IMPLAN AND WORKFORCE ANALYSES FOR US DOE PORTS SITE REINDUSTRIALIZATION IN PIKE COUNTY, OHIO

OHIO
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EXECUTIVE SUMMARY:

The US Department of Energy (DOE) former Portsmouth Gaseous Diffusion Plant (PORTS) facility near Piketon, Ohio employed over 20,000 people during the site's construction in the 1950s. Employment during operations of the facility was approximately 2,500 per annum. Following a cold shutdown in 2005, in 2010, DOE awarded a $2.1 billion contract to Fluor B&W to conduct site cleanup activities. As this process continues, remediated land is being deeded to a local nonprofit known as the Southern Ohio Diversification Initiative (SODI) for private-sector economic development use. Ohio University's PORTSfuture Program is partnering with SODI to facilitate reindustrializing the site into an Integrated Energy System-Closed Loop Manufacturing (IESCLM) facility. The PORTS site's unique assets will be leveraged for the synergistic production and use of energy with added efficiency and reduced greenhouse gas (GHG) emissions.

The desired future use focuses on utilizing the site location and infrastructure assets to develop a regional energy transmission and distribution hub, engaging in power generation to include all-of-the-above energy strategies, and co-locating sustainable manufacturing initiatives. These energy and manufacturing initiatives will include, but not be limited to, 1. Decarbonized hydrogen to power generation for 300 Megawatts annually (650 metric tons of hydrogen per day (methane reformer)), 2. 1,700 metric tons of oxygen per day, 3. Carbon sequestration of 4,100 metric tons per day, 4. Processing 200 metric tons of biomass and plastics per day, and 5. 1,500 metric tons of green cement production per day. This analysis seeks to quantify the workforce required to support construction and operational activities for each component and to quantify the economic impact of these initiatives on the Ohio Valley Regional Development Commission (OVRDC) region which serves as the primary labor market for new development.

Table 1 and Table 2 show the economic impact of construction and operations of the proposed activities on the economy of the OVRDC region. The construction of facilities will support about 3,962 jobs during the construction period, and about 806 jobs during the operations and maintenance phase. One note of importance, the hydrogen to power, air separation, and carbon capture and sequestration activities will be integrated in this project and thus realize economies of scale and reduce job duplication, yielding an aggregate job number of 357.98 for those three activities as shown on page 12 below. Those jobs coupled with the biomass and green cement activities, would result in the final job tally of 611.23 operational jobs under the integrated approach as shown in the table on page 17. Additionally, the construction of facilities will generate about $528 million in economic activity during the construction phase and generate an additional $424 million annually through operations.

Table 1: Total Economic Impact of Construction Phase of the Activities

CONSTRUCTION				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	2,912.42	$167,454,391	$178,427,890	$356,697,907
Indirect Effect	394.81	$25,057,967	$40,070,599	$78,682,947
Induced Effect	655.18	$26,799,475	$52,537,076	$93,055,138
Total Effect	3,962.25	$219,311,838	$271,035,570	$528,435,995

Table 2:Total Economic Impact of Operational Phase of the Activities

OPERATIONS				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	218.00	$52,114,518	$112,401,392	$275,830,071
Indirect Effect	323.46	$27,580,158	$55,302,363	$111,006,744
Induced Effect	264.73	$10,830,780	$21,231,378	$37,603,671
Total Effect	806.18	$90,525,459	$188,935,135	$424,440,491

Table 3: Workforce Analysis for Construction Phase of the Activities

CONSTRUCTION		
Occupation	**Total Ohio Workforce**	**Construction Jobs**
Construction and Extraction Occupations	171,950	1,636
Management Occupations	278,880	379
Office and Administrative Support Occupations	674,570	232
Business and Financial Operations Occupations	319,410	230
Architecture and Engineering Occupations	87,420	100
Transportation and Material Moving Occupations	508,580	98
Installation, Maintenance, and Repair Occupations	203,870	96
Production Occupations	466,570	60
Sales and Related Occupations	457,930	25
Building and Grounds Cleaning and Maintenance Occupations	141,740	20

Table 3 and Table 4 present the results of the workforce analysis for the construction and the operations phase of the proposed projects. Out of 3,962 jobs created during the construction phase, 1,636 will be in Construction and Extraction Occupations. Out of 806 jobs created during the operations phase, 92 jobs will be created in production occupations.

Table 4: Workforce Analysis for Operational Phase of the Activities

OPERATIONS		
Occupation	**Total Ohio Workforce**	**Operations Jobs**
Production Occupations	466,570	92
Transportation and Material Moving Occupations	508,580	25
Installation, Maintenance, and Repair Occupations	203,870	21
Office and Administrative Support Occupations	674,570	16
Management Occupations	278,880	15
Architecture and Engineering Occupations	87,420	14
Life, Physical, and Social Science Occupations	34,740	10
Business and Financial Operations Occupations	319,410	9
Sales and Related Occupations	457,930	5
Computer and Mathematical Occupations	162,510	2

PROJECT STUDY AREA:

The project's goal was to define a study area around Piketon, Ohio, within a 50-mile radius. However, IMPLAN and workforce analysis require well-defined regions, so we use the 12-county Ohio Valley Regional Development Commission region. These counties form a regional partnership dedicated to the development of Southern Ohio and thus have close economic ties. The 12 counties consist of Adams, Brown, Clermont, Fayette, Gallia, Highland, Jackson, Lawrence, Pike, Ross, Scioto, and Vinton Counties.

