Ohio.com. May 25, 2018.

[9] Source: https://www.cdc.gov/mmwr/volumes/67/wr/mm6712a1.htm?s_cid=mm6712a1_w

ACADEMIC VITA
for
Stephen A. Buser, Ph.D
as of Fall 2018
buser.1@osu.edu

Education:
Ph.D. Boston College, 1972 (Economics)
A.B. Princeton University, 1969 (Economics)

Employment:

2015-16	Adjunct Professor of Finance at the University of Chicago
2005-7	Member of the Board of Directors for STRS of Ohio
2004 (fall)	Visiting Professor of Finance at MIT
2004-13	Historian for the American Finance Association
2003-	Professor Emeritus at The Ohio State University
1997 (fall)	Visiting Professor of Finance at MIT (on leave from OSU)
1995-02	Associate Dean for the Fisher College of Business at OSU
1992-03	Chair of the Department of Finance at OSU
1988-95	Coeditor of the Journal of Finance
1988-02	Coordinator for the Student Investment Program at OSU
1986-02	Professor of Finance at The Ohio State University
1983-84	Visiting Associate Professor of Finance at the University of Chicago Graduate School of Business (on leave from OSU)
1979-86	Associate Professor of Finance at The Ohio State University
1975-79	Assistant Professor of Finance at The Ohio State University
1974-75	Financial Economist for the Federal Deposit Insurance Corporation (on leave from Southern Illinois University)
1972-75	Assistant Professor of Economics at Southern Illinois University

Courses Taught

Undergraduate: The Stock Market, Investments, Portfolio Analysis, Real Estate Finance, Corporate Finance, Statistics, Money and Banking, Principles of Microeconomics, Principles of Macroeconomics, Intermediate Macroeconomics, Risk and Insurance, and The History of Financial Thought and Practice.

Graduate: The Stock Market, Investments, Portfolio Analysis, Corporate Finance, Corporate Theory Seminar, Empirical Methods in Finance, Money and Banking, Monetary Theory, International Trade Theory, Macroeconomics, and The History of Financial Thought and Practice.

Journal Articles:

"Why is There Little or No Contingency Planning for the Fiscal Response to an Economic Recession?" The Open Journal of Economics and Finance 2017, Vol. 1.

"The First Difference Property of the Present Value Operator", with Bjarne Jensen, Quarterly Journal of Finance, (August 2017), Vol. 7, No. 4.

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"Implicit and Explicit Prices of Deposit Insurance and the Bank Capital Decision," with A.H. Chen and E.J. Kane, Proceedings of a Conference on Bank Structure and Competition (May 1980), pp. 174-193.

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“The History of Financial Thought,” presented at the Financial Management Association Annual Meeting in Orlando (October 2015)

“New Properties of the Old Present Value Operator,” presented at the Midwest Finance Association Annual Meetings in Chicago (March 2013).

“A State-Contingent Theory of Optimal Public Finance,” presented at the American Economic Association Annual Meetings in Atlanta (January 2012).

"The French Mortgage Market," with A.B. Sanders, presented at: University of Pennsylvania (Wharton, November 1993); and the American Real Estate and Urban Economic Association Annual Meetings in New York (December 1989).

"Recent Evidence on the Expectations Hypothesis," with A.B. Sanders, presented at: SMU (January 1993); the University of Notre Dame (November 1992); and the University of Connecticut (November 1991).

"Stock Returns, Inflation and Treasury Yields," with P.J. Hess, presented at: Tulane University (October 1988); and the University of Michigan (September 1987).

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Boston (November 1984); American Real Estate and Urban Economics Association Annual Meetings in Dallas (December 1984).

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IMPACTS OF SOLAR PLANT CONSTRUCTION AND OPERATION ON THE OHIO ECONOMY

Bill LaFayette, Ph.D.
Owner, Regionomics® LLC

Stephen A. Buser, Ph.D.
Professor Emeritus, Fisher College of Business
The Ohio State University

September 20, 2018

Regionomics®
From Trends to Insight to Action

THE OHIO STATE UNIVERSITY
FISHER COLLEGE OF BUSINESS

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IMPACTS OF SOLAR PLANT CONSTRUCTION AND OPERATION ON THE OHIO ECONOMY

Bill LaFayette, Ph.D., Owner, Regionomics® LLC
Stephen A. Buser, Ph.D.
Professor Emeritus, Fisher College of Business, The Ohio State University[1]
September 20, 2018

I. Summary of Major Findings

The purpose of this report is to document the impacts of the construction and operation of two solar energy projects on the Ohio economy, as well as less quantifiable economic and social benefits. The quantifiable economic impacts include increases in production and spending (output), household earnings, employment, and value added, a measure of the increase in Gross Domestic Product (GDP).

The impacts include not only the direct construction and operating expenditures, but also the activity of suppliers (indirect impacts) and the spending of earnings by households (induced impacts). Construction impacts last only for the construction period, but operating impacts are ongoing.

Table S-1 shows the construction impacts on the Ohio economy of the two projects. (Value added impacts are available only in total.) Ohio output increases $696.7 million, household earnings increase $252.7 million, nearly 3,900 full-time and part-time jobs are created or sustained, and Ohio's GDP increases $388.8 million. These impacts last for the duration of the construction projects.

Table S-1
Construction Impacts of the Two Solar Energy Projects

	Direct	Indirect	Induced	Total
Output ($000)	$ 332,396	$ 157,159	$ 207,174	$ 696,729
Earnings ($000)	$ 136,374	$ 46,730	$ 69,618	$ 252,722
Employment	1,690	710	1,470	3,870
Value added ($000)	---	---	---	$ 388,761

Components may not add to totals because of rounding.

The annual operating impacts are presented in Table S-2. The increase in annual output in Ohio totals $38.4 million, annual earnings total $2.6 million, jobs created or sustained total 51, and the increase in value added totals $33.4 million. Unlike the construction impacts, these annual impacts are ongoing.

[1] The authors acknowledge the essential research assistance provided by Amy Buser, Ph.D.

Table S-2
Annual Operating Impacts of the Two Solar Energy Projects

	Direct	Indirect	Induced	Total
Output ($000)	$ 34,313	$ 1,667	$ 2,379	$ 38,359
Earnings ($000)	$ 1,363	$ 490	$ 704	$ 2,558
Employment	26	9	16	51
Value added ($000)	---	---	---	$ 33,433

Components may not add to totals because of rounding.

State and local tax impacts, include state commercial activity taxes, state and local income taxes, and state and local sales taxes, are also estimated. Table S-3 summarizes state and local taxes from construction. These one-time revenues total $24 million to the state and $6.8 million to local jurisdictions statewide.

Table S-3
State and Local Tax Revenues from Facility Construction

	Commercial activity	Income	Sales	Total
Ohio taxes	$ 2,188,000	$ 7,368,000	$ 14,449,000	$ 24,005,000
Local taxes	---	3,847,000	2,949,000	6,796,000

Components may not add to totals because of rounding.

Table S-4 provides increases in annual tax revenues related to operations. Ongoing revenues for the state total $319,000 annually and local revenues total $52,000.

Table S-4
Annual State and Local Tax Revenues from Facility Operation

	Commercial activity	Income	Sales	Total
Ohio taxes	$ 180,300	$ 57,600	$ 80,700	$ 318,600
Local taxes	---	32,000	19,600	51,600

Components may not add to totals because of rounding.

There are various less-quantifiable economic and social benefits of renewable energy technologies. Concerns over the effects of traditional energy sources are drawing favorable attention to renewable sources. However, other countries including Brazil and China are ahead of the U.S. in employment in renewable energy production. The social benefits of renewable energy are also sometimes overlooked. A focus on social benefits can encourage greater awareness and discussions among U.S. residents leading to wider adoption of alternative energy and energy conservation practices.

One immediate benefit of the development of the proposed solar facilities is the increase in available power in the areas where those facilities would be developed. These areas have significantly lagged Ohio in employment growth during the expansion, and the potential economic development opportunities that the additional power could attract would be a positive development.

It might be argued that these jobs would be created at the expense of the oil and gas extraction jobs in eastern Ohio. While employment in some of the counties in the region has grown significantly, employment in other counties has lagged. Even in counties enjoying rapid growth, that growth has occurred primarily in other industries. Overall, direct oil and gas-related employment in these counties has increased far less than early studies predicted. Moreover, the share of women in alternative energy

fields is far greater than that in traditional energy industries. With suitable workforce development efforts, the development of alternative energy could promote gender equity and fairness.

The economic development that these alternative energy projects would promote could lead to better quality of life for the residents of these areas. Broad measures of well-being such as health and personal security are believed to be highly correlated with disposable household income. Linkages have also been identified between living conditions and jobs, income, wealth, housing conditions, and quality of life.

The opioid crisis has hit Ohio to a far greater degree than other parts of the U.S. The crisis has resulted in wasted lives, deaths, and billions of dollars of public expenditures. A lack of gainful employment and hope can lead people to self-medicate, which is one explanation for the high incidence of opioid abuse in Ohio's struggling legacy cities and rural areas. If that is the case, the direct, indirect, and induced employment increases created by the two solar energy projects could be helpful in addressing this problem.

