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Economic Analysis of Proposed Arevon Solar Farm in Montgomery and Putnam Counties, Indiana

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Executive Summary

Arevon plans to invest nearly $231.5 million to construct a 1,700-acre solar electricity generation facility in Montgomery and Putnam Counties, Indiana. The construction phase of this project is estimated to take 14 months to complete and require an estimated 520,000 person-hours of labor.

Most of the impact of the project in Montgomery and Putnam Counties will be generated by the hiring of construction workers and their subsequent spending of earnings in the area. The estimated labor budget for the construction phase translates into an estimated 214 full time equivalent (FTE) workers for 14 months earning roughly $23.4 million in total compensation during the construction period, which represents direct effects provided by the project within the two-county region. The workers will have a further economic impact in the two-county region by spending money locally (on housing, healthcare, groceries, entertainment, etc.), resulting in impact multipliers or "ripple effects."[1] The ripple effects of this construction project will generate an additional 118 jobs at other businesses in the two-county region, bringing the total employment footprint of the construction phase to 332 FTE jobs for 14 months, worth $28.3 million in compensation, as well as $36.6 million contributed to the two-county region's gross domestic product (GDP).[2]

The annual operation and maintenance of the facility will involve five employees who will earn total compensation of approximately $420,000. Additionally, Arevon will spend $882,000 annually to procure the necessary goods and services to operate the facility. The annual ripple effects generated by these supply chain purchases and by the household spending of the onsite employees will support an additional 11 jobs in Montgomery and Putnam Counties. All told, the full ongoing annual economic impact of the operations of the facility in the two-county region are approximately 16 FTE jobs and $889,000 in employee compensation, as well as a $1.4 million contribution to the two-county region's GDP.

[1] Defined as the economic activity generated by workers when they purchase needed goods and services from other Montgomery County and Putnam County businesses, as well as the impacts of household spending in the county by the workers.

[2] In terms of multipliers, every job directly tied to the construction phase of this project supports another 0.55 jobs in the county, while every dollar of payroll generates an additional $0.21 in compensation with other local employers. Every dollar of GDP generated triggers an additional $0.30 in economic activity.

1 Introduction

Arevon, a leading renewable energy developer, has proposed to develop a 240 megawatt DC/200 megawatt AC solar farm in Montgomery and Putnam Counties, Indiana. This document summarizes an input-output economic modeling analysis to estimate the economic effects of this development on employment, labor income, and gross state product in the two-county region.

Section 2 of this report provides background information, characterizing Indiana's baseline energy and electricity sector and Montgomery and Putnam Counties' existing economic conditions. Section 3 describes the data and methods used to model the impacts of the planned solar development, and Section 4 presents and explains the results. Section 5 provides references, and the appendices provide supplemental information, including additional discussion of the modeling approach used for the analysis and a description of the authors of this report.

2 Background

This section provides background information about Indiana's energy and electricity sector (Section 2.1) and the recent economic conditions of Montgomery County and Putnam County where the development will be located (Sections 2.2 and 2.3, respectively).

2.1 Indiana Energy and Electricity Sector

Indiana consumes more energy than it produces, making the state a net importer of energy. According to the United States Energy Information Administration (U.S. EIA; 2021a), the total energy production for the state of Indiana in 2019 was 981.4 trillion BTUs, comprising 0.97 percent of energy production for the U.S. Total Indiana energy consumption for the same year was 2,777.5 trillion BTUs. Thus, Indiana's net energy import was 1,796.1 trillion BTUs (U.S. EIA, 2021a).

Primary energy production in Indiana is dominated by coal. In 2019, statewide coal production was 712.2 trillion BTUs, which accounted for 72.6 percent of all estimated energy produced in Indiana that year (Table 1). Indiana is the nation's sixth largest coal producer and second largest coal consumer (by volume) after Texas (U.S. EIA, 2021a). In terms of Indiana's total energy production, coal is followed by biofuels (15.5 percent) and other renewable energy (10.5 percent).