SIMULACRUM:

Because each activity in this project represents a facility that doesn't exist, the researchers do not have information on the employment requirements for operations and construction. Instead, each activity includes a simulacrum for each facility to estimate the economic impacts of the proposed facility. A simulacrum represents a similar facility and what the researchers expect the proposed facility to look like using a similar facility that currently operates within the same industry. For example, suppose the aim is to estimate the employment required to operate and produce one metric ton of hydrogen per year, assuming the production technology stays the same. In that case, the researchers use an existing facility that produces two metric tons of hydrogen per year and divides their operational employment in half to get the result. Researchers can also apply similar logic to estimate construction employment requirements.

IMPLAN OVERVIEW:

IMPLAN, or IMpact analysis for PLANing, is a widely used tool for economic impact analyses. IMPLAN uses a general input-output model that uses secondary data from the Bureau of Economic Analysis (BEA), Bureau of Labor Statistics (BLS), and Census. The main difference between a general equilibrium model, which the input-output model is derived from, and a partial equilibrium model is that, unlike a partial equilibrium model that focuses only on one industry, the general equilibrium model captures all monetary market transactions between industries. Among four main sources of commercial input-output-based tools, IMPLAN is best equipped to handle modeling multiple regions as well as smaller regions (Khalaf, Jolley, and Clouse, 2021).[1]

KEY DEFINITIONS:

The economic impact is derived directly through a firm or industry operation called the direct effect. When a firm buys goods and services from another local firm, the latter firm pays its employees in wages and makes subsequent purchases to additional firms. In an input-output model, the impacts generated by these activities are referred to as indirect effects. These firms in turn make purchases of goods and services from other firms, and so on. In other words, the indirect effect is generated through the supply chain and supporting industries' operations. In addition to direct and indirect effects, employees of these simulated firms will spend their wages on other industries in the region, which also creates ripple effects on the region's economy. These additional ripple effects are referred to as induced effects. In other words, the induced effect is the economic impact through local re-spending of income by direct and indirect employees. The total effect is the summation of direct, indirect, and induced effects. As a result, each initial dollar spent on activities supporting the operations and construction of firms may be circulated several times within the region.

The concept of multipliers derived from input-output tables is the key to economic impact analyses. The Multiplier is the ratio of the "Total Effect" to the "Direct Effect". In other words, multipliers measure the ripple effect of a change (or contribution) of an industry (or firm) in a region. For instance, the employment multiplier equals 1.34 in the hydrogen production facility, indicating that for every three jobs in a hydrogen production facility, the facility would support one additional full-time job in related industries. When it comes to Labor income, value added and output multipliers, instead of discussing the number, they need to be interpreted as the dollar value. For instance, an output multiplier of 1.48 implies that each dollar supporting the operations of the hydrogen production facility will generate an additional 48 cents for the regional economy.

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[1]For more information, see Khalaf, C., Jolley, G. J., & Clouse, C. (2021). The Economic Impact of Small Colleges on Local Economies: A Guide to Attainable Data and Best Practices. Economic Development Quarterly, 08912424211033655.

KEY DEFINITIONS (CONTINUED):

IMPLAN reports an economic impact analysis of activities through several economic indicators. Employment is the total annual average number of jobs, including all full-time, part-time, and seasonal workers. Labor Income is composed of both the wages and benefits paid to employees and the profits earned by self-employed people. Value Added (or Gross Regional Product) is the combination of Labor Income plus corporate profits, interest income, rental payments, sales tax, excise tax, property tax, fees, fines, and licenses. Finally, the output is the combination of Value Added plus the materials and services (other than employment) required by an industry to create its products.

IMPLAN ASSUMPTIONS:

IMPLAN is built based on the input-output model. Thus, its assumptions follow the input-output model assumptions, which include a constant return to scale, fixed input structure, industry homogeneity, no supply constraints, fixed technology, constant byproduct coefficients, static model, measuring only backward linkages, and an unclear time dimension for the region to settle at its new equilibrium after the change.[2]

In this report, the researchers report two sets of economic impacts for each activity: 1) the economic impacts of the operations phase of the activity; 2) the economic impacts of the construction phase of the activity. While the economic impact of the operation phase is on an annual basis, the economic impact of the construction phase occurs only one time (during the construction period). Therefore, impacts will be reported in 2022 dollars but will be calculated using 2019 data. While IMPLAN has recently included 2020 data, this was an uncommon year due to the COVID-19 pandemic and can be viewed as an outlier.

WORKFORCE OVERVIEW:

Researchers include a workforce analysis for each project's operations and construction phases. Workforce analysis is essential for identifying skill and occupational gaps between current and future employment needs. These analyses are organized by occupation title, retrieved from the nationally expected averages from the Bureau of Labor Statistics' May 2021 Occupational Employment Statistics (OES). The Workforce analysis report includes the top ten largest occupations by representation within an industry (when possible). Each Workforce table displays total Ohio jobs for each occupation, which are reported from the Bureau of Labor Statistics' May 2021 State Occupational Employment and Wage Estimates data for Ohio. These numbers are then rounded, which may lead to percentages of project sums being less than 100, and sums of occupations being less than the total number of jobs.