II. Introduction

In 2015, AEP Ohio made a commitment as part of a larger case settlement to pursue development of 900 megawatts (MW) of renewable projects in Ohio, including 500 MW of wind projects and 400 MW of solar projects. Since that time, AEP Ohio has been pursuing that goal and currently has a proposal for approval of two solar energy projects that have resulted from competitive RFPs. These plants are proposed for installation in two rural locations in southern Ohio. Hecate Energy LLC proposes a 300 megawatt (MW) solar project on 2,611 acres in Sardinia, Highland County, within the Appalachian region of Ohio. (An additional 1,200 acres are available for expansion.) Open Road Renewables, LLC, and MAP Royalty, Inc., is proposing a 100 MW solar project, Willowbrook Solar, on 1,300 acres in Winchester, also in Highland County. These projects would begin delivering power at the end of 2021.

The purpose of this report is to document the construction and operation impacts of these two projects on the Ohio economy. These impacts include production and spending (output), household earnings, employment, and value added. Value added is income generated by production, a measure of the increase in gross domestic product. It is the sum of payments to labor, payments to governments (taxes), and returns to investment (gross operating surplus). The impacts can be measured quantitatively using standard economic impact analysis. The analytical approach is discussed in Section III. Section IV presents the results of the economic impact calculations. These economic activities will also generate tax revenues for state and local governments in Ohio, which are estimated in Section V. However, important impacts of these alternative energy projects cannot readily be measured in quantitative terms. These non-quantitative impacts are discussed in Section VI.

III. Estimation and Interpretation of Economic Impacts

The construction and operation of the two solar projects would generate production and spending, household earnings, employment, and value added. But these “direct impacts” comprise only a part of the total impacts on Ohio’s economy. The suppliers of goods and services used in construction and operation of the facilities generate output and purchase from their own suppliers to accommodate their activities. They may hire additional employees, but whether they do so or not, their current workers will become busier and their firms will become more profitable. The impacts created by these supplier activities are referred to as “indirect impacts.” Employees of the construction companies, the operators, and their suppliers earn wages and salaries, and self-employed business owners earn profits. These individuals spend these wages, salaries, and profits on household goods and services of all kinds. This spending also impacts Ohio’s economic activity and output. This household spending is referred to as an induced impact.

It is important to emphasize that the direct activities *cause* the indirect and induced spending. For this reason, the indirect and induced impacts are as much a part of the total economic impact as are the direct impacts. This is the point that makes economic impact analysis legitimate – and makes it legitimate to consider the impacts on commercial activity, income, and sales taxes generated by all three levels of activity as part of the overall impact of the construction and operation of the solar facilities.

Indirect and induced output, earnings, and employment impacts can be estimated by applying an economic impact model to the direct spending increase. (Value added is only available in total.) Several generally-accepted models are available to estimate these impacts; this analysis uses the Regional Input-

Output Modeling System (RIMS II) multipliers from the U.S. Bureau of Economic Analysis.[2] These multipliers are derived from a framework called an input-output table. For a given industry in a given geographic area, the input-output table shows the increase in purchases from other local firms by industry and the sales to other local firms by industry resulting from a one-dollar increase in the original industry's output. Thus, the input-output table can be used to derive the impact on those other local firms of an increase in production within a specific industry.

These impacts are specific both to a given industry and to a given geography. The array of suppliers that benefit from the spending to sustain the construction and operation of these projects is generally the same regardless of where they are located. But if the structure of the Ohio economy is such that significant purchases must be made from vendors outside the state – such as sophisticated electronic equipment – then that share of the impact will leak from the economy. Conversely, a broad economy with many relevant suppliers will keep more of the impact of the output increase circulating within the Ohio economy, and the indirect and induced impacts will be greater. Thus, the values within the input-output table are unique to Ohio. RIMS II summarizes the information in Ohio's input-output table by calculating a set of unique impact factors (multipliers) for each of 369 detailed industries and 62 generalized industries within the state. Because of their origin in the input-output table, the factors implicitly reflect the structure of Ohio's economy and the presence or absence of specific types of suppliers within the state. This can permit revenues or receipts (possibly modified as discussed below) to be multiplied by factors for output, earnings, employment, and value added to generate the impacts directly. However, an important point is that the results of even the most carefully-constructed economic impact analysis represent only the order of magnitude of the true impacts.

The nature of the solar projects poses a particular challenge, however. The construction of such a facility is significantly different from the standard construction projects that are assumed in the four available construction multipliers. Similarly, the operating characteristics of these facilities are markedly different from the operation of a typical electric power plant. This implies that using the standard construction and power generation multipliers could significantly misstate the impacts of these facilities. Accordingly, it is vital to take a different "bill of goods" estimation approach. This involves assembling budget information in as much detail as possible and estimating the economic impacts of purchases and labor line by line.

In doing so, attention must be paid to whether the goods are sourced in Ohio. The purchase price of an electronic component manufactured elsewhere includes not only the activities of an Ohio-based wholesaler, but also the manufacturing and transportation activities that occur outside of Ohio. To include the value of these activities would be to overstate the impact on the Ohio economy. The Bureau of Economic Analysis provides tables that separate the manufacturing, transportation, and wholesale components of the price of a good. These enable only the Ohio-based wholesaling activity to be included among the impacts. This change generally affects only prices of goods, not prices of services, which are almost always produced and consumed in the same location. However, for goods manufactured in Ohio – solar panels being the largest example here – the entire process from manufacture through delivery can be included.

[2] For detailed discussion of the RIMS II model and economic impact estimation techniques, see United States Bureau of Economic Analysis. *RIMS II: An essential tool for regional developers and planners*, n.d. https://apps.bea.gov/regional/pdf/rims/rimsii_user_guide.pdf.

Care also must be taken to net out the impacts of any operations for which these new facilities are a replacement. For example, if an old plant were to be decommissioned as a result of these facilities coming online, the impacts of the old facilities would have to be deducted from the new impacts. But no shutdowns are planned as a result of these projects. Consequently, these facilities represent a net increase in available power.

Employment estimates in an economic impact analysis must be interpreted particularly carefully. First, these are not all full-time jobs. Instead, a RIMS II analysis provides a mix of full-time jobs and part-time jobs (i.e., headcount) that is typical for the industry in question. While it is legitimate to refer to the direct jobs in a new activity as "created," the same cannot be said for indirect and induced jobs. The implication of an estimated employment impact is that additional activity exists to increase the headcount to the specified extent, but the model cannot determine whether this need is filled by new hiring or by existing workers increasing their hours and/or effort. Therefore, it is more appropriate to refer to these jobs not as created but as sustained. Note, however, that even if no new workers are hired, the income of existing workers would increase. This alone would give rise to additional induced activity.

This project has both construction components and operating components. Construction has a finite term, and so do the indirect and induced impacts associated with that activity. When the construction ends, so do the associated impacts. In contrast, operations continue indefinitely and so do the indirect and induced impacts associated with those operations. Because the construction and operating impacts are two different classes of impacts, they are presented and discussed separately in the results below.

IV. Economic Impact Results

Table 1 presents the results of the bill-of-goods construction estimates for the two solar projects. As noted above, value added estimates are available only in total. Together, the two construction projects add $332.4 million in production and spending to the Ohio economy during the construction period. Household earnings increase $136.4 million, 1,700 full-time and part-time jobs are created or sustained, and Ohio's gross domestic product increases $388.8 million.

The RIMS II model also provides output, earnings, and employment impacts allocated among the primary industry sectors. These are shown for each of the projects an in total in Tables A-1 through A-9 in the Appendix. Unlike the summary impacts shown in Table 1, these are not rounded because some of them are small. It bears repeating that these impacts represent only the order of magnitude of the unobservable actual impacts.

Table 2 provides estimates of operating impacts on the Ohio economy of the operation of each of the facilities individually and collectively. In contrast to the construction impacts that last only as long as the construction, these annual impacts are ongoing. Appendix Tables A-10 through A-18 allocate these impacts among industry sectors.

Table 1
Construction Impacts of the Solar Energy Projects

	Direct	Indirect	Induced	Total
Output ($000)				
Highland	$ 254,968	$ 119,161	$ 158,249	$ 532,378
Willowbrook	77,427	37,998	48,925	164,351
Total	**$ 332,396**	**$ 157,159**	**$ 207,174**	**$ 696,729**
Earnings ($000)				
Highland	$ 108,020	$ 36,972	$ 55,131	$ 200,124
Willowbrook	28,354	9,757	14,487	52,598
Total	**$ 136,374**	**$ 46,730**	**$ 69,618**	**$ 252,722**
Employment				
Highland	1,160	530	1,050	2,750
Willowbrook	520	180	410	1,120
Total	**1,690**	**710**	**1,470**	**3,870**
Value added ($000)				
Highland	---	---	---	299,516
Willowbrook	---	---	---	89,245
Total	**---**	**---**	**---**	**$ 388,761**

Components may not add to totals because of rounding.

Table 2
Annual Operating Impacts of the Solar Energy Projects

	Direct	Indirect	Induced	Total
Output ($000)				
Highland	$ 24,166	$ 648	$ 925	$ 25,740
Willowbrook	10,147	1,019	1,454	12,619
Total	**$ 34,313**	**$ 1,667**	**$ 2,379**	**$ 38,359**
Earnings ($000)				
Highland	$ 530	$ 191	$ 274	$ 995
Willowbrook	833	299	430	1,563
Total	**$ 1,363**	**$ 490**	**$ 704**	**$ 2,558**
Employment				
Highland	12	4	8	25
Willowbrook	14	4	8	26
Total	**26**	**9**	**16**	**51**
Value added ($000)				
Highland	---	---	---	$ 23,163
Willowbrook	---	---	---	10,270
Total	**---**	**---**	**---**	**$ 33,433**

Components may not add to totals because of rounding.

