**BEFORE**
**THE OHIO POWER SITING BOARD**

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| In the Matter of the Application of Scioto Farms Solar Project, LLC for a Certificate of Environmental Compatibility and Public Need for the Construction of a Solar Powered Electric Generation Facility in Wayne Township, Pickaway County, Ohio. | )<br>)<br>)<br>)<br>)<br>) | Case No. 21-0868-EL-BGN |

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**DIRECT TESTIMONY OF**

**Adam Poll**

**On behalf of**

**Scioto Farms Solar Project, LLC**

**January 30, 2023**

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**Q.1 Please state your name, current title, and business address.**

**A.1** My name is Adam Alexander Poll. I am a Senior Air Quality Specialist for Dudek. My business address is 621 Chapala Street, Santa Barbara, California 93101.

**Q.2 Please summarize your educational background and professional experience.**

**A.2** I received my Bachelor of Science degree in Environmental Studies from the University of California at Santa Barbara in 2006. I received my Masters of Applied Science in Environmental Policy and Management from Denver University in 2011. My area of study in graduate school was Energy and Sustainability. My career has focused on environmental analysis and permitting, specializing in air quality and greenhouse gas ("GHG") emissions analysis, for renewable energy projects throughout the country. Over the last 10 plus years, my focus has shifted primarily to commercial-scale renewable energy projects including solar photovoltaic, wind, and battery storage projects. In addition to air quality and GHG analyses, I have prepared health risk assessments, risk of upset analyses, energy assessments, and odor modeling for clients throughout the country. A copy of my resume is attached to my testimony as Attachment A.

**Q.3 On whose behalf are you offering testimony?**

**A.3** I am testifying on behalf of Scioto Farms Solar Project, LLC ("Scioto Farms Solar" or "Applicant"), which is seeking to develop the proposed Scioto Farms Solar facility ("Project") in Pickaway County, Ohio.

**Q.4 What is the purpose of your testimony?**

**A.4** The purpose of my testimony is to provide additional context, support, and clarification regarding the "Assessment of Potential Air Pollutant Related Benefits from the Scioto Farms Solar Project," which is included as an attachment to my testimony as Attachment B.

**Q.5 Please summarize the findings of the "Assessment of Potential Air Pollutant Related Benefits from the Scioto Farms Solar Project".**

**A.5** Dudek prepared the "Assessment of Potential Air Pollutant Related Benefits from the Scioto Farms Solar Project" to estimate criteria air pollutant emissions benefits of the Project and to calculate the dollar value of potential health benefits. Using the EPA's

AVoided Emissions and geneRation Tool ("AVERT") and the Mid-Atlantic (including the entirety of the District of Columbia, Delaware, Maryland, New Jersey, Ohio, Pennsylvania, Virginia, and West Virginia as well as partial areas of Illinois, Indiana, Kentucky, Michigan, North Carolina, and Tennessee) regional data file for 2021 showed that operation of the Project will displace particulate matter less than 2.5 microns in diameter ("$PM_{2.5}$"), sulfur dioxide ("$SO_2$"), oxides of nitrogen ("$NO_x$"), carbon dioxide ("$CO_2$"), volatile organic compounds ("VOCs"), and ammonia ("$NH_3$" emissions both regionally and locally. The EPA's CO–Benefits Risk Assessment ("COBRA") tool showed statewide health benefits between $841,089 and $2,126,509 resulting from reductions in mortality, hospital admissions, and other health conditions, with statistically significant reductions in mortality, infant mortality, nonfatal heart attacks, hospital admits, minor restricted activity days, and work loss days. I also used the COBRA tool to analyze the social cost of carbon displaced by the Project. This analysis showed that $CO_2$ emissions displaced by the Project would have an economic benefit of $7,504,885 in the Mid-Atlantic region and $25,909 per year in Pickaway County. Finally, emissions displaced by the Project would directly help the County and State reduce its nonattainment pollutants to meet current and future National Ambient Air Quality Standards ("NAAQS") as well as potentially reduce regulatory compliance obligations.