[2]*For more information see https://support.implan.com/hc/en-us/articles/115009505587-Detailed-Key-Assumptions-of-IMPLAN-Input-Output-Analysis*

ECONOMIC IMPACT ANALYSIS FOR PROPOSED

650 METRIC TONS OF HYDROGEN PER DAY (METHANE REFORMER)

PROJECT SIMULACRUM: Nutrien, Lima, Ohio

PROJECT STUDY AREA: Ohio Valley Regional Development Commission region: Adams, Brown, Clermont, Fayette, Gallia, Highland, Jackson, Lawrence, Pike, Ross, Scioto, and Vinton Counties.

Activity 1: 650 Metric Tons of Hydrogen per Day

CONSTRUCTION				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	512.00	$29,102,884	$29,611,902	$59,626,715
Indirect Effect	62.46	$4,098,031	$6,470,576	$12,905,541
Induced Effect	112.69	$4,609,865	$9,036,979	$16,006,375
Total Effect	687	$37,810,782	$45,119,458	$88,538,632
Multiplier	**1.34**	**1.30**	**1.52**	**1.48**

OPERATIONS				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	96.00	$18,004,058	$51,917,201	$143,739,781
Indirect Effect	157.10	$15,047,072	$27,888,508	$54,361,008
Induced Effect	104.88	$4,294,279	$8,416,380	$14,903,557
Total Effect	357.98	$37,345,410	$88,222,089	$213,004,346
Multiplier	**3.73**	**2.07**	**1.70**	**1.48**

FINDINGS:

- During the construction period, IMPLAN estimates a 650 metric tons of hydrogen per day project would create:
  - 687 total annual jobs;
  - $37,810,782 in total value paid to local workers;
  - $45,119,458 in industry's contribution to regional GDP;
  - $88,538,632 in industry sales.
- During the operational period, IMPLAN estimates a 650 metric tons of hydrogen per day project would create:
  - 358 total annual jobs;
  - $37,345,410 in total value paid to local workers;
  - $88,222,089 in industry's contribution to regional GDP;
  - $213,004,346 in industry sales.

FOOTNOTE: The employment needed for the operations phase is based on Nutrien in Lima, Ohio. The researchers adjusted the number of jobs based on the proposed facility capacity.
- Employment needed for the construction phase is based on a report of new construction of an ammonia facility in Pennsylvania. The researchers adjusted the number of jobs based on the proposed facility's capacity.

WORKFORCE ANALYSIS FOR PROPOSED

650 METRIC TONS OF HYDROGEN PER DAY (METHANE REFORMER)

CONSTRUCTION

Occupation	Total Ohio Workforce	Percentage of Project	Construction Jobs
Construction and Extraction Occupations	171,950	55.41	284
Management Occupations	278,880	14.61	75
Business and Financial Operations Occupations	319,410	8.91	46
Office and Administrative Support Occupations	674,570	8.43	43
Architecture and Engineering Occupations	87,420	3.57	18
Installation, Maintenance, and Repair Occupations	203,870	2.77	14
Transportation and Material Moving Occupations	508,580	1.96	10
Production Occupations	466,570	1.61	8
Sales and Related Occupations	457,930	0.94	5
Building and Grounds Cleaning and Maintenance Occupations	141,740	0.59	3

OPERATIONS

Occupation	Total Ohio Workforce	Percentage of Project	Operations Jobs
Production Occupations	466,570	43.46	42
Installation, Maintenance, and Repair Occupations	203,870	8.72	8
Architecture and Engineering Occupations	87,420	8.19	8
Office and Administrative Support Occupations	674,570	7.64	7
Management Occupations	278,880	7.5	7
Life, Physical, and Social Science Occupations	34,740	7.43	7
Transportation and Material Moving Occupations	508,580	6.69	6
Business and Financial Operations Occupations	319,410	4.92	5
Sales and Related Occupations	457,930	2.44	2
Computer and Mathematical Occupations	162,510	1.35	1

FOOTNOTE: Underlying industry, occupation, and employment data are derived using nationally and state expected averages from the Bureau of Labor Statistics' May 2021 Occupational Employment Statistics (OES) survey and 2020 Industry-occupation matrix data, by industry tables. Occupations that constitute less than 0.1 percent of the industry, have fewer than 50 jobs, are confidential, or include poor quality data are not displayed. Post analysis occupations that constitute less than 1 percent of any particular project and account for less than 1 job are omitted. Jobs numbers are then rounded. These compounding suppression effects cause the percentages to add to less than 100 and the sum of occupations to be less than the total number of jobs.
- Total Ohio Workforce shows the total number of employees in each occupation in Ohio in 2021.
- Percentage of Project shows the percent of jobs in the hydrogen production facility that will be employed by each occupation in the U.S.
- Operation Jobs shows the total number of employees that are directly created by the hydrogen production facility in each occupation assuming the percentage of employees in each occupation in Ohio follows the U.S.