V. State and Local Tax Impacts

A. Overview of Taxes and Tax Impact Estimation

Because the impacts of the solar projects are a direct result of the construction and operation of those facilities, they can also be credited with the taxes that arise from these activities, as well as taxes arising from the earnings and spending of worker households. Taxes include Ohio Commercial Activity Tax (CAT), state and local income taxes, and state and local sales taxes. It is important to note that these tax impacts are a component of the economic impacts and therefore cannot be added to those impacts. It is also important to note that because any estimates from an economic impact model give only the order of magnitude of the true impact, these tax impacts are order-of-magnitude estimates as well. RIMS II does not provide tax impacts; these are estimated by a separate model developed by Regionomics and calibrated to Ohio's tax structure. CAT can be estimated fairly directly from the RIMS II output estimates. Given information on the wages and salaries of the direct, indirect, and induced jobs; tax rates; and expenditure patterns, the taxes paid by households can be estimated as well.

B. Commercial Activity Taxes

The CAT is the primary tax on businesses in Ohio. Conceptually, the tax is straightforward: 0.26 percent of gross receipts from most goods and services that are sold in Ohio, whether the vendor is Ohio-based or not. However, because businesses earning Ohio income between $15,000 and $1 million pay only a minimum tax of $150, the effective rate is less than 0.26 percent.

The relevant rate for the tax impact is the marginal rate because the revenues from sales of the power generated by the solar facilities are incremental to AEP's total revenue, and because the suppliers generating the indirect and induced impacts have many other customers. However, because only businesses with revenues of $1 million or more are subject to the CAT at the full 0.26 percent rate, simply multiplying output totals by 0.26 percent overestimates the tax revenue, even at the margin. The strategy is to obtain a bracketed estimate by using the 0.26 percent rate to derive a ceiling and calculating a floor based on average tax rates by sector. The Ohio Department of Taxation provides 2016 total collections by industry sector and the business revenues on which these collections are based. This information is used to calculate a set of sector-specific average tax rates by dividing aggregate tax liability after all credits by aggregate gross receipts. The resulting CAT rates vary from 0.167 percent for agriculture, forestry, fishing, and hunting to 0.258 percent for utilities. The sector tax rates are multiplied by the sector-specific output estimates and the results summed.

Recall, however, that direct purchases of goods are only included in output to the extent that production and distribution activities occur within Ohio. Even though only the margin of wholesalers represents relevant economic activity, the entire sales price of the good is taxable economic activity. Consequently, prices of goods are always included in the calculation at their full value. The product of the sector tax rates and outputs is a floor because it is based on average tax rates rather than the appropriate (but unobservable) marginal rates. The estimate of CAT liability is obtained by adding one-third of the floor to two-thirds of the ceiling.

This estimate is understated in two respects. First, although the direct goods prices are restated to their full value, the information is not available that would allow a similar restatement for indirect and induced output. Although services are included in the output estimates at their full value, the value of goods can be far less than their sale prices. A second understatement comes from the fact that the

indirect and induced output estimates include only the goods and services produced within Ohio. However, the sales to Ohio businesses and consumers by producers outside the state are also subject to the CAT, so these purchases also yield state tax revenue not included in the estimate.

C. State and Municipal Income Taxes

The RIMS II model generates earnings estimates directly, as shown in Tables 1 and 2. However, these are inappropriate for the estimation of income taxes because they include proprietors' income, which is part of the business income subject to the CAT rather than the personal income tax. Rather, the calculation of income taxes is based on the sector-specific employment impacts and the average wage for each sector.

The progressive income tax rate is a complicating factor in estimating state tax revenues. To address this problem, tax liability is calculated through the Ohio personal income tax form, and a tax rate determined for each industry sector at the 2017 Ohio average wage for the sector from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages. In practice, Ohio adjusted gross income includes other sources of income and other credits and deductions as well. It would be conceptually incorrect to include these, however, because doing so would incorporate factors not relevant to the impacts of the construction and operation of the facilities. Analysis of the Internal Revenue Service's Statistics of Income for 2015 reveals that households claimed an average of 2.07 exemptions, so two exemptions are assumed in the calculation. Half of returns are assumed to take the joint filing credit. Tax liability is divided by average income to give an effective tax rate for workers in each industry sector. This is the correct rate for direct employees, but the marginal rate is correct for indirect and induced jobs. Marginal rates are derived by increasing the sector wage by one dollar, rerunning the calculation, and calculating the difference in tax liability. The resulting rates are multiplied by the sector's aggregate income (number of workers times average wage) and the products summed across sectors to yield annual state income tax revenue.

Ohio municipalities tax wage, salary, and self-employment income earned within their borders. Although these taxes are levied at a flat rate, the complication here is that these rates vary significantly among jurisdictions. Generally, workers pay tax where they work regardless of where they live, although if the tax rate is higher in the municipality of residence than in the municipality of employment, the worker must pay the difference to the municipality where he/she lives. Townships are statutorily prohibited from charging income tax, so the workers both working and living outside municipalities pay no income tax at all.

The income on which tax liability is derived is calculated from sector-specific earnings. Neither of the facilities is within a taxing municipality, so employees will be taxed where they live if a tax exists. Based on the locations of the projects, direct Highland employees are assumed to live in Brown and Highland Counties, and direct Willowbrook employees are assumed to live in Adams, Brown, and Highland Counties. Other employees can live anywhere in the state. The Ohio Department of Taxation provides the 2016 income tax revenue and tax rates for each of the 624 taxing municipalities in the state. Collections are divided by the tax rate to derive the underlying taxed earnings. Collections and earnings are summed for the state and for the relevant counties of the two facilities; collections divided by earnings yields the average tax rate for the state or the two or three-county area. The resulting average rates are 1.90 percent for the state, 1.27 percent for the Highland area, and 1.24 percent for the Willowbrook area. However, these averages overstate the effective municipal income tax rates because they fail to reflect the fact that workers living and working outside taxing municipalities pay no tax. This

is especially true of the rural areas in which the solar facilities will be located. To reflect these workers, the total implied earnings are divided by the 2016 total wages and proprietors' income from the U.S. Bureau of Economic Analysis (BEA). The resulting ratio is multiplied by the average tax rate to produce an effective tax rate. The Highland area implied income is 76.0 percent of BEA income, giving an effective rate of 0.96 percent. Implied income in the Willowbrook area is 62.4 percent of the BEA income, so the effective municipal tax rate is 0.77 percent. A 90.5 percent statewide ratio produces an Ohio effective rate of 1.72 percent.

Businesses located in taxing municipalities also pay income taxes on their net income. These activities definitely increase net income of businesses across the state. The outputs from the RIMS II models do not include the information that would allow these taxes to be calculated, however.

D. State and Municipal Sales Taxes

In order to estimate state and county sales and use taxes paid on purchases made from direct, indirect, and induced wages, it is necessary to estimate the share of household earnings that is spent on taxable consumption so that sales tax rates can be linked to income. The Bureau of Labor Statistics' Consumer Expenditure Survey for 2016 provides average expenditure shares for nearly 100 detailed consumer goods and services. These are available for a variety of household characteristics including region of residence. Each expenditure category for Midwestern households is evaluated and the spending on those taxable in Ohio is summed and divided by total income to yield an estimate of the share of income that is spent on goods and services taxable in Ohio. The result is a taxable share of 22.94 percent of income. This percentage is multiplied by the sector-specific earnings to produce estimates of taxable spending, which in turn are multiplied by state and local sales tax rates to give sales tax revenue.

The Ohio sales tax rate is 5.75 percent; county rates piggyback on the state rate. County sales tax rates and collections for calendar year 2017 are provided by the Ohio Department of Taxation. Similar to the approach used to derive municipal income tax rates, average sales tax rates are calculated by dividing collections by county rates to derive implied taxable sales. Average sales tax rates are derived by summing collections and taxable sales and dividing the former by the latter. The average rate for all counties in Ohio is 1.15 percent. Each county in the two areas where the projects will be developed is 1.5 percent, so the average rate for both areas is 1.5 percent.

With few exceptions, for-profit businesses pay sales taxes on taxable purchases also. The categorized construction and operating expenditures allow direct sales taxes to be calculated. These are calculated from the statewide average because although the purchases will be made in Ohio, they will not necessarily be made in the vicinity of the facilities. As in the case of municipal income taxes, however, there is no similar information available for indirect and induced business purchases, so these cannot be calculated. Consequently, the taxes contributed by businesses as a result of the development and operation of the solar projects – and local tax impacts in total – are understated.

E. State and Local Tax Revenue Estimates

Table 3 reveals the results of the tax calculations that arise from construction activity, including indirect and induced activity, for each of the facilities. These revenues are earned during the construction period only. As the table shows, the state receives $24 million in CAT, income taxes, and sales taxes.

Municipalities throughout Ohio earn $3.8 million in income taxes and counties statewide earn $2.9 million in sales taxes. Total tax revenues of all governments within the state total $30.8 million.

Table 3
State and Local Tax Revenues from Construction of the Two Solar Plants

	Highland	Willowbrook	Total
Ohio taxes			
Commercial activity	$ 1,638,000	$ 551,000	$ 2,188,000
Income	5,813,000	1,554,000	7,368,000
Sales	10,288,000	4,161,000	14,449,000
Total	**$ 17,739,000**	**$ 6,267,000**	**$ 24,005,000**
Local taxes			
Income	$ 3,048,000	$ 799,000	$ 3,847,000
Sales	2,105,000	844,000	2,949,000
Total	**$ 5,153,000**	**$ 1,643,000**	**$ 6,796,000**
Total taxes	**$ 22,892,000**	**$ 7,910,000**	**$ 30,801,000**

Components may not add to totals because of rounding.