**Q.6 In what way does the Project create air pollutant benefits?**

**A.6** The Project will displace fossil fuel electricity generation and the air pollutant emissions associated with it.

**Q.7 How does the general public benefit from the Project's air pollutant benefits?**

**A.7** The Project will displace $PM_{2.5}$, $SO_2$, $NO_X$, $NH_3$, $CO_2$, and VOC emissions, each of which have acute (short-term) and chronic (long-term) adverse health effects. The adverse health effects associated with air pollution are diverse and include[1]

- Premature mortality
- Cardiovascular effects

[1] EPA. 2015. Environments and Contaminants. October. https://www.epa.gov/sites/default/files/2015-10/documents/ace3_criteria_air_pollutants.pdf.

- Increased health care utilization (hospitalization, physician and emergency room visits)
- Increased respiratory illness and other morbidity (symptoms, infections, and asthma exacerbation)
- Decreased lung function (breathing capacity)
- Lung inflammation
- Potential immunological changes
- Increased airway reactivity to a known pharmacological agent exposure - a method used in laboratories to evaluate the tendency of airways to have an increased possibility of developing an asthmatic response
- A decreased tolerance for exercise
- Adverse birth outcomes such as low birth weights

In addition to reducing these adverse health effects from fossil fuel generation, the Project will reduce mortality, infant mortality, nonfatal heart attacks, hospital admits, minor restricted activity days, and work loss days both regionally and locally.

**Q.8 Can the public health benefit from the Project be quantified?**

**A.8** Yes. This is a two-step process. The EPA's AVERT quantifies the emission concentrations displaced by the Project, and the EPA's COBRA model takes the air pollution concentrations from AVERT and translates them into health effect impacts and monetary impacts.

**Q.9 Please describe how the air pollutant/public health benefits are quantified?**

**A.9** To estimate the air pollutant emission benefits of the Project, the EPA AVERT was utilized.[2] AVERT is a statistical tool that uses historical data to identify which fossil fuel resources would be displaced by new renewables or energy efficiency. Based on site-specific generation profiles, the tool estimates the air emissions that would be avoided by displacing specific power plants on the grid. The model accounts for reductions in $SO_2$,

[2] EPA 2022a. Avoided Emissions and geneRation Tool ("AVERT"). March. Accessed September 2022. https://www.epa.gov/avert/download-avert.

$NO_X$, $CO_2$, $PM_{2.5}$, VOCs, and $NH_3$. AVERT produces hourly level results at the county level for all included pollutants and can be aggregated up to various levels of granularity.

Many states and municipalities are adopting, implementing and expanding cost-effective energy efficiency (“EE”) and renewable energy (“RE”) policies and programs. States are investing in EE/RE policies and programs to achieve benefits including lowered customer costs, improved electric supply reliability, and diversified energy supply portfolios. Energy efficiency and renewable energy also have the potential to reduce pollution from criteria air pollutants and greenhouse gases, especially on high electricity demand days that typically coincide with poor air quality.

Quantifying the emissions impacts of EE/RE policies and programs can be challenging. The EPA developed AVERT to help state air quality planners calculate the emissions benefits of EE/RE policies and programs so that these emission reductions can be incorporated in Clean Air Act plans to meet NAAQS and other clean air goals. Additionally, AVERT has been used by universities, think tanks, and national laboratories to evaluate impacts of EE/RE policies and projects.[3]

AVERT's Statistical Module uses hourly "prepackaged" data from EPA’s Air Markets Program Data (“AMPD) and National Emissions Inventory to perform statistical analysis on actual behavior of past generation, heat input, $PM_{2.5}$, $SO_2$, $NO_x$, $CO_2$, VOCs, and $NH_3$ emissions data given various regional demand levels.

AVERT’s Main Module prompts users to select one of 14 AVERT regional data files and enter energy impacts [megawatt-hour (“MWh”) or megawatt (“MW”)] from a selection of options. The AVERT Main Module calculates emissions impacts based on the hourly electric generating unit information in the regional data files and the impacts entered into the tool. The emission rates generated from AVERT estimate the magnitude of emission impacts within an AVERT region for six categories: onshore wind energy, offshore wind energy, rooftop-scale photovoltaic installations, utility-scale photovoltaic installations, portfolio energy efficiency (“EE”) programs, and baseload EE programs.