Table 1: Total Energy Production in Indiana, 2019

Resource Type	Energy Production Estimates (trillion BTU)	Percent of Total Energy Production in Indiana
Coal	712.2	72.6%
Biofuels	152.2	15.5%
Other Renewable Energy	102.6	10.5%
Crude Oil	9.0	0.9%
Natural Gas	5.3	0.5%
Total Production	**981.4**	**100.0%**
Source: United States Energy Information Administration (2021a)		

Energy consumption refers to energy used as a direct fuel source for industry, heating, transportation, and electricity. The energy consumed in Indiana mainly comes from fossil fuels, with coal and natural gas accounting for over 60 percent (Table 2). Renewables represent only a small fraction of Indiana's energy consumption, with renewables other than hydroelectric power and biomass accounting for 2.3 percent of all energy consumed in 2019, or 64.2 trillion BTUs.

Table 2: Total Indiana Energy Consumption, 2019

Resource Type	Energy Consumption Estimates (trillion BTU)	Percent of Total Energy Consumption in Indiana
Coal	821.5	29.6%
Natural Gas	933.9	33.6%
Motor Gasoline excl. Ethanol	340.6	12.3%
Distillate Fuel Oil	218.0	7.8%
Biomass	118.6	4.3%
Other Petroleum	102.2	3.7%
Jet Fuel	26.4	1.0%
Other Renewables	64.2	2.3%
Net Interstate Flow of Electricity[a]	124.3	4.5%
HGL	23.7	0.9%
Hydroelectric Power	2.3	0.1%
Residual Fuel	1.7	0.1%
Total Consumption	**2,777.5**	**100.0%**

Source: United States Energy Information Administration (2021a)
a. Defined by the U.S. EIA as follows: "Includes the energy losses associated with the generation, transmission, and distribution of the electricity flowing across state lines. A positive number indicates that more electricity came into the state than went out of the state during the year." Also includes electricity traded with Canada and Mexico.

Generation refers to the amount of electricity generated within the state of Indiana. Electricity in Indiana is generated by a variety of sources, with the largest shares attributable to coal (almost 60 percent) and natural gas (almost 30 percent) (Table 3). Wind is the most developed renewable energy resource in Indiana, representing more than 8 percent of electricity generated, followed by solar and hydropower, which each account for less than 1 percent. In addition to electricity generated within the state, Indiana imports approximately 5 percent of the electricity it consumes (U.S. EIA, 2021c).

Table 3. Electricity Generation in Indiana, 2021

Resource Type	Thousands MWh Generated Within Indiana	Percent of Total Energy Generation in Indiana
Coal	54,541	57.7%
Natural gas	27,913	29.5%
Wind	7,903	8.4%
Other gas	2,212	2.3%
Other biomass	452	0.5%
Other	489	0.5%
Solar	669	0.7%
Hydroelectric	257	0.3%
Petroleum	129	0.1%
Total Electricity Generation	**94,565**	**100.0%**

Source: United States Energy Information Administration (2021b)

In recent years, the share of Indiana's electricity generated from coal has decreased, as shown in Figure 1 (U.S. EIA, 2021b). Between 2010 and 2021, 32 of the 60 coal-fired generation units in Indiana have retired because they are no longer competitive, and, based on the Indiana Utilities Commissions (IURC) integrated resource planning, it is anticipated that 24 more coal-fired generation units will retire by 2038 (IURC, 2021). As a result of the decline in coal together with the relatively low cost of natural gas, natural gas usage for electricity generation within the state has increased four-fold in the last decade, from 6,475 MWh in 2010 to 27,913 MWh in 2021 (U.S. EIA, 2021b).