Table 4 provides the estimates of state and local tax revenues from direct, indirect, and induced activities surrounding the operation of the facilities. These are ongoing annual revenues. Ohio tax revenues total $0.32 million and local governments earn $0.05 million. Government revenues in total amount to $0.37 million each year.

Table 4
Annual State and Local Tax Revenues from Operation of the Two Solar Plants

	Highland	Willowbrook	Total
Ohio taxes			
Commercial activity	$ 126,300	$ 54,000	$ 180,300
Income	22,400	35,200	57,600
Sales	31,400	49,300	80,700
Total	**$ 180,100**	**$ 138,500**	**$ 318,600**
Local taxes			
Income	$ 12,400	$ 19,600	$ 32,000
Sales	7,600	12,000	19,600
Total	**$ 20,100**	**$ 31,500**	**$ 51,600**
Total taxes	**$ 200,200**	**$ 170,000**	**$ 370,200**

Components may not add to totals because of rounding.

VI. Non-Quantifiable Economic and Social Benefits of Renewable Energy Technology

A. Introduction

Access to traditional sources of energy such as coal, oil, and gas and their negative effects on the environment are becoming a greater concern. As a result, renewable energy sources such as solar power are growing in favor both in the U.S. and in other countries. Despite this growing approval, and despite significant advances that have occurred in the U.S., various studies report that the U.S. actually lags

behind other countries, such as China and Brazil, in the number of employees allocated to renewable energy sources.[3] A number of economic benefits exist that are more difficult to quantify than those included in the impact analysis in the previous sections. These are discussed below.

The social benefits of renewable energy are also sometimes overlooked. A focus on social benefits can encourage discussions of the positive aspects of alternative energy sources among U.S. residents, which could in turn help promote access to these energy sources over time. This section of the report seeks to encourage such discussions by considering examples of the social benefits for renewable energy such as: (a) public health benefits; (b) the development of transferable skills which can lead to enhanced gender equality in the energy industry; (c) economic benefits; (d) general benefits of improved living standards; and (e) potential linkages to other issues such as strategies for addressing the state's and the nation's growing opioid crisis.

B. Public Health Benefits

A greater emphasis on alternative energy sources could reduce occupational deaths and injuries. Although occupational fatalities in oil, gas, and coal mining industries have declined in recent years, the death rate in these industries remains far higher than average.[4] As Figure 1 documents, the death rate across all private sector industries has remained below 0.5 deaths per 10,000 workers at least since 2003. In contrast, there were nearly 1.5 deaths per 10,000 oil and gas workers in 2016 and roughly the same rate per 10,000 coal mining workers, a death rate four times the national average. This was an improvement from the previous decade, when oil and gas-related occupational deaths were six to seven times higher than average and coal-related deaths were generally seven to eight times higher. Excluding 2006 and 2010, when the death rate in coal mining spiked due to single disasters with mass casualties, the average death rates since 2003 in oil and gas mining and coal mining have been identical: 2.4 deaths per 10,000 over the period.

The BLS estimates that workers who either engaged in the drilling of new oil and gas wells or provided support for continuing operations for existing oil and gas wells suffered approximately 8,500 nonfatal injuries and illnesses during 2011.[5] The same BLS fact sheet indicates that nonfatal injuries and illnesses are more severe for oil and gas workers than for workers in other private industries. During 2011, the median number of days injured oil and gas employees were unable to work was 24, three times higher than the median for injured workers in private industries in general. The report notes that oil and gas injuries are frequently due to bone fractures that typically require extended periods of recovery. These extended recovery periods not only represent a public health problem, they can also lead to significant difficulties for the households of the injured workers, who may face large medical bills, the need to file worker compensation claims, and a possible reduction of income while the worker recovers. These injuries also adversely affect the productivity of the industry and the economy as a whole.

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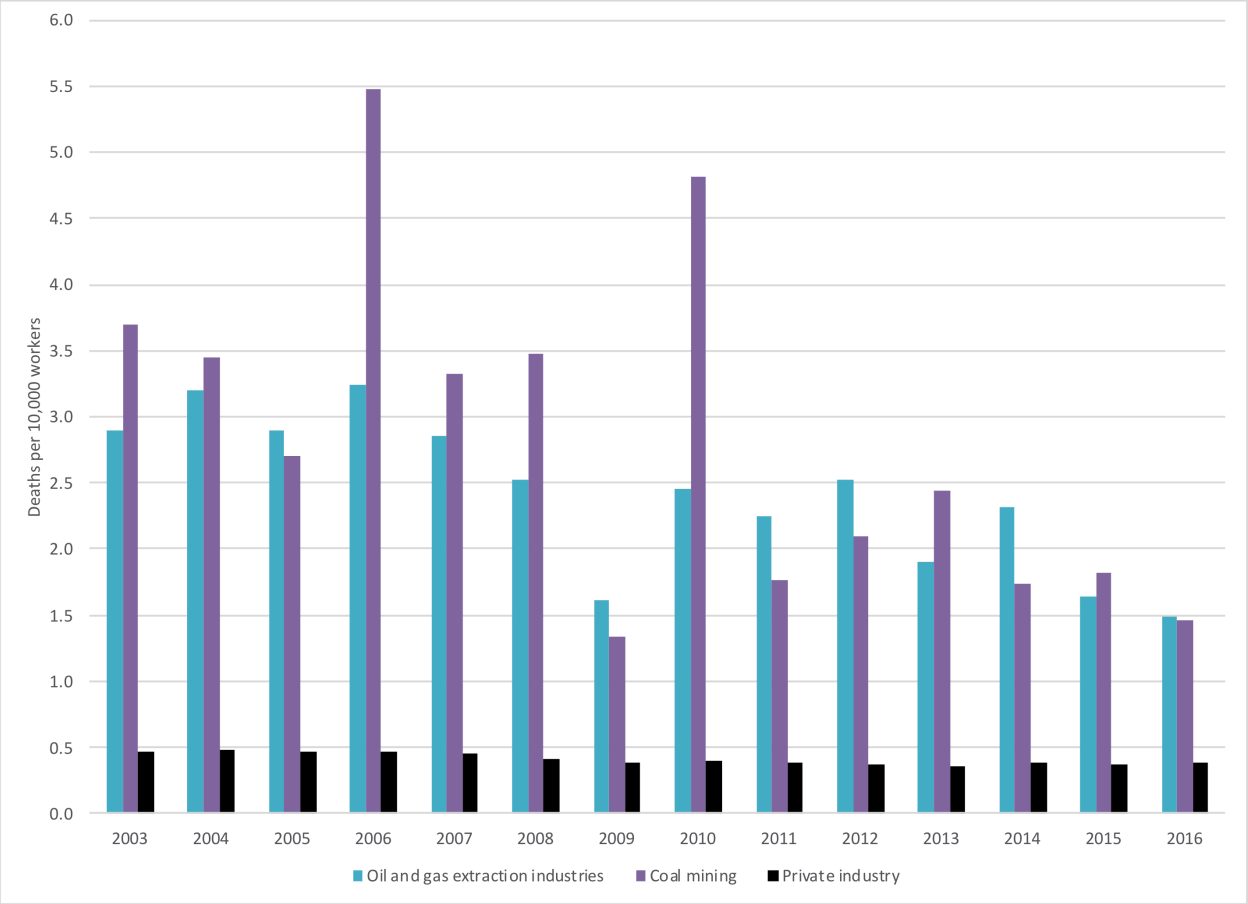
[3] International Renewable Energy Agency. Renewable energy benefits: Understanding the socio-economics, November 2017, p.5. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/IRENA_Understanding_Socio_Economics_2017.pdf?la=en&hash=C430B7EF772BA0E631190A75F7243B992211F102.

[4] Oil and gas mining industries include oil and gas extraction, drilling oil and gas wells, and support activities for oil and gas operations. Coal mining industries include coal mining and support activities for coal mining.

[5] United States Bureau of Labor Statistics. Fact sheet, oil and gas industry, April 2014. https://www.bls.gov/iif/oshwc/cfoi/osar0018.htm.