[3] EPA. 2022b. Publications that Cite AVERT. March 29. https://www.epa.gov/system/files/documents/2022-03/avert_publications_03-29-22.pdf.

To estimate the health benefits of the Project, the EPA's COBRA screening model was used to explore how changes in air pollution from clean energy policies and programs, including energy efficiency and renewable energy, can affect human health at the county, state, regional, or national levels (EPA 2021). COBRA also estimates the economic value of the health benefits associated with clean energy policies and programs to compare against program costs. COBRA can map and visually represent the air quality, human health, and health-related economic benefits from reductions in emissions of $PM_{2.5}$, $SO_2$, $NO_X$, $NH_3$, and VOCs that result from clean energy policies and programs.

COBRA estimates changes in total annual ambient concentrations of $PM_{2.5}$, including primary $PM_{2.5}$ emissions and the formation of secondary $PM_{2.5}$ from precursor pollutants, such as $SO_2$, $NO_x$, $NH_3$, and VOCs. COBRA then uses a series of health impact functions, taken from the peer-reviewed epidemiological literature, to estimate how changes in outdoor air quality result in changes in the incidence of a variety of health outcomes (e.g., premature mortality, heart attacks, asthma exacerbation, lost workdays). Finally, COBRA multiplies the change in incidence for each health outcome by a monetary value specific to that outcome. COBRA outputs the Health Effects and Valuation Results, which includes a table of nationwide results as COBRA calculates health benefits in all counties in the contiguous United States due to the transport of outdoor air pollutants between counties and states. Accordingly, results are available for a particular state or county and are also provided in map form. Both the table and the map provide county-level changes in air quality (e.g., total annual average $PM_{2.5}$ concentration in $\mu g/m^3$), incidence of each health endpoint, and associated economic values. COBRA provides estimates on changes in mortality, infant mortality, nonfatal heart attacks, respiratory hospital admissions, cardiovascular hospital admissions, acute bronchitis, emergency room visits, work loss days, and asthma exacerbation.

The EPA COBRA does not take into account the benefits in changes to concentrations of $CO_2$ emissions, which are quantified by EPA AVERT. As such, it is necessary to apply a social cost of carbon value to the changes in $CO_2$ concentrations to estimate the monetary benefit.

**Q.10 Please summarize the quantitative air pollutant/public health benefits resulting from the Project.**

**A.10** Using the EPA AVERT model, the Project was shown to result in a displacement of $PM_{2.5}$, $SO_2$, $NO_X$, $NH_3$, and VOC emissions from fossil fuel electricity generation both regionally and locally (within the County). The largest displacement in emissions is of $SO_2$, due to the predominant generation of electricity by coal in the region.[4] The largest displacement of emissions in the County is for $NO_x$, therefore, it is reasonable to assume that the predominant generation of energy is by natural gas. Seasonally, the largest displacement in $SO_2$ and $NO_x$ is during late winter and early spring, whereas the largest displacement of $CO_2$ and $PM_{2.5}$ occurs during the summer months. The total health benefits from the Project statewide ranged from $841,089 to $2,126,509 per year due to reductions in mortality, hospital admissions, and other health conditions. The COBRA quantified health benefits from the Project within Pickaway County showed statistically relevant reductions in mortality, infant mortality, nonfatal heart attacks, hospital admits, minor restricted activity days, and work loss days. The Interagency Working Group on the Social Cost of Greenhouse Gases reported in its 2021 Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide that in 2020 the 3% average discounted rate would be $51 per metric ton (MT) of $CO_2$. Using this estimate of $51 MT $CO_2$ and the results of the AVERT model, the Project would result in an economic benefit of $7,504,885 per year in the Mid-Atlantic region and $25,909 per year in the County.

**Q.11 Does this conclude your direct testimony?**

**A.11** Yes, it does. However, I reserve the right to offer supplemental testimony if necessary.

[4] EPA. 2022c. eGRID Power Profiler. Accessed September 2022. https://www.epa.gov/egrid/power-profiler#/RFCW.

<u>**CERTIFICATE OF SERVICE**</u>

The undersigned hereby certifies that a true and correct copy of the foregoing *Testimony of Adam Poll* was served this 30th day of January 2023, via electronic mail upon the following parties of record.