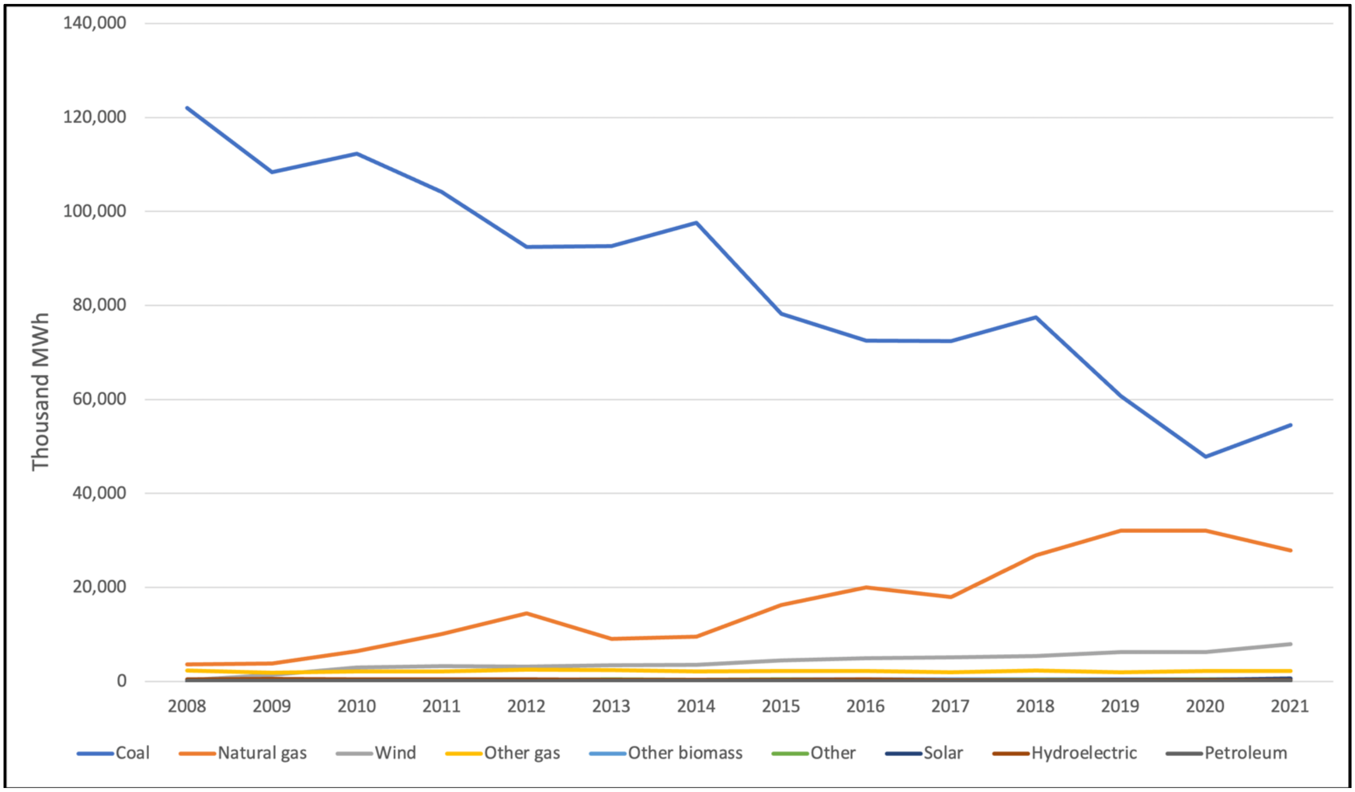

Figure 1: Electricity Generation in Indiana, 2008 to 2019

Although renewables represent only a small fraction of Indiana's energy portfolio, their development within the state of Indiana is increasing every year. Solar power generating capacity increased from zero in 2011 to 279 MW by 2020, while wind capacity increased from 1,340 MW to 2,940 MW over the same period (U.S. EIA, 2021d). Net metering[3] and increasing ability to use batteries to store energy are likely to be significant factors in the continued expansion of renewables. Additionally, advances in renewable technology together with state and regional trends encouraging renewables (such as feed-in tariffs and public benefit funds, among others), are expected to continue making renewables more widespread and competitive (IURC, 2020).