Figure 1
Fatal Occupational Injuries in Private Sector Mining Industries, 2003-2016



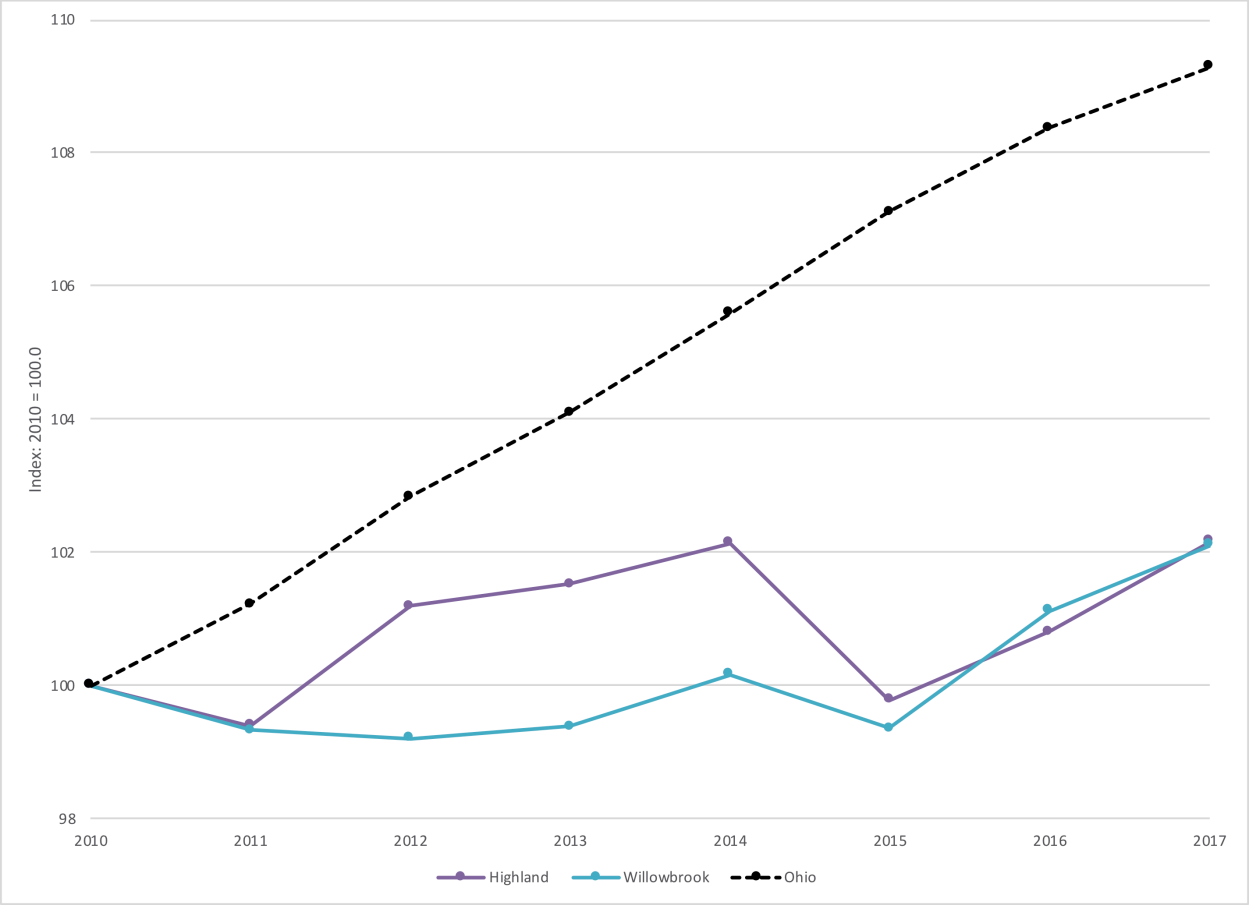
Source: Calculated from Census of Fatal Occupational Industries and Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

C. Economic Benefits

One immediate benefit of the development of the proposed solar facilities is the increase in available power in the areas where those facilities would be developed. This could improve the attractiveness of these areas for economic development, thereby increasing local employment. Figure 2 compares employment growth since 2010 in each of the two areas proposed for facility development to statewide employment growth.[6] As the chart reveals, each area has lagged far behind Ohio in employment growth during the expansion. (Ohio in turn has lagged the U.S.)

[6] The areas here are the same as those defined above for the tax impacts. Highland includes Brown and Highland Counties, and Willowbrook includes Adams, Brown, and Highland Counties.

Figure 2
Employment Growth in the Two Alternative Energy Development Areas and Ohio, 2010-2017



Source: Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

It might be argued that the alternative energy jobs contemplated in this report would be created at the expense of jobs related to hydraulic fracturing (fracking). The development of the Utica and Marcellus shale deposits in eastern and southeastern Ohio over the past decade led to a significant increase in oil and gas extraction activity in the region as fracking technology became available to release oil and gas that was not accessible through more traditional extraction means.

However, the evidence of a significant employment benefit of this activity to eastern and southeastern Ohio economies is mixed. One of the authors of this report analyzed employment changes in the Ohio counties where fracking activity was most prevalent as this activity was rapidly expanding.[7] Updating this analysis to include the period after the oil price collapse at the end of 2014 leads to the findings in Table 5. Belmont County, which ranked at or near the top of all Ohio counties for drilling permits between 2010 and 2014, has grown at a slower rate than Ohio through the entire expansion. In contrast, Carroll, Guernsey, and Harrison Counties grew at double digits during the boom and yielded only a modest amount of these gains subsequently. However, many of the gains in these three counties occurred in sectors other than mining. Carroll's growth was largely in manufacturing, Guernsey's was in healthcare, and Harrison's was in construction and trade. (However, some of the manufacturing jobs in

[7] Bill LaFayette. Statewide and regional employment growth in Ohio. *On the Money*, a Hannah News Service publication, August 8, 2014.

particular could have been indirect jobs related to fracking.) Total employment in natural resources and mining in all nine of these counties, not merely in oil and gas exploration – which is largely unavailable – totaled 3,600 in 2010 as the boom was beginning. More than 40 percent of that total was in Belmont County. Employment in the nine counties increased 2,700 between 2010 and 2014, and declined by more than 2,100 between 2014 and 2017. This growth is a far cry from the 20,000 to 66,000 net new jobs predicted by the Ohio Shale Coalition and others as a result of fracking activity, and again, includes jobs in industries other than oil and gas.[8]

Table 5
Employment in Counties impacted by Oil and Gas Exploration Activity, 2010-2017

County	2010	2014	2017	2010-2014	2014-2017	2010-2017
Belmont	22,506	23,682	23,216	5.2%	-2.0%	3.2%
Carroll	5,486	6,766	6,680	23.3%	-1.3%	21.8%
Columbiana	28,980	30,840	29,437	6.4%	-4.5%	1.6%
Guernsey	13,513	15,340	15,306	13.5%	-0.2%	13.3%
Harrison	3,275	4,068	4,001	24.2%	-1.6%	22.2%
Monroe	3,522	3,080	2,711	-12.5%	-12.0%	-23.0%
Noble	2,975	3,261	3,004	9.6%	-7.9%	1.0%
Portage	49,643	53,676	54,473	8.1%	1.5%	9.7%
Stark	148,817	158,336	159,197	6.4%	0.5%	7.0%
Ohio	4,908,571	5,183,462	5,364,537	5.6%	3.5%	9.3%

Source: Quarterly Census of Employment and Wages, U.S. Bureau of Labor Statistics.

The energy sector has traditionally been a heavily male-dominated field. According to the BLS, of the 87,000 employed nationwide in oil and gas exploration in 2017, only 12.8 percent were women.[9] In contrast, the International Renewable Energy Agency reports that females account for roughly 35 percent of the labor force in the modern renewable energy sector.[10] Despite these gains, females continue to face difficult barriers in the energy field, and additional support is needed to provide essential tools such as: (a) mentorship and training; (b) policies and supports to facilitate the raising of children; and (c) greater flexibility in the workplace. To provide additional benefits in the transfer from conventional to renewable energy, ideally, one would continue to draw on the local workforce, offer skills training programming and supportive services such as childcare and transportation assistance, and actively promote gender fairness and equality.

[8] However, two Ohio State University agricultural economists as early as 2011 identified critical flaws in the methods of these studies and predicted job creation much closer to the level that actually occurred. See Mark Partridge and Amanda Weinstein. Ohio Shale Coalition report appears to have overestimated Ohio shale job creation by about 400%. AED Economics Swank Program in Rural-Urban Policy, The Ohio State University, March 8, 2012.
https://aede.osu.edu/sites/aede/files/publication_files/Response%20to%20The%20Ohio%20Shale%20Coalition.pdf.

[9] Bureau of Labor Statistics. Employed persons by detailed industry, sex, race, and Hispanic or Latino ethnicity. *Labor Force Statistics from the Current Population Survey,* January 19, 2018.
https://www.bls.gov/cps/cpsaat18.htm.

[10] International Renewable Energy Agency, *op. cit.*

D. Social Benefits of Improved Living Standards

The economic development that these solar energy projects would promote could also lead to improved living standards and enhanced well-being. The United Nations Millennium Development program has identified a variety of measures of well-being such as health, personal security and subjective well-being. Each of these measures is believed to be highly correlated with disposable household income. For example, the International Organization for Economic Co-operation and Development (OECD) has identified links between living conditions and jobs, income, wealth, and housing conditions.[11] OECD also identifies additional dimensions related to quality of life, such as education and skills, health status, work-life balance, civic engagement and governance, social connections, personal security, environmental quality and subjective well-being. Such interactions highlight the need for policies and programs that would benefit all constituents and help close the income gaps among social groups. Economic development that is truly inclusive must take into account the security and well-being of all community members in all situations. In addition, social protections can lead to growing tax revenues that can be recycled into health, education, and infrastructure improvements, all of which can help advance human development. Thus, the economic benefits discussed above also promote social and emotional benefits.

E. Combatting the Opioid Crisis

Ohio has been described as "ground zero" for the nation's ongoing drug overdose epidemic.[12] The cost of addiction and treatment is enormous: state government expenditures of between $6.6 billion and $8.8 billion in 2015, compared to spending that year of $8.2 billion on public kindergarten through high school education throughout the state.[13] According to the Center for Disease Control (CDC), opioids – whether prescribed or illicit – are a major contributor to deaths due to drug overdose. The CDC identified 63,632 drug overdose deaths during 2016.[14] The CDC found that opioids were involved in 42,249 of those deaths. The CDC also reports that more than 10 percent of all opioid deaths in the U.S. occur in the state of Ohio. (Ohio's population is 3.6 percent of U.S. population, so Ohio's concentration of opioid deaths is nearly three times what would be expected.) As a result of the general opioid problem, both human and financial resources are subject to increasing stress in a variety of fields including public health, social services, addiction treatment, law enforcement, and workforce.