ECONOMIC IMPACT ANALYSIS FOR PROPOSED

1,700 METRIC TONES OF OXYGEN PER DAY (FROM AIR SEPARATION UNIT)

PROJECT SIMULACRUM: Pengerang Gas Solutions Sdn. Bhd (PGSSB), a joint venture between Petronas Gas Bhd and Linde Johor, Malaysia

PROJECT STUDY AREA: Ohio Valley Regional Development Commission region: Adams, Brown, Clermont, Fayette, Gallia, Highland, Jackson, Lawrence, Pike, Ross, Scioto, and Vinton Counties.

Activity 2: 1,700 Metric Tons of Oxygen per Day

CONSTRUCTION

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	187.00	$10,629,373	$10,815,284	$21,777,726
Indirect Effect	22.81	$1,496,742	$2,363,276	$4,713,547
Induced Effect	41.16	$1,683,681	$3,300,615	$5,846,078
Total Effect	250.97	$13,809,797	$16,479,177	$32,337,351
Multiplier	**1.34**	**1.30**	**1.52**	**1.48**

OPERATIONS

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	35.00	$3,286,556	$8,919,750	$33,198,332
Indirect Effect	47.09	$3,290,506	$7,737,485	$16,235,696
Induced Effect	20.77	$850,673	$1,667,098	$2,951,810
Total Effect	102.85	$7,427,735	$18,324,334	$52,385,839
Multiplier	**2.94**	**2.26**	**2.05**	**1.58**

FINDINGS:

- During the construction period, IMPLAN estimates a 1,700 metric tons of oxygen per day project would create
  - 251 total annual jobs;
  - $13,809,797 in total value paid to local workers;
  - $16,479,177 in industry's contribution to regional GDP;
  - $32,337,351 in industry sales.
- During the operational period, IMPLAN estimates a 1,700 metric tons of oxygen per day project would create:
  - 103 total annual jobs;
  - $7,427,735 in total value paid to local workers;
  - $18,324,334 in industry's contribution to regional GDP;
  - $52,385,839 in industry sales.

FOOTNOTE: The employment needed for the operations phase is based on Pengerang Gas Solutions Sdn. Bhd (PGSSB), a joint venture between Petronas Gas Bhd and Linde Johor, Malaysia. The researchers adjusted the number of jobs based on the proposed facility capacity.
- Researchers calculated the employment needed for the construction phase based on the assumption that the hydrogen production facility has a similar production function as the construction of an oxygen production facility.

WORKFORCE ANALYSIS FOR PROPOSED

1,700 METRIC TONES OF HYDROGEN PER DAY (FROM AIR SEPARATION UNIT)

CONSTRUCTION

Occupation	Total Ohio Workforce	Percentage of Project	Construction Jobs
Construction and Extraction Occupations	171,950	55.41	104
Management Occupations	278,880	14.61	27
Business and Financial Operations Occupations	319,410	8.91	17
Office and Administrative Support Occupations	674,570	8.43	16
Architecture and Engineering Occupations	87,420	3.57	7
Installation, Maintenance, and Repair Occupations	203,870	2.77	5
Transportation and Material Moving Occupations	508,580	1.96	4
Production Occupations	466,570	1.61	3
Sales and Related Occupations	457,930	0.94	2
Building and Grounds Cleaning and Maintenance Occupations	141,740	0.59	1

OPERATIONS

Occupation	Total Ohio Workforce	Percentage of Project	Operations Jobs
Production Occupations	466,570	43.46	15
Installation, Maintenance, and Repair Occupations	203,870	8.72	3
Architecture and Engineering Occupations	87,420	8.19	3
Office and Administrative Support Occupations	674,570	7.64	3
Management Occupations	278,880	7.5	3
Life, Physical, and Social Science Occupations	34,740	7.43	3
Transportation and Material Moving Occupations	508,580	6.69	2
Business and Financial Operations Occupations	319,410	4.92	2
Sales and Related Occupations	457,930	2.44	1
Computer and Mathematical Occupations	162,510	1.35	1

FOOTNOTE: Underlying industry, occupation, and employment data are derived using nationally and state expected averages from the Bureau of Labor Statistics' May 2021 Occupational Employment Statistics (OES) survey and 2020 Industry-occupation matrix data, by industry tables. Occupations that constitute less than 0.1 percent of the industry, have fewer than 50 jobs, are confidential, or include poor quality data are not displayed. Post analysis occupations that constitute less than 1 percent of any particular project and account for less than 1 job are omitted. Jobs numbers are then rounded. These compounding suppression effects cause the percentages to add to less than 100 and the sum of occupations to be less than the total number of jobs.

- Total Ohio Workforce shows the total number of employees in each occupation in Ohio.

- Percentage of Project shows the percent of jobs in the oxygen production facility that will be employed by each occupation in the U.S.

- Operation Jobs shows the total number of employees that are directly created by the oxygen production facility in each occupation assuming the percentage of employees in each occupation in Ohio follows the U.S.