[3] Net metering is a service by which customers can self-supply some or all of their electricity usage by installing renewable energy facilities, selling any overproduction to the electric grid at retail electric rates. This is becoming increasingly popular in Indiana; by the end of 2019, 4,800 customers had installed net metering with 132 MW of total capacity (IURC, 2021).

Indiana has historically seen lower electricity prices than the rest of the United States, with an overall favorability (i.e., affordability) rating of 4th nationally in 2004. However, the state remains reliant on coal and as such electricity prices are tethered to coal markets. Since 2003, coal prices have tended to increase, while natural gas and renewables prices have tended to decrease. As a result, Indiana's electricity prices have increased compared to the rest of the United States, with a favorability rating of 27th in 2020. Investment costs to address environmental mandates and the replacement of aging infrastructure have also contributed to the reduced relative price advantage (IURC, 2021). Furthermore, as coal-fired energy generation within the state has decreased, Indiana's total generation has decreased, requiring more electricity to be imported to meet statewide demand (U.S. EIA, 2021c).

Indiana's State Utility Forecasting Group (SUFG), established by statute to provide an independent forecast of Indiana's electricity needs, projects in their 2021 Indiana Energy Forecast that electricity usage will grow at a rate of 0.21 percent per year over the next 20 years (SUFG, 2021). They also predict that Indiana electricity prices will increase through the year 2028, due to increases in fuel costs and the installation of new emissions control equipment, and then level off. When prices for coal, natural gas, and oil increase, electricity demand faces multiple pressures. To the extent that these fuels generate electricity, when their price increases, electricity prices rise and electricity demand falls, all else being equal. On the other hand, because fossil fuels compete directly with electricity to provide end use services such as heating, when the price of fossil fuels rises electricity becomes relatively more attractive and electricity demand tends to rise, all else being equal. The net impact of these opposing forces depends on how they affect utility costs, the responsiveness of customer demand to electricity price changes, and the availability and competitiveness of fossil fuels in the end-use services markets. In the long term, the projected additional resource requirements are generally lower than in previous forecasts, which indicates a need for a "mix of natural gas-fired combustion turbines and combined cycle units, with wind and solar capacity." This is due to lower projected peak demand (SUFG, 2021).

2.2 Montgomery County Economy

Montgomery County, in west central Indiana, has a total population of 38,063 as of 2021, ranking 39th out of Indiana's 92 counties and accounting for 0.6 percent of the state's population (STATS Indiana, 2022a). Recent data[4] indicate that economic characteristics for the county's population are about average compared to statewide statistics, with median household income of $54,366 (slightly lower than the statewide $57,617), annual unemployment rate of 2.6 percent (lower than the state rate of 3.6 percent), and a poverty rate of 12.1 percent (slightly higher than the statewide rate of 11.9 percent).

Table 4 summarizes key economic indicators for the county broken out by industry.

Table 4: Summary of Montgomery County Economic Data by Industry, 2020

Sector	Employment	Labor Income (millions)	Total Sales (millions)
Manufacturing	4,683	$375.8	$2,027.1
Administrative Government	1,864	$107.0	$138.1
Transportation and Warehousing	1,176	$61.4	$122.7
Retail Trade	1,807	$46.3	$143.3