President Trump formally declared opioids to be a public health crisis in October 2017. In March 2018, the President said that he would work with Congress to find $6 billion in new funding to fight the crisis in 2018 and 2019. Various studies suggest that for low income workers, increased income and enhanced living standards can reduce the dependence on opioids. By virtue of these findings, there might very well be an indirect link between improved living standards and a reduction in the nature and extent of the opioid problem in Ohio and elsewhere. The NBC report referenced above noted that a lack of gainful employment and hope can lead people to turn to opioids as a way to self-medicate, which is one

[11] International Renewable Energy Agency, *op. cit.*
[12] Jacob Soboroff. Opioid addiction: How Ohio has become the epicenter. *NBC News*, June 20, 2017. https://www.nbcnews.com/nightly-news/video/opioid-addiction-how-ohio-has-become-the-epicenter-971802691633.
[13] Amanda Garrett. How much has the opioid crisis cost Ohio? *Akron Beacon Journal/Ohio.com*, May 25, 2018. https://www.ohio.com/akron/news/how-much-has-the-opioid-crisis-cost-ohio.
[14] Puja Seth *et al*. Overdose deaths involving opioids, cocaine, and psychostimulants — United States, 2015–2016. *Morbidity and Mortality Weekly Report,* March 30, 2018. https://www.cdc.gov/mmwr/volumes/67/wr/mm6712a1.htm?s_cid=mm6712a1_w.

explanation for the high incidence of opioid abuse in Ohio's struggling legacy cities and rural areas. If that is the case, the direct, indirect, and induced income and employment increases driven by these two solar energy projects and documented in this report could be helpful in addressing this crisis.

Appendix

Table A-1
Output Impacts of Highland Construction by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0	168,013	1,485,389	1,653,402
Mining	0	867,366	411,623	1,278,988
Utilities	0	2,119,986	4,064,454	6,184,440
Construction	74,590,921	785,810	1,454,950	76,831,681
Durable goods manufacturing	96,576,480	36,256,895	6,943,923	139,777,298
Nondurable goods manufacturing	0	14,872,704	16,019,184	30,891,888
Wholesale trade	10,496,149	13,571,293	8,724,418	32,791,860
Retail trade	0	1,643,406	16,489,061	18,132,467
Transportation and warehousing	0	6,271,138	6,097,479	12,368,616
Information	0	2,578,963	5,348,336	7,927,299
Finance and insurance	0	6,933,112	15,836,892	22,770,005
Real estate and rental and leasing	37,645,807	6,056,185	20,975,113	64,677,105
Professional, scientific, and technical services	35,659,008	11,747,477	5,144,114	52,550,599
Management of companies and enterprises	0	5,491,420	2,896,358	8,387,779
Administrative and waste management services	0	6,078,843	4,217,683	10,296,526
Educational services	0	57,699	2,641,212	2,698,911
Health care and social assistance	0	78,702	22,120,357	22,199,059
Arts, entertainment, and recreation	0	336,496	2,318,283	2,654,779
Accommodation	0	212,384	924,302	1,136,687
Food services and drinking places	0	1,236,679	6,381,687	7,618,366
Other services and government	0	1,796,116	7,753,936	9,550,052
Total	**254,968,365**	**119,160,687**	**158,248,755**	**532,377,807**

Table A-2
Earnings Impacts of Highland Construction by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0	45,879	360,372	406,250
Mining	0	179,674	83,612	263,286
Utilities	0	353,849	698,949	1,052,797
Construction	52,213,645	276,262	544,965	53,034,871
Durable goods manufacturing	30,846,891	8,915,682	1,534,095	41,296,668
Nondurable goods manufacturing	0	2,820,807	3,033,165	5,853,971
Wholesale trade	3,253,861	4,857,990	3,174,829	11,286,680
Retail trade	0	764,701	6,873,020	7,637,720
Transportation and warehousing	0	2,319,924	2,273,257	4,593,181
Information	0	658,153	1,250,386	1,908,539
Finance and insurance	0	1,959,453	4,641,214	6,600,667
Real estate and rental and leasing	7,755,916	1,156,145	3,854,509	12,766,570
Professional, scientific, and technical services	13,949,940	5,597,666	2,717,241	22,264,847
Management of companies and enterprises	0	2,407,136	1,354,317	3,761,452
Administrative and waste management services	0	3,046,770	2,171,426	5,218,195
Educational services	0	27,649	1,457,625	1,485,274
Health care and social assistance	0	45,408	11,676,644	11,722,052
Arts, entertainment, and recreation	0	144,004	865,504	1,009,508
Accommodation	0	70,188	294,797	364,985
Food services and drinking places	0	446,463	2,462,657	2,909,120
Other services and government	0	878,611	3,538,966	4,417,577
Households	0	0	269,436	269,436
Total	**108,020,254**	**36,972,412**	**55,130,984**	**200,123,649**

Table A-3
Employment Impacts of Highland Construction by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0.0	1.1	10.8	11.9
Mining	0.0	1.2	0.8	2.0
Utilities	0.0	2.4	4.3	6.8
Construction	268.0	4.3	7.0	279.3
Durable goods manufacturing	522.8	92.3	17.5	632.6
Nondurable goods manufacturing	0.0	27.2	34.2	61.5
Wholesale trade	48.1	50.5	31.3	129.9
Retail trade	0.0	12.9	174.3	187.2
Transportation and warehousing	0.0	33.1	32.4	65.5
Information	0.0	8.3	13.6	21.9
Finance and insurance	0.0	28.1	58.2	86.3
Real estate and rental and leasing	106.7	40.8	158.9	306.4
Professional, scientific, and technical services	219.0	81.3	32.2	332.5
Management of companies and enterprises	0.0	19.2	8.9	28.1
Administrative and waste management services	0.0	82.4	46.4	128.7
Educational services	0.0	0.8	39.3	40.1
Health care and social assistance	0.0	0.5	170.5	171.0
Arts, entertainment, and recreation	0.0	4.9	25.8	30.7
Accommodation	0.0	1.9	7.5	9.4
Food services and drinking places	0.0	20.9	91.7	112.7
Other services and government	0.0	15.4	69.4	84.9
Households	0.0	0.0	16.2	16.2
Total	**1,164.6**	**529.6**	**1,051.5**	**2,745.7**

Table A-4
Output Impacts of Willowbrook Construction by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	1,443,050	250,119	459,780	2,152,950
Mining	0	299,954	128,466	428,420
Utilities	0	822,181	1,256,127	2,078,307
Construction	23,647,400	298,814	449,249	24,395,463
Durable goods manufacturing	47,946,500	13,694,400	2,149,096	63,789,996
Nondurable goods manufacturing	0	5,331,527	4,951,484	10,283,010
Wholesale trade	3,106,926	4,244,184	2,696,484	10,047,594
Retail trade	0	479,926	5,097,775	5,577,702
Transportation and warehousing	0	1,934,616	1,884,976	3,819,592
Information	0	690,472	1,653,846	2,344,318
Finance and insurance	0	1,660,349	4,897,201	6,557,550
Real estate and rental and leasing	0	1,543,082	6,484,677	8,027,759
Professional, scientific, and technical services	532,000	2,750,372	1,591,991	4,874,363
Management of companies and enterprises	0	1,827,511	896,153	2,723,664
Administrative and waste management services	618,450	1,417,720	1,302,413	3,338,583
Educational services	0	12,352	816,588	828,940
Health care and social assistance	0	20,365	6,838,616	6,858,981
Arts, entertainment, and recreation	0	74,783	716,714	791,497
Accommodation	0	36,021	285,124	321,145
Food services and drinking places	0	179,295	1,972,399	2,151,694
Other services and government	133,000	429,966	2,396,308	2,959,274
Total	**77,427,326**	**37,998,008**	**48,925,470**	**164,350,803**

Table A-5
Earnings Impacts of Willowbrook Construction by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	564,747	91,078	95,091	750,916
Mining	0	48,493	23,215	71,708
Utilities	0	121,833	182,553	304,386
Construction	11,135,798	94,784	143,825	11,374,407
Durable goods manufacturing	15,228,749	2,731,969	402,958	18,363,676
Nondurable goods manufacturing	0	841,466	796,070	1,637,537
Wholesale trade	963,163	1,314,996	834,649	3,112,808
Retail trade	0	170,623	1,807,521	1,978,144
Transportation and warehousing	0	600,811	595,860	1,196,671
Information	0	161,835	328,248	490,083
Finance and insurance	0	445,566	1,217,553	1,663,119
Real estate and rental and leasing	0	257,429	1,014,372	1,271,801
Professional, scientific, and technical services	223,184	1,224,266	714,197	2,161,647
Management of companies and enterprises	0	736,828	354,933	1,091,761
Administrative and waste management services	208,008	619,185	570,099	1,397,292
Educational services	0	3,739	384,883	388,622
Health care and social assistance	0	7,817	3,071,107	3,078,924
Arts, entertainment, and recreation	0	31,691	225,923	257,614
Accommodation	0	11,076	77,109	88,185
Food services and drinking places	0	60,450	647,077	707,527
Other services and government	30,369	181,210	929,941	1,141,520
Households	0	0	69,559	69,559
Total	**28,354,018**	**9,757,145**	**14,486,743**	**52,597,906**