ECONOMIC IMPACT ANALYSIS FOR PROPOSED

4,100 METRIC TONS OF CARBON SEQUESTRATION PER DAY (CO_2)

PROJECT SIMULACRUM: Port Arthur Hydrogen Production Facility (Air Products), Port Arthur, TX

PROJECT STUDY AREA: Ohio Valley Regional Development Commission region: Adams, Brown, Clermont, Fayette, Gallia, Highland, Jackson, Lawrence, Pike, Ross, Scioto, and Vinton Counties.

Activity 3: 4,100 Metric Tons of Carbon Sequestration per Day (CO_2)

CONSTRUCTION

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	250.00	$14,217,644	$15,576,090	$37,675,771
Indirect Effect	56.47	$3,357,133	$5,428,727	$10,407,026
Induced Effect	59.83	$2,447,246	$4,797,508	$8,497,449
Total Effect	366.30	$20,022,023	$25,802,324	$56,580,247
Multiplier	**1.47**	**1.41**	**1.66**	**1.50**

OPERATIONS

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	5.00	$21,676,189	$22,083,679	$23,522,854
Indirect Effect	6.19	$332,711	$510,197	$1,005,676
Induced Effect	80.91	$3,303,486	$6,478,879	$11,480,744
Total Effect	92.1	$25,312,385	$29,072,755	$36,009,274
Multiplier	**18.42**	**1.17**	**1.32**	**1.53**

FINDINGS:

- During the construction period, IMPLAN estimates a 4,100 metric tons of CO_2 per day project would create:
  - 366 total annual jobs;
  - $20,022,023 in total value paid to local workers;
  - $25,802,324 in industry's contribution to regional GDP;
  - $56,580,247 in industry sales.
- During the operational period, IMPLAN estimates a 4,100 metric tons of CO_2 per day project would create:
  - 92 total annual jobs;
  - $25,312,385 in total value paid to local workers;
  - $29,072,755 in industry's contribution to regional GDP;
  - $36,009,274 in industry sales.

FOOTNOTE: The employment needed for the carbon sequestration facility's operations and construction phases is provided by Newpoint Gas, LLC. - The employment multiplier for the operations phase is larger than usual. While there could be several explanations for that, the main driver of the large employment multiplier for a carbon sequestration facility might be that a pipeline transportation industry does not buy a lot of inputs to create its output.

WORKFORCE ANALYSIS FOR PROPOSED

4,100 METRIC TONS OF CARBON SEQUESTRATION PER DAY (CO_2)

CONSTRUCTION

Occupation	Total Ohio Workforce	Percentage of Project	Construction Jobs
Construction and Extraction Occupations	171,950	58.72	147
Transportation and Material Moving Occupations	508,580	7.85	20
Management Occupations	278,880	7.71	19
Office and Administrative Support Occupations	674,570	6.41	16
Installation, Maintenance, and Repair Occupations	203,870	5.00	13
Business and Financial Operations Occupations	319,410	4.68	12
Production Occupations	466,570	3.40	9
Architecture and Engineering Occupations	87,420	3.06	8
Building and Grounds Cleaning and Maintenance Occupations	141,740	1.10	3
Sales and Related Occupations	457,930	0.55	1

OPERATIONS

Occupation	Total Ohio Workforce	Percentage of Project	Operations Jobs
Production Occupations	466,570	31.62	1.6
Installation, Maintenance, and Repair Occupations	203,870	17.26	0.9
Transportation and Material Moving Occupations	508,580	8.58	0.4
Architecture and Engineering Occupations	87,420	7.89	0.4
Management Occupations	278,880	7.84	0.4
Business and Financial Operations Occupations	319,410	7.69	0.4
Construction and Extraction Occupations	171,950	7.26	0.4
Office and Administrative Support Occupations	674,570	5.88	0.3
Computer and Mathematical Occupations	162,510	2.87	0.1
Life, Physical, and Social Science Occupations	34,740	1.56	0.1

FOOTNOTE: Underlying industry, occupation, and employment data are derived using nationally and state expected averages from the Bureau of Labor Statistics' May 2021 Occupational Employment Statistics (OES) survey and 2020 Industry-occupation matrix data, by industry tables. Occupations that constitute less than 0.1 percent of the industry, have fewer than 50 jobs, are confidential, or include poor quality data are not displayed. Post analysis occupations that constitute less than 1 percent of any particular project and account for less than 1 job are omitted. Jobs numbers are then rounded. These compounding suppression effects cause the percentages to add to less than 100 and the sum of occupations to be less than the total number of jobs.
- Total Ohio Workforce shows the total number of employees in each occupation in Ohio.
- Percentage of Project shows the percent of jobs in the carbon sequestration facility that will be employed by each occupation in the U.S.
- Operation Jobs shows the total number of employees that are directly created by the carbon sequestration facility in each occupation assuming the percentage of employees in each occupation in Ohio follows the U.S.

EFFECT OF INTEGRATED SYSTEM DESIGN AND OPERATION:

The hydrogen plant with electrical power generation, air separation unit (1700 MT/day oxygen), and the carbon sequestration system are individually assessed and predicted jobs are given. By combining the operations of these individual facilities and their close proximity, significant efficiencies are realized.