4 Compiled and summarized by STATS Indiana (2022a).

Sector	Employment	Labor Income (millions)	Total Sales (millions)
Professional, Scientific, and Technical Services	769	$24.1	$88.2
Construction	941	$34.6	$116.1
Administrative and Support and Waste Management and Remediation Services	871	$21.1	$63.9
Accommodation and Food Services	1,527	$37.4	$102.7
Agriculture, Forestry, Fishing and Hunting	1,050	$26.9	$218.1
Health Care and Social Assistance	1,695	$109.4	$186.5
Wholesale Trade	542	$42.2	$138.8
Other Services (except Public Administration)	1,113	$51.5	$78.4
Real Estate and Rental and Leasing	676	$11.7	$245.1
Finance and Insurance	475	$19.7	$98.7
Educational Services	403	$20.4	$31.1
Mining, Quarrying, and Oil and Gas Extraction	12	$0.8	$4.0
Utilities	31	$4.4	$34.8
Government Enterprises	117	$8.7	$20.2
Arts, Entertainment, and Recreation	141	$2.4	$8.1
Management of Companies and Enterprises	54	$3.9	$9.2
Information	145	$9.4	$80.4
Total	20,090	$1,019.2	$3,955.4
Source: IMPLAN			

2.3 Putnam County Economy

Putnam County, in west central Indiana, has a total population of 36,979 as of 2021, ranking 41st out of Indiana's 92 counties and accounting for 0.5 percent of the state's population (STATS Indiana, 2022b). Recent data[5] indicate that economic characteristics for the county's population are favorable compared to statewide statistics, with median household income of $64,098 (higher than the statewide $57,617), annual unemployment rate of 3.1 percent (lower than the state rate of 3.6 percent), and a poverty rate of 10.5 percent (lower than the statewide rate of 11.9 percent).

Table 5 summarizes key economic indicators for the county broken out by industry.

Table 5: Summary of Putnam County Economic Data by Industry, 2020

Sector	Employment	Labor Income (millions)	Total Sales (millions)
Manufacturing	2,091	$129.5	$956.5

[5] Compiled and summarized by STATS Indiana (2022b).

Sector	Employment	Labor Income (millions)	Total Sales (millions)
Administrative Government	2,187	$130.7	$168.0
Transportation and Warehousing	1,779	$93.5	$194.6
Retail Trade	1,338	$37.5	$122.3
Professional, Scientific, and Technical Services	627	$27.8	$87.5
Construction	1,161	$60.4	$165.3
Administrative and Support and Waste Management and Remediation Services	748	$20.2	$62.8
Accommodation and Food Services	1,380	$37.3	$97.7
Agriculture, Forestry, Fishing and Hunting	837	$4.6	$105.5
Health Care and Social Assistance	1,992	$52.7	$104.5
Wholesale Trade	165	$11.9	$52.1
Other Services (except Public Administration)	816	$40.2	$69.6
Real Estate and Rental and Leasing	564	$8.1	$232.3
Finance and Insurance	576	$24.4	$128.0
Educational Services	1,036	$49.7	$76.0
Mining, Quarrying, and Oil and Gas Extraction	94	$6.3	$40.6
Utilities	93	$10.2	$93.2
Government Enterprises	100	$6.4	$12.6
Arts, Entertainment, and Recreation	180	$3.7	$11.9
Management of Companies and Enterprises	30	$1.2	$4.0
Information	132	$11.1	$49.0
Total	17,926	$767.6	$2,834.2
Source: IMPLAN			

3 Data, Assumptions, and Methods

Table 6 shows construction phase assumptions used in the economic modeling, while Table 7 shows assumptions for the subsequent operations phase.

The planned Montgomery and Putnam Counties development will be a 240 megawatt DC/200 megawatt AC solar installation on approximately 1,700 acres, representing a 72 percent increase relative to the U.S. EIA's estimated 2020 solar capacity (see Section 2.1). For the purposes of the economic modeling, we assume that the construction phase will take approximately 14 months and a total of 520,000 hours of labor, equating to 250 person-years or 65,000 person-days in construction labor,[6] or 214 workers employed on a full-time basis for 14 months. The operations phase will entail the employment of 5 full-time workers.