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# Adam Poll, LEED AP BD+C

## Environmental Specialist

Adam Poll is an environmental specialist with 16 years' experience, trained in organizational greenhouse gas (GHG) accounting, which provided a thorough understanding of the Western Research Institute (WRI)/World Business Council for Sustainable Development (WBCSD) GHG Protocol Corporate Standard, while referring to the ISO 14064: Part 1 international standard for GHG inventories. Mr. Poll is experienced in GHG accounting principles, defining applications for GHG inventories, designing and development of GHG inventories, establishing GHG boundaries for an organization, identifying emission sources, tracking emissions over time, recalculations, establishing a base year, setting GHG reduction targets, inventory quality management, preparing a GHG inventory report, and preparing for verification.

Adam Poll

*University of Denver*

*MS, Environmental Policy and Management, Energy and Sustainability, 2011*

*University of California, Santa Barbara*

*BS, Environmental Studies, 2006*

***Certifications***

*LEED AP BD+C, No. 10364581*
*International Organization for Standardization (ISO), No. 14001, Lead Auditor*

*Qualified Environmental Professional (QEP), No. 03120007*

***Professional Affiliations***

*Air & Waste Management Association*

## Project Experience

**Torrey Wind Project, County of San Diego, California.** Prepared the air quality, GHG, and energy technical studies and EIR sections for the development of a utility scale wind project. Because the project was surrounded by existing residents, a construction health risk assessment was prepared. The GHG analysis evaluated the GHG emissions of the project and compared them to the overall avoided GHG emissions from production of renewable energy in place of using fossil fuel generated energy. The project was evaluated using the County's CAP consistency checklist.

**Coachella Flats Wind Project, City of Palm Springs, California.** Prepared the air quality and GHG technical studies for the repowering of a utility scale wind project. The project would replace 363 wind turbines with 24 new wind turbines and produce up to 60 MW. The project was found to have less than significant impacts when comparing to applicable South Coast Air Quality Management District (SCAQMD) thresholds. The project was shown to be consistent with the City of Palm Springs climate action plan.

**Desert Hot Springs Wind Energy Repowering Project, Desert Hot Springs, California.** Prepared the air quality and GHG technical studies for the repowering of a utility scale wind project. The project would replace 69 wind turbines with 4 new wind turbines and produce up to 17 MW. The project was found to have less than significant impacts when comparing to applicable SCAQMD thresholds. The project was shown to be consistent with the City of Desert Hot Springs climate action plan.

**Painted Hills Wind Energy Repowering Project, Riverside County, California.** Prepared the air quality and GHG technical studies for the repowering of a utility scale wind project. The project would replace 291 wind turbines with 14 new wind turbines and produce up to 43 MW. The project was found to have less than significant impacts when comparing to applicable SCAQMD thresholds. The project was shown to be consistent with the County of Riverside's climate action plan.

**Environmental Impact Report for the JVR Energy Park Project, San Diego County, California.** Prepared the air quality, GHG, and energy technical reports and sections for the EIR. The project includes installation of up to 300,000 PV panels and is rated at 90 MW with 360 MWh battery storage facility. This project included evaluating the health risk from project construction. The project was evaluated against the County's Climate Action Plan (CAP) Checklist. The project was found to be less than significant with mitigation.

**Air Quality and GHG Technical Study for the Little Bear Solar Project, Fresno County, California.** Prepared the air quality and GHG technical report for the Project. The project proposes to construct and operate an approximately 180 MW solar photovoltaic power generation facility on lands located near Mendota in unincorporated Fresno County, California. The project included an ambient air quality assessment and a construction health risk assessment. The project was found to be less than significant.

**Environmental Impact Report for the Mountain View Wind Repower Project, Riverside County, California.** Prepared the air quality, GHG, and energy technical reports and sections for the EIR. The project includes the decommissioning and removal of 93 existing antiquated turbines and installation of 16 new wind turbines. The project would still produce an additional 25,794 megawatt-hours of electricity per year compared to the decommissioned turbines. As such the project showed a net GHG benefit compared to the decommissioned turbines and impacts were determined to be less than significant.