Table A-6
Employment Impacts of Willowbrook Construction by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	25.3	4.0	4.2	33.6
Mining	0.0	0.6	0.3	0.9
Utilities	0.0	1.1	1.7	2.8
Construction	209.7	1.8	2.8	214.3
Durable goods manufacturing	258.9	48.6	6.9	314.4
Nondurable goods manufacturing	0.0	12.0	13.5	25.5
Wholesale trade	14.2	19.4	12.4	46.0
Retail trade	0.0	6.2	68.7	74.9
Transportation and warehousing	0.0	11.9	12.8	24.7
Information	0.0	2.6	5.4	7.9
Finance and insurance	0.0	7.9	23.0	30.9
Real estate and rental and leasing	0.0	11.4	62.6	74.1
Professional, scientific, and technical services	4.0	20.3	12.7	37.0
Management of companies and enterprises	0.0	7.2	3.5	10.7
Administrative and waste management services	8.3	19.7	18.3	46.3
Educational services	0.0	0.2	15.5	15.7
Health care and social assistance	0.0	0.2	67.2	67.4
Arts, entertainment, and recreation	0.0	1.2	10.2	11.4
Accommodation	0.0	0.4	2.9	3.3
Food services and drinking places	0.0	3.3	36.1	39.4
Other services and government	0.4	4.0	27.4	31.8
Households	0.0	0.0	6.4	6.4
Total	**520.8**	**184.2**	**414.4**	**1,119.4**

Table A-7
Output Impacts of the Two Construction Projects by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	1,443,050	418,132	1,945,169	3,806,352
Mining	0	1,167,320	540,089	1,707,408
Utilities	0	2,942,166	5,320,581	8,262,747
Construction	98,238,321	1,084,625	1,904,199	101,227,144
Durable goods manufacturing	144,522,980	49,951,295	9,093,020	203,567,295
Nondurable goods manufacturing	0	20,204,230	20,970,668	41,174,898
Wholesale trade	13,603,074	17,815,477	11,420,901	42,839,453
Retail trade	0	2,123,332	21,586,836	23,710,169
Transportation and warehousing	0	8,205,754	7,982,455	16,188,209
Information	0	3,269,435	7,002,182	10,271,617
Finance and insurance	0	8,593,462	20,734,093	29,327,555
Real estate and rental and leasing	37,645,807	7,599,267	27,459,790	72,704,863
Professional, scientific, and technical services	36,191,008	14,497,849	6,736,105	57,424,963
Management of companies and enterprises	0	7,318,931	3,792,511	11,111,442
Administrative and waste management services	618,450	7,496,563	5,520,096	13,635,109
Educational services	0	70,051	3,457,800	3,527,851
Health care and social assistance	0	99,066	28,958,973	29,058,039
Arts, entertainment, and recreation	0	411,279	3,034,997	3,446,276
Accommodation	0	248,405	1,209,427	1,457,832
Food services and drinking places	0	1,415,974	8,354,087	9,770,061
Other services and government	133,000	2,226,082	10,150,244	12,509,326
Total	**332,395,690**	**157,158,695**	**207,174,224**	**696,728,610**

Table A-8
Earnings Impacts of the Two Construction Projects by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	564,747	136,957	455,462	1,157,166
Mining	0	228,167	106,827	334,994
Utilities	0	475,681	881,502	1,357,183
Construction	63,349,443	371,046	688,790	64,409,278
Durable goods manufacturing	46,075,641	11,647,650	1,937,053	59,660,344
Nondurable goods manufacturing	0	3,662,273	3,829,235	7,491,508
Wholesale trade	4,217,024	6,172,986	4,009,478	14,399,488
Retail trade	0	935,324	8,680,541	9,615,865
Transportation and warehousing	0	2,920,734	2,869,117	5,789,851
Information	0	819,988	1,578,634	2,398,622
Finance and insurance	0	2,405,019	5,858,767	8,263,786
Real estate and rental and leasing	7,755,916	1,413,574	4,868,881	14,038,371
Professional, scientific, and technical services	14,173,124	6,821,932	3,431,438	24,426,494
Management of companies and enterprises	0	3,143,964	1,709,249	4,853,213
Administrative and waste management services	208,008	3,665,955	2,741,524	6,615,487
Educational services	0	31,388	1,842,508	1,873,896
Health care and social assistance	0	53,225	14,747,750	14,800,976
Arts, entertainment, and recreation	0	175,695	1,091,427	1,267,121
Accommodation	0	81,263	371,907	453,170
Food services and drinking places	0	506,913	3,109,734	3,616,647
Other services and government	30,369	1,059,821	4,468,907	5,559,097
Households	0	0	338,996	338,996
Total	**136,374,272**	**46,729,556**	**69,617,727**	**252,721,555**

Table A-9
Employment Impacts of the Two Construction Projects by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	25.3	5.1	15.0	45.4
Mining	0.0	1.9	1.1	3.0
Utilities	0.0	3.5	6.1	9.6
Construction	477.7	6.1	9.8	493.6
Durable goods manufacturing	781.6	140.9	24.4	947.0
Nondurable goods manufacturing	0.0	39.2	47.7	87.0
Wholesale trade	62.3	69.9	43.7	175.9
Retail trade	0.0	19.1	243.0	262.1
Transportation and warehousing	0.0	45.0	45.2	90.2
Information	0.0	10.9	19.0	29.9
Finance and insurance	0.0	36.0	81.2	117.2
Real estate and rental and leasing	106.7	52.2	221.6	380.5
Professional, scientific, and technical services	223.1	101.6	44.8	369.5
Management of companies and enterprises	0.0	26.3	12.4	38.7
Administrative and waste management services	8.3	102.1	64.6	175.0
Educational services	0.0	1.0	54.8	55.9
Health care and social assistance	0.0	0.7	237.7	238.4
Arts, entertainment, and recreation	0.0	6.2	35.9	42.1
Accommodation	0.0	2.3	10.4	12.7
Food services and drinking places	0.0	24.2	127.9	152.1
Other services and government	0.4	19.4	96.8	116.7
Households	0.0	0.0	22.6	22.6
Total	**1,685.4**	**713.8**	**1,465.8**	**3,865.1**

Table A-10
Annual Output Impacts of Highland Operation by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0	786	8,700	9,486
Mining	0	7,126	2,485	9,611
Utilities	22,800,000	26,782	23,780	22,850,561
Construction	0	112,229	8,500	120,728
Durable goods manufacturing	0	51,095	40,563	91,658
Nondurable goods manufacturing	0	47,463	93,640	141,103
Wholesale trade	93,340	23,435	51,024	167,799
Retail trade	0	14,979	96,457	111,436
Transportation and warehousing	0	26,791	35,572	62,363
Information	0	17,372	31,235	48,607
Finance and insurance	0	93,953	92,567	186,519
Real estate and rental and leasing	763,708	53,569	122,717	939,994
Professional, scientific, and technical services	0	62,138	30,124	92,261
Management of companies and enterprises	0	13,417	16,878	30,296
Administrative and waste management services	0	74,645	24,713	99,358
Educational services	0	343	15,412	15,755
Health care and social assistance	0	324	129,290	129,614
Arts, entertainment, and recreation	0	1,962	13,614	15,576
Accommodation	0	1,227	5,410	6,637
Food services and drinking places	0	6,990	37,359	44,349
Other services and government	509,138	11,691	45,372	566,201
Total	**24,166,185**	**648,314**	**925,413**	**25,739,912**

Table A-11
Annual Earnings Impacts of Highland Operation by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0	206	1,747	1,953
Mining	0	1,206	342	1,547
Utilities	0	3,937	3,431	7,368
Construction	0	35,828	2,757	38,585
Durable goods manufacturing	0	10,345	7,566	17,911
Nondurable goods manufacturing	0	7,783	15,071	22,854
Wholesale trade	28,936	7,276	15,796	52,007
Retail trade	0	5,241	34,106	39,347
Transportation and warehousing	0	8,802	11,268	20,070
Information	0	3,756	6,229	9,985
Finance and insurance	0	24,704	23,057	47,761
Real estate and rental and leasing	114,194	8,317	19,190	141,701
Professional, scientific, and technical services	0	26,589	13,484	40,073
Management of companies and enterprises	0	5,384	6,798	12,182
Administrative and waste management services	0	33,169	10,794	43,963
Educational services	0	146	7,209	7,354
Health care and social assistance	0	137	58,042	58,179
Arts, entertainment, and recreation	0	704	4,328	5,032
Accommodation	0	324	1,493	1,817
Food services and drinking places	0	2,352	12,209	14,561
Other services and government	116,254	4,341	17,619	138,214
Households	270,862	0	1,378	272,240
Total	**530,245**	**190,547**	**273,913**	**994,706**