Table 6: Construction Phase Assumptions in Modeling of Montgomery and Putnam Counties Development

Assumption	Value
Number of person hours	520,000
Duration of project (months)	14
Total project investment amount	$231,400,000
Amount for labor	$23,400,000
Amount for equipment and materials	$198,400,000
Amount for engineering and other professional services	$9,600,000
Percent of labor provided by out-of-state contractors	30%
Percent of equipment and materials provided by out-of-state vendors	90%
Percent of engineering and professional services provided by out-of-state vendors	85%

Table 7: Operations Phase Assumptions in Modeling of Montgomery and Putnam Counties Development

Assumption	Value
Generation capacity (megawatts DC/megawatts AC)	240/200
Number of employees	5
Total annual payroll (wages and benefits)	$420,000
Annual spending on goods and services[a]	$882,000
Spare parts (cost per kwdc annually)	$0.25
Vegetation management (cost per acre annually)	$300
Size (acres)	1,700
Misc (cost per kwdc annually)	$0.30
Asset management services (total annual cost)	$240,000
a. Calculated as (spare parts cost x generation capacity x 1,000) + (vegetation management cost x size) + (misc. cost x generation capacity x 1,000) + asset management services costs	

[6] Assuming 2,080 hours for one person-year and 8 hours for one person-day.

As with any production or construction activity, some portion of the goods and services needed to complete the project will be purchased outside of the local economy from manufacturers and service providers that are located elsewhere. In fact, given that solar facilities consist almost entirely of highly specialized equipment and material, Arevon estimates that between 85 percent and 90 percent of the supply chain inputs needed for the installation phase of this project will be provided by vendors from outside the local area. Within the economic impact analysis, this non-local spending is considered leakage and does not factor into the economic impacts of Arevon's investments discussed in this report.

The employment and spending assumptions shown in Table 6 and Table 7 represent direct effects of the development. The economic effects of this project do not end there, however. A resident in the two-county region working on the construction of the facility, for instance, will spend much of their earnings in the local area on housing, health care, groceries, entertainment, etc. Even construction workers who do not reside in the area will have an economic effect in Montgomery and Putnam Counties by spending money on lodging, meals, gasoline, and other incidentals while on the job. Additionally, construction contractors create additional secondary effects when they purchase needed goods and services from other businesses in Montgomery and Putnam Counties.

To estimate these so-called economic "ripple effects," we used the IMPLAN economic modeling software to conduct an input-output analysis for both the initial construction phase of this project as well as the ongoing operation and maintenance phase.[7] Specifically, we assume that workers who reside in the two-county region have typical local spending habits broken out by sector. For workers from outside the two-county region, we assume that their in-county spending is more akin to visitor spending, with assumed daily per-visitor expenditures summarized in Table 8.

The ripple effect estimates derived from this analysis combine with the direct effects to describe the full economic contributions of Arevon's investments.

Table 8: Assumptions Regarding Local Expenditures by Non-Resident Workers

Category	Daily Expenditure (2022 $)
Lodging	$54.50
Restaurants	$25.27
Food Stores	$25.27
General Merchandise Stores	$4.23
Gas Stations	$4.23

Source: Based on U.S. General Service Administration's per-diem rates for Indiana for meals and incidentals, except for lodging. The lodging rate is based on previous research related to similar projects in Southern Indiana. The number is derived from a survey of motels that offer weekly rates, and is updated to 2022 dollars using the Bureau of Labor Statistics' Consumer Price Index.

[7] This widely used modeling software relies on a variety of secondary data sources to build economic models that are tailored to reflect the unique industry mix of any given geographic area. For additional details on IMPLAN, see the Technical Appendix.

4 Findings and Results

Table 9 summarizes the modeled economic effects of Arevon's development during construction. During installation, the economic effects in Montgomery and Putnam Counties will largely be generated by the hiring of construction workers. Arevon estimates that the construction phase will take 14 months to complete and require 520,000 person-hours of labor. These hours translate to an estimated 214 full time equivalent (FTE) workers for 14 months[8] who will earn roughly $23.4 million in total compensation. Up to 150 of these FTE workers will likely reside in the area, with another 64 FTEs coming to the worksite from outside of Indiana. These employment, payroll, and investment numbers are referred to as the "direct effects" of this project and are provided by Arevon based on best available information at the time of this report and are subject to change.