Staffing for each of these units requires very similar skill sets. Therefore, each unit does not require separate operation and maintenance personnel. The control room can also be integrated so that facility operators and management can safely monitor, optimize, and troubleshoot all three units. Maintenance personnel are also cross-trained on each of the units as each requires similar safety training programs, technical expertise, and experience. This type of integration applies to transportation and material moving, management occupations and much more. The overall effect is that the total number of jobs for operations and maintenance of these three units is optimized, requiring approximately the same as for the stand-alone hydrogen power facility. The economic impact analysis of the operational phase of integrated activity is presented below:

The Economic Impact of Integrated System Design

CONSTRUCTION				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	96.00	$18,004,058	$51,917,201	$143,739,781
Indirect Effect	157.10	$15,047,072	$27,888,508	$54,361,008
Induced Effect	104.88	$4,294,279	$8,416,380	$14,903,557
Total Effect	357.98	$37,345,410	$88,222,089	$213,004,346
Multiplier	**3.73**	**2.07**	**1.70**	**1.48**

ECONOMIC IMPACT ANALYSIS FOR PROPOSED

200 METRIC TONS OF BIOMASS PER DAY (FOREST RESIDUE/WOODY BIOMASS, AND PLASTICS)

PROJECT SIMULACRUM: Joensuu, Finland, the Savon Voima Plant

PROJECT STUDY AREA: Ohio Valley Regional Development Commission region: Adams, Brown, Clermont, Fayette, Gallia, Highland, Jackson, Lawrence, Pike, Ross, Scioto, and Vinton Counties.

Activity 4: 200 Metric Tons of Biomass per Day (Forest Residue/Woody Biomass and Plastics)

CONSTRUCTION

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	437.76[3]	$26,783,684	$34,187,037	$59,941,945
Indirect Effect	66.95	$3,895,513	$6,527,660	$12,202,781
Induced Effect	105.70	$4,322,459	$8,474,079	15,010,352
Total Effect	610.41	$35,001,657	$49,188,777	$87,155,078
Multiplier	**1.39**	**1.31**	**1.44**	**1.45**

OPERATIONS

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	24.00	$3,190,701	$16,623,038	$40,567,273
Indirect Effect	55.46	$4,819,303	$11,756,199	$24,282,862
Induced Effect	25.86	$1,058,959	$2,075,471	$3,675,237
Total Effect	105.32	$9,068,965	$30,454,708	$68,525,374
Multiplier	**4.39**	**2.84**	**1.83**	**1.69**

FINDINGS:

- During the construction period, IMPLAN estimates a 200 metric tons of biomass per day project would create:
  - 610 total annual jobs;
  - $35,001,657 in total value paid to local workers;
  - $49,188,777 in industry's contribution to regional GDP;
  - $87,155,078 in industry sales.
- During the operational period, IMPLAN estimates a 200 metric tons of biomass per day project would create:
  - 105 total annual jobs;
  - $9,068,965 in total value paid to local workers;
  - $30,454,708 in industry's contribution to regional GDP;
  - $68,525,374 in industry sales.

FOOTNOTE: The employment needed for the operations phase is based on Joensuu, Finland, the Savon Voima Plant. The researchers adjusted the number of jobs based on the proposed facility capacity.
- Researchers calculated the employment needed for the construction phase considering metric tons to gallon converter of 337.8 (the most related one the researchers found is ethanol).

[3] For more information see Newcomb, J. (2009). US economic impact of advanced biofuels production: Perspectives to 2030. Bio Economic Research Associates, Cambridge, Massachusetts.

WORKFORCE ANALYSIS FOR PROPOSED

200 METRIC TONS OF BIOMASS PER DAY (FOREST RESIDUE/WOODY BIOMASS, AND PLASTICS)

CONSTRUCTION

Occupation	Total Ohio Workforce	Percentage of Project	Construction Jobs
Construction and Extraction Occupations	171,950	58.72	257
Transportation and Material Moving Occupations	508,580	7.85	34
Management Occupations	278,880	7.71	34
Office and Administrative Support Occupations	674,570	6.41	28
Installation, Maintenance, and Repair Occupations	203,870	5.00	22
Business and Financial Operations Occupations	319,410	4.68	21
Production Occupations	466,570	3.40	15
Architecture and Engineering Occupations	87,420	3.06	13
Building and Grounds Cleaning and Maintenance Occupations	141,740	1.10	5
Sales and Related Occupations	457,930	0.66	3

OPERATIONS[4]

Occupation	Total Ohio Workforce	Percentage of Project	Operations Jobs
Production Occupations	466,570	48.82	12
Installation, Maintenance, and Repair Occupations	203,870	19.62	5
Architecture and Engineering Occupations	87,420	8.12	2
Management Occupations	278,880	7.42	2
Office and Administrative Support Occupations	674,570	4.55	1
Construction and Extraction Occupations	171,950	4.07	1
Transportation and Material Moving Occupations	508,580	3.14	1
Business and Financial Operations Occupations	319,410	2.46	1

FOOTNOTE: Underlying industry, occupation, and employment data are derived using nationally and state expected averages from the Bureau of Labor Statistics' May 2021 Occupational Employment Statistics (OES) survey and 2020 Industry-occupation matrix data, by industry tables. Occupations that constitute less than 0.1 percent of the industry, have fewer than 50 jobs, are confidential, or include poor quality data are not displayed. Post analysis occupations that constitute less than 1 percent of any particular project and account for less than 1 job are omitted. Jobs numbers are then rounded. These compounding suppression effects cause the percentages to add to less than 100 and the sum of occupations to be less than the total number of jobs.
- Total Ohio Workforce shows the total number of employees in each occupation in Ohio.
- Percentage of Project shows the percent of jobs in the biofuel production facility that will be employed by each occupation in the U.S.
- Operation Jobs shows the total number of employees that are directly created by the biofuel production facility in each occupation assuming the percentage of employees in each occupation in Ohio follows the U.S.