Table A-12
Annual Employment Impacts of Highland Operation by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0.0	0.0	0.1	0.1
Mining	0.0	0.0	0.0	0.0
Utilities	0.0	0.0	0.0	0.1
Construction	0.0	0.7	0.1	0.7
Durable goods manufacturing	0.0	0.2	0.1	0.3
Nondurable goods manufacturing	0.0	0.1	0.3	0.4
Wholesale trade	0.4	0.1	0.2	0.8
Retail trade	0.0	0.2	1.3	1.5
Transportation and warehousing	0.0	0.2	0.2	0.4
Information	0.0	0.1	0.1	0.2
Finance and insurance	0.0	0.4	0.4	0.9
Real estate and rental and leasing	7.6	0.5	1.2	9.3
Professional, scientific, and technical services	0.0	0.5	0.2	0.7
Management of companies and enterprises	0.0	0.1	0.1	0.1
Administrative and waste management services	0.0	1.1	0.3	1.4
Educational services	0.0	0.0	0.3	0.3
Health care and social assistance	0.0	0.0	1.3	1.3
Arts, entertainment, and recreation	0.0	0.0	0.2	0.2
Accommodation	0.0	0.0	0.1	0.1
Food services and drinking places	0.0	0.1	0.7	0.8
Other services and government	1.7	0.1	0.5	2.3
Households	2.7	0.0	0.1	2.8
Total	**12.4**	**4.4**	**7.8**	**24.7**

Table A-13
Annual Output Impacts of Willowbrook Operation by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0	1,235	13,670	14,905
Mining	0	11,197	3,904	15,102
Utilities	8,000,000	42,081	37,365	8,079,446
Construction	0	176,343	13,355	189,698
Durable goods manufacturing	0	80,284	63,736	144,020
Nondurable goods manufacturing	0	74,579	147,135	221,713
Wholesale trade	146,663	36,823	80,174	263,659
Retail trade	0	23,536	151,561	175,097
Transportation and warehousing	0	42,096	55,894	97,990
Information	0	27,296	49,079	76,375
Finance and insurance	0	147,626	145,448	293,075
Real estate and rental and leasing	1,200,000	84,172	192,823	1,476,995
Professional, scientific, and technical services	0	97,636	47,333	144,969
Management of companies and enterprises	0	21,083	26,520	47,603
Administrative and waste management services	0	117,288	38,831	156,119
Educational services	0	539	24,217	24,756
Health care and social assistance	0	509	203,151	203,660
Arts, entertainment, and recreation	0	3,083	21,392	24,474
Accommodation	0	1,928	8,501	10,429
Food services and drinking places	0	10,983	58,702	69,685
Other services and government	800,000	18,369	71,293	889,662
Total	**10,146,663**	**1,018,684**	**1,454,085**	**12,619,432**

Table A-14
Annual Earnings Impacts of Willowbrook Operation by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0	324	2,745	3,069
Mining	0	1,895	537	2,431
Utilities	0	6,187	5,391	11,578
Construction	0	56,296	4,332	60,628
Durable goods manufacturing	0	16,255	11,889	28,143
Nondurable goods manufacturing	0	12,229	23,680	35,910
Wholesale trade	45,466	11,433	24,819	81,718
Retail trade	0	8,235	53,591	61,825
Transportation and warehousing	0	13,831	17,705	31,535
Information	0	5,901	9,788	15,689
Finance and insurance	0	38,817	36,228	75,046
Real estate and rental and leasing	179,431	13,068	30,153	222,652
Professional, scientific, and technical services	0	41,779	21,187	62,965
Management of companies and enterprises	0	8,460	10,682	19,142
Administrative and waste management services	0	52,119	16,960	69,079
Educational services	0	229	11,327	11,556
Health care and social assistance	0	215	91,201	91,415
Arts, entertainment, and recreation	0	1,107	6,800	7,907
Accommodation	0	509	2,346	2,855
Food services and drinking places	0	3,696	19,183	22,879
Other services and government	182,668	6,821	27,685	217,174
Households	425,600	0	2,166	427,766
Total	**833,165**	**299,404**	**430,394**	**1,562,963**

Table A-15
Annual Employment Impacts of Willowbrook Operation by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0.0	0.0	0.1	0.1
Mining	0.0	0.0	0.0	0.0
Utilities	0.0	0.0	0.0	0.1
Construction	0.0	0.7	0.1	0.7
Durable goods manufacturing	0.0	0.2	0.1	0.3
Nondurable goods manufacturing	0.0	0.1	0.3	0.4
Wholesale trade	0.4	0.1	0.2	0.8
Retail trade	0.0	0.2	1.3	1.5
Transportation and warehousing	0.0	0.2	0.2	0.4
Information	0.0	0.1	0.1	0.2
Finance and insurance	0.0	0.4	0.4	0.9
Real estate and rental and leasing	7.6	0.5	1.2	9.3
Professional, scientific, and technical services	0.0	0.5	0.2	0.7
Management of companies and enterprises	0.0	0.1	0.1	0.1
Administrative and waste management services	0.0	1.1	0.3	1.4
Educational services	0.0	0.0	0.3	0.3
Health care and social assistance	0.0	0.0	1.3	1.3
Arts, entertainment, and recreation	0.0	0.0	0.2	0.2
Accommodation	0.0	0.0	0.1	0.1
Food services and drinking places	0.0	0.1	0.7	0.8
Other services and government	1.7	0.1	0.5	2.3
Households	4.3	0.0	0.1	4.4
Total	**14.0**	**4.4**	**7.8**	**26.2**

Table A-16
Annual Output Impacts of Operation of the Two Facilities by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0	2,020	22,370	24,390
Mining	0	18,324	6,389	24,713
Utilities	30,800,000	68,863	61,145	30,930,008
Construction	0	288,571	21,855	310,426
Durable goods manufacturing	0	131,378	104,299	235,677
Nondurable goods manufacturing	0	122,042	240,774	362,816
Wholesale trade	240,002	60,257	131,198	431,458
Retail trade	0	38,515	248,018	286,533
Transportation and warehousing	0	68,887	91,466	160,353
Information	0	44,668	80,314	124,982
Finance and insurance	0	241,579	238,015	479,594
Real estate and rental and leasing	1,963,708	137,741	315,541	2,416,989
Professional, scientific, and technical services	0	159,774	77,456	237,230
Management of companies and enterprises	0	34,500	43,398	77,898
Administrative and waste management services	0	191,933	63,545	255,477
Educational services	0	881	39,629	40,511
Health care and social assistance	0	833	332,441	333,274
Arts, entertainment, and recreation	0	5,045	35,006	40,051
Accommodation	0	3,155	13,912	17,067
Food services and drinking places	0	17,972	96,061	114,034
Other services and government	1,309,138	30,060	116,665	1,455,863
Total	**34,312,848**	**1,666,998**	**2,379,498**	**38,359,344**

Table A-17
Annual Earnings Impacts of Operation of the Two Facilities by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0	530	4,493	5,023
Mining	0	3,100	878	3,979
Utilities	0	10,124	8,822	18,946
Construction	0	92,124	7,089	99,213
Durable goods manufacturing	0	26,599	19,455	46,055
Nondurable goods manufacturing	0	20,012	38,751	58,763
Wholesale trade	74,402	18,708	40,615	133,725
Retail trade	0	13,475	87,697	101,172
Transportation and warehousing	0	22,633	28,972	51,605
Information	0	9,657	16,018	25,675
Finance and insurance	0	63,522	59,285	122,807
Real estate and rental and leasing	293,624	21,385	49,343	364,352
Professional, scientific, and technical services	0	68,367	34,670	103,038
Management of companies and enterprises	0	13,844	17,480	31,324
Administrative and waste management services	0	85,288	27,754	113,042
Educational services	0	375	18,535	18,910
Health care and social assistance	0	351	149,243	149,594
Arts, entertainment, and recreation	0	1,811	11,128	12,939
Accommodation	0	833	3,839	4,672
Food services and drinking places	0	6,048	31,392	37,440
Other services and government	298,923	11,162	45,304	355,388
Households	696,462	0	3,544	700,006
Total	**1,363,411**	**489,951**	**704,307**	**2,557,669**

Table A-18
Annual Employment Impacts of Operation of the Two Facilities by Industry Sector

	Direct	Indirect	Induced	Total
Agriculture, forestry, fishing, and hunting	0.0	0.0	0.2	0.2
Mining	0.0	0.0	0.0	0.0
Utilities	0.0	0.1	0.1	0.1
Construction	0.0	1.4	0.1	1.5
Durable goods manufacturing	0.0	0.4	0.3	0.6
Nondurable goods manufacturing	0.0	0.2	0.5	0.7
Wholesale trade	0.9	0.2	0.5	1.5
Retail trade	0.0	0.4	2.6	3.0
Transportation and warehousing	0.0	0.3	0.5	0.8
Information	0.0	0.1	0.2	0.3
Finance and insurance	0.0	0.9	0.9	1.7
Real estate and rental and leasing	15.2	1.0	2.4	18.6
Professional, scientific, and technical services	0.0	0.9	0.5	1.4
Management of companies and enterprises	0.0	0.1	0.1	0.2
Administrative and waste management services	0.0	2.2	0.7	2.9
Educational services	0.0	0.0	0.6	0.6
Health care and social assistance	0.0	0.0	2.5	2.5
Arts, entertainment, and recreation	0.0	0.1	0.4	0.4
Accommodation	0.0	0.0	0.1	0.1
Food services and drinking places	0.0	0.3	1.4	1.6
Other services and government	3.4	0.2	1.0	4.6
Households	7.0	0.0	0.2	7.2
Total	**26.4**	**8.8**	**15.7**	**50.9**

CERTIFICATE OF SERVICE

I hereby certify that a service copy of the foregoing was sent by, or on behalf of, the undersigned counsel to the following parties of record this 27th day of September, 2018, via electronic transmission.

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