The additional economic activity created by the household spending of these workers, as well as the construction-related supply chain spending, will support an estimated 118 additional jobs over the duration of construction (approximately 14 months). These additional impacts are the "ripple effects." This brings the full employment footprint of construction activities to an estimated 332 FTE jobs in the two-county region. This employment impact will combine to produce an estimated $28.3 million in total compensation.

A helpful way to interpret these effects is to look at the multipliers. The ratio of direct jobs to total jobs, for instance, gives a ratio of 1.55, meaning that every job directly tied to the construction phase of this project supports another 0.55 jobs with other employers in the two-county region (or every 10 direct jobs support 5.5 additional jobs). The compensation multiplier of 1.21 suggests that every dollar of direct payroll generates an additional $0.21 in compensation with other local employers.

In terms of total economic activity, the full impact of the construction phase of this project will combine to contribute an estimated $36.6 million to the gross domestic product (GDP) of Montgomery and Putnam Counties. The multiplier of 1.30 indicates that every dollar of GDP directly generated by these investments will trigger an additional $0.30 in economic activity in the area.

Table 9: Employment and Economic Impacts of Construction Spending in Montgomery and Putnam Counties

	Direct Effects	Ripple Effects	Total Effects	Multiplier
Employment (full-time equivalent)	214[b]	118	332	1.55
Employee Compensation (thousands, 2022 $)	$23,400.0	$4,855.8	$28,255.8	1.21
Gross Domestic Product (thousands, 2022 $)	$28,043.1	$8,532.6	$36,575.7	1.30

a. Note: The employment estimates refer to annual full-time equivalent workers. However, these workers are expected to work on the project over a 14 month period. The compensation and GDP estimates refer to the totals generated over the 14 month period.
b. All of the direct construction jobs are counted as though they are in Montgomery and Putnam counties. Arevon expects that up to 64 of these workers will reside outside of the area. See the appendix for a discussion of the different approaches the research team used for the spending related to local and non-local construction labor.

[8] Note that the actual number of jobs may be higher or lower over the course of construction; however, the estimated labor hours average to 214 full-time equivalent employees for 14 months.

Once the facility is fully installed, it will continue to provide an economic effect to Montgomery and Putnam Counties through ongoing operation and maintenance activities, as summarized in Table 10. During a typical year of operation, Arevon expects that it will employ 5 FTE workers at the facility and spend roughly $1.3 million annually on compensation and other operating expenditures (direct effects).

This level of spending will support an additional 11 jobs in the two-county region worth $469,000 in annual employee compensation (ripple effects). All told, the annual operation and maintenance activities for the facility will support an estimated 16 jobs with $889,000 in annual compensation. The combined effects of facility operations will contribute an estimated $1.4 million per year to the GDP of Montgomery and Putnam Counties.

Table 10: Employment and Economic Impacts of Facility Operations in Montgomery and Putnam Counties

	Direct Effects	Ripple Effects	Total Effects	Multiplier
Employment (full-time equivalent)	5	11	16	3.20
Employee Compensation (thousands; 2022 $)	$420.0	$469.0	$889.0	2.12
Gross Domestic Product (thousands, 2022 $)	$828.4	$586.0	$1,414.4	1.71

5 References

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6 Technical Appendix

This appendix provides additional detail on the modeling software used to estimate economic effects (Section 6.1) and a glossary of key terms (Section 6.2).

6.1 IMPLAN Modeling

IMPLAN is built on a mathematical input-output (I-O) model that expresses relationships between sectors of the economy in a chosen geographic location. In expressing the flow of dollars through a regional economy, the input-output model assumes fixed relationships between producers and their suppliers based on demand. It also omits any dollars spent outside of the regional economy—say, by producers who import raw goods from another area, or by employees who commute and do their household spending elsewhere.