[4] *The BLS 2020 workforce reports only eight major occupation sectors.*

ECONOMIC IMPACT ANALYSIS FOR PROPOSED

1,500 METRIC TONS OF GREEN CEMENT PER DAY

PROJECT SIMULACRUM: Eagle Materials – Fairborn Plant, OH

PROJECT STUDY AREA: Ohio Valley Regional Development Commission region: Adams, Brown, Clermont, Fayette, Gallia, Highland, Jackson, Lawrence, Pike, Ross, Scioto, and Vinton Counties.

Activity 5: 1,500 Metric Tons of Green Cement per Day

CONSTRUCTION				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	1,525.66[5]	$86,720,806	$88,237,577	$177,675,750
Indirect Effect	186.12	$12,210,548	$19,280,360	$38,454,052
Induced Effect	335.80	$13,736,224	$26,927,895	$47,694,884
Total Effect	2,047.57	$112,667,579	$134,445,834	$263,824,687
Multiplier	**1.34**	**1.30**	**1.52**	**1.48**

OPERATIONS				
Impact Type	**Employment**	**Labor Income**	**Value Added**	**Output**
Direct Effect	58.00	$5,957,014	$12,857,724	$34,801,831
Indirect Effect	57.62	$4,090,566	$7,409,974	$15,121,502
Induced Effect	32.31	$1,323,383	$2,593,550	$4,592,323
Total Effect	147.93	$11,370,964	$22,861,249	$54,515,658
Multiplier	**2.55**	**1.91**	**1.78**	**1.57**

FINDINGS:

- During the construction period, IMPLAN estimates a 1,500 metric tons of green cement per day project would create:
  - 2,048 total annual jobs;
  - $112,667,579 in total value paid to local workers;
  - $134,445,834 in industry's contribution to regional GDP;
  - $263,824,687 in industry sales.
- During the operational period, IMPLAN estimates a 1,500 metric tons of green cement per day project would create:
  - 148 total annual jobs;
  - $11,370,964 in total value paid to local workers;
  - $22,861,249 in industry's contribution to regional GDP;
  - $54,515,658 in industry sales.

FOOTNOTE: The employment needed for the operations phase is based on Eagle Materials – Fairborn Plant, OH. The researchers adjusted the number of jobs based on the proposed facility capacity.
- Researchers calculated the employment needed for the construction phase based on previous studies and considered the inflation rate as well as the Euro to the USD exchange rate.

[5] *For more information see https://iea-etsap.org/*

WORKFORCE ANALYSIS FOR PROPOSED

1,500 METRIC TONS OF GREEN CEMENT PER DAY

CONSTRUCTION

Occupation	Total Ohio Workforce	Percentage of Project	Construction Jobs
Construction and Extraction Occupations	171,950	55.41	845
Management Occupations	278,880	14.61	223
Business and Financial Operations Occupations	319,410	8.91	136
Office and Administrative Support Occupations	674,570	8.43	129
Architecture and Engineering Occupations	87,420	3.57	54
Installation, Maintenance, and Repair Occupations	203,870	2.77	42
Transportation and Material Moving Occupations	508,580	1.96	30
Production Occupations	466,570	1.61	25
Sales and Related Occupations	457,930	0.94	14
Building and Grounds Cleaning and Maintenance Occupations	141,740	0.59	9

OPERATIONS

Occupation	Total Ohio Workforce	Percentage of Project	Operations Jobs
Production Occupations	466,570	37.97	22.0
Transportation and Material Moving Occupations	508,580	25.70	14.9
Office and Administrative Support Occupations	674,570	8.47	4.9
Construction and Extraction Occupations	171,950	7.28	4.2
Installation, Maintenance, and Repair Occupations	203,870	6.86	4.0
Management Occupations	278,880	4.36	2.5
Sales and Related Occupations	457,930	3.39	2.0
Business and Financial Operations Occupations	319,410	2.26	1.3
Architecture and Engineering Occupations	87,420	2.06	1.2
Life, Physical, and Social Science Occupations	34,740	0.52	0.3

FOOTNOTE: Underlying industry, occupation, and employment data are derived using nationally and state expected averages from the Bureau of Labor Statistics' May 2021 Occupational Employment Statistics (OES) survey and 2020 Industry-occupation matrix data, by industry tables. Occupations that constitute less than 0.1 percent of the industry, have fewer than 50 jobs, are confidential, or include poor quality data are not displayed. Post analysis occupations that constitute less than 1 percent of any particular project and account for less than 1 job are omitted. Jobs numbers are then rounded. These compounding suppression effects cause the percentages to add to less than 100 and the sum of occupations to be less than the total number of jobs.
- Total Ohio Workforce shows the total number of employees in each occupation in Ohio.
- Percentage of Project shows the percent of jobs in the green cement production facility that will be employed by each occupation in the U.S.
- Operation Jobs shows the total number of employees that are directly created by the green cement production facility in each occupation assuming the percentage of employees in each occupation in Ohio follows the U.S.

ECONOMIC IMPACT ANALYSIS FOR PROPOSED

COMBINED FIVE ACTIVITIES WITH INTEGRATED SYSTEM DESIGN

PROJECT STUDY AREA: Ohio Valley Regional Development Commission region: Adams, Brown, Clermont, Fayette, Gallia, Highland, Jackson, Lawrence, Pike, Ross, Scioto, and Vinton Counties.

Activity 6: Summation of All Five Activities

CONSTRUCTION

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	2,912.42	$167,454,391	$178,427,890	$356,697,907
Indirect Effect	394.81	$25,057,967	$40,070,599	$78,682,947
Induced Effect	655.18	$26,799,475	$52,537,076	$93,055,138
Total Effect	3,962.25	$219,311,838	$271,035,570	$528,435,995

OPERATIONS

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	218.00	$52,114,518	$112,401,392	$275,830,071
Indirect Effect	323.46	$27,580,158	$55,302,363	$111,006,744
Induced Effect	264.73	$10,830,780	$21,231,378	$37,603,671
Total Effect	806.18	$90,525,459	$188,935,135	$424,440,491

Operations with integrated systems design- This analysis takes advantage of integrated system design and operations. The combining of operations for the hydrogen plant with electrical power generation, air separation unit (1700 MT/day oxygen), and the carbon sequestration system plus the biomass and green cement activities shown below.

OPERATIONS

Impact Type	Employment	Labor Income	Value Added	Output
Direct Effect	178.00	$27,151,773	$81,397,963	$219,108,885
Indirect Effect	270.18	$23,956,941	$47,054,681	$93,765,372
Induced Effect	163.05	$6,676,621	$13,085,401	$23,171,117
Total Effect	611.23	$57,785,339	$141,538,046	$336,045,378

FINDINGS:

- During the construction period, IMPLAN estimates all five projects would create:
  - 3,962 total annual jobs;
  - $219,311,838 in total value paid to local workers;
  - $271,035,570 in industry's contribution to regional GDP;
  - $528,435,995 in industry sales.
- During the operational period, IMPLAN estimates all five projects would create:
  - 611.23 total annual jobs;
  - $57,785,339 in total value paid to local workers;
  - $141,538,046 in industry's contribution to regional GDP;
  - $336,045,378 in industry sales.

FOOTNOTE: To report the total impact of the construction and operations phase of all five proposed activities, researchers combined the values listed in each table for five proposed activities.
- Since the combined impact includes five different activities, the multipliers would not be calculated.

WORKFORCE ANALYSIS FOR PROPOSED

COMBINED FIVE ACTIVITIES

CONSTRUCTION		
Occupation	**Total Ohio Workforce**	**Construction Jobs**
Construction and Extraction Occupations	171,950	1,636
Management Occupations	278,880	378
Office and Administrative Support Occupations	674,570	232
Business and Financial Operations Occupations	319,410	230
Architecture and Engineering Occupations	87,420	100
Transportation and Material Moving Occupations	508,580	98
Installation, Maintenance, and Repair Occupations	203,870	96
Production Occupations	466,570	59
Sales and Related Occupations	457,930	25
Building and Grounds Cleaning and Maintenance Occupations	141,740	21

OPERATIONS		
Occupation	**Total Ohio Workforce**	**Operations Jobs**
Production Occupations	466,570	92
Transportation and Material Moving Occupations	508,580	25
Installation, Maintenance, and Repair Occupations	203,870	21
Office and Administrative Support Occupations	674,570	16
Management Occupations	278,880	15
Architecture and Engineering Occupations	87,420	14
Life, Physical, and Social Science Occupations	34,740	10
Business and Financial Operations Occupations	319,410	9
Sales and Related Occupations	457,930	5
Computer and Mathematical Occupations	162,510	2

FOOTNOTE: Underlying industry, occupation, and employment data are derived using nationally and state expected averages from the Bureau of Labor Statistics' May 2021 Occupational Employment Statistics (OES) survey and 2020 Industry-occupation matrix data, by industry tables. Occupations that constitute less than 0.1 percent of the industry, have fewer than 50 jobs, are confidential, or include poor quality data are not displayed. Post analysis occupations that constitute less than 1 percent of any particular project and account for less than 1 job are omitted. Jobs numbers are then rounded. These compounding suppression effects cause the percentages to add to less than 100 and the sum of occupations to be less than the total number of jobs.
- To report the total impact of the construction and operations phase of all five proposed activities, researchers combined the values listed in each table for five proposed activities.
- Since the combined impact includes five different activities, the "percentage of the project" column would not be calculated.

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