The idea behind I-O modeling is that the inter-industry relationships within a region largely determine how that economy will respond to economic changes. In an I-O model, the increase in demand for a certain product or service causes a multiplier effect, layers of effect that come in a chain reaction. Increased demand for a product affects the producer of the product, the producer's employees, the producer's suppliers, the supplier's employees, and so on—ultimately generating a total effect in the economy that is greater than the initial change in demand. The ratio of that overall effect to the initial change is called a regional multiplier and can be expressed as:

(Direct Effect + Ripple Effects) / (Direct Effect) = Multiplier

Multipliers are industry- and region-specific. Each industry has a unique output multiplier, because each industry has a different pattern of purchases from firms inside and outside of the regional economy. The output multiplier is in turn used to calculate income and employment multipliers.

IMPLAN constructs its I-O model using aggregated production, employment and trade data from a variety of secondary sources, such as the U.S. Census Bureau's annual *County Business Patterns* report and the U.S. Bureau of Labor Statistics' annual report *Covered Employment and Wages*. In addition to gathering enormous amounts of data from government sources, the company also estimates some data where they haven't been reported at the level of detail needed (county-level production data, for instance), or where detail is omitted in government reports to protect the confidentiality of individual companies.

The IMPLAN modeling software includes predefined industry spending patterns and local purchasing coefficients which can be used to estimate economic impacts when these variables are unknown. In assessing the economic impact of the planned solar development, we were instead able to construct a custom production function tailored to fit the specifics of the project, as detailed in Section 3, including a breakout of spending by categories including manufacturers, service providers, and workers located outside the immediate area. This approach greatly improved the accuracy of the economic impact estimates.

6.2 Key Terminology

Direct Effects: The increase in final demand or employment in a given area that can be attributed specifically to Arevon proposed investments and operations.

Ripple Effects: A combination of the indirect and induced effects generated by the direct effects. Indirect effects measure the change in dollars or employment caused when Arevon increases its purchase of goods and services from suppliers and, in turn, those suppliers purchase more inputs and so on throughout the economy. Induced effects reflect the changes — whether in dollars or employment — that result from the household spending of direct workers, along with the employees in the supply chain.

Total Effects: The size of the economic impact, calculated as the sum of direct effects and ripple effects.

Multiplier: The magnitude of the economic response in a particular geographic area associated with a change in the direct effects, calculated as the total effect divided by the direct effect.

Gross Domestic Product (GDP): A measure of the economic activity generated by a company, industry, state, nation, etc., calculated as the difference between total output (i.e., sales) and the cost of production inputs. GDP consists of four components: employee compensation, proprietor income, other property income, and indirect business tax.

7 Description of Authors

Dr. Kenneth Richards teaches and conducts research in the fields of sustainability and environmental policy at Indiana University's O'Neill School of Public and Environmental Affairs. His work combines academic research with policy advice to the public and private sector. In Master of Business Administration (MBA) and Master of Public Affairs (MPA) programs, he teaches sustainability management courses that include conceptual framing related to the business case for sustainability, business and society and the relation among the public, private and nonprofit sectors. He also holds appointments in environmental economics, policy and law at the Maurer School of Law and the Ostrom Workshop in Political Theory and Policy Analysis and frequently collaborates with Gnarly Tree Sustainability Institute (GTSI) on economic analyses of policies and projects in public and private sectors.

Kenneth obtained a Ph.D. from the Wharton School of Business and a J.D. from the Law School at the University of Pennsylvania. He also holds a Master of Science (M.S.) and a Bachelor of Science (B.S.) in Civil Engineering from Northwestern University and a Bachelor of Arts (B.A.) degree in Botany and Chemistry from Duke University. Previous appointments include the Oxford Martin School and the Smith School of Enterprise and the Environment, both at the University of Oxford, as well as a chaired visiting position in sustainability at the NUS Business School. He has also served as an economist at the U.S. Council of Economic Advisers in the Executive Office of the President, the U.S. Department of Agriculture's Economic Research Service, and the U.S. Department of Energy's Pacific Northwest National Laboratory.

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