**Air Quality and GHG Technical Study for the Calcite Solar Project, San Bernardino County, California.** Prepared the air quality and GHG technical report for the Project. The project proposes to construct and operate the proposed project on five sites totaling approximately 664 acres to produce approximately 266,000 megawatt-hours MWh of renewable energy annually. The proposed project would be a 100-MW alternating current (AC) photovoltaic (PV) solar energy facility with associated on-site substation, inverters, fencing, roads, and supervisory control and data acquisition (SCADA) system. The proposed project and substation would avoid a total of 632,719 MT CO2e from 2022 through 2044. As such the project showed a GHG benefit and impacts were determined to be less than significant.

**Air Quality and GHG Technical Study for the Sonrisa Solar Project, Fresno County, California.** Prepared the air quality and GHG technical report for the Project. The Project would construct and operate an approximately 200 MW solar photovoltaic power generation facility on approximately 1,700 acres of land in Fresno County, California. The facility will also include battery energy storage system (BESS) up to approximately 160 MW hours (40 MWac for a duration of 4 hours), which will be used for example to optimize power to the grid, such as charging the batteries when excess electrical generation is available and supplying power to the grid when electrical demand is high. A construction health risk assessment was prepared for the project. The Project would provide a potential reduction of 37,391 MT $CO_2e$ per year if the electricity generated by the Project were to be used instead of electricity generated by fossil-fuel sources. Impacts were determined to be less than significant.

## Publications

Poll, Adam. 2011. "The Identification of Best Management Practices in a Materials Recovery Facility to Increase Solid Waste Diversion in the Department of Defense (DoD) Installations along the Front Range of Colorado to Satisfy the DoD Solid Waste Diversion Goal of 40%." University of Denver, Capstone Project. February 2011.

Poll, A., Reed, J., and Grover, B. 2018. "Evaluation of Greenhouse Gas Emissions Offset Availability within San Diego County." December. https://www.ci.oceanside.ca.us/civicax/filebank/blobdload.aspx?BlobID=49641.

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# MEMORANDUM

| | |
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| **To:** | Brian Kunz, Candela Renewables |
| **From:** | Adam Poll, Dudek |
| **Subject:** | Assessment of Potential Air Pollutant Related Benefits from the Scioto Farms Solar Project |
| **Date:** | October 4, 2022 |
| **cc:** | David Hochart, Dudek |
| **Attachment:** | A — COBRA Description of Health Effects and their Economic Values |

Dudek is pleased to present Candela Renewables with the following air quality analysis for the proposed Scioto Farms Solar Project (project) located in Pickaway County (County), Ohio. This memorandum estimates criteria air pollutant emissions benefits of the project and monetizes the potential health benefits. The contents and organization of this memorandum are as follows: Project Description, Background and Methodology, Emissions Assessment, Health Benefits Assessment, National Ambient Air Quality Standards (NAAQS) Assessment, Conclusions, and References Cited.

# 1 Project Description

Candela Renewables, LLC is developing the Scioto Farms Solar Project, a 110 megawatt (MW) solar photovoltaic generating station (PV) in Central Ohio. Southwest of Circleville, Scioto Farms will cover approximately 1,070 acres of land and will interconnect to the 138kV Biers Run – Circleville AEP transmission line on site.

This project will create an average of 150 to 350 local jobs during construction and provide significant funds to the Circleville School District via a tax abatement agreement.

Additionally, this project will help support Ohio's state-wide green energy goals, which are to achieve 8.5% renewable energy by 2026.

Candela expects to begin construction around Quarter 4 2022, with the project becoming fully operational in 2024. Scioto Farms Solar will generate over 247,000 MW-hours of carbon-free energy annually during the 40 year life of the project.

# 2 Background and Methodology

## Criteria Air Pollutants and Associated Health Effects

Criteria air pollutants are defined as pollutants for which the federal and state governments have established ambient air quality standards, or criteria, for outdoor concentrations to protect public health. The national standards have been set, with an adequate margin of safety, at levels above which concentrations could be harmful to human health and welfare. The NAAQS standards are designed to protect the most sensitive persons from illness or discomfort. Pollutants of concern include ozone ($O_3$), nitrogen dioxide ($NO_2$), carbon monoxide (CO), sulfur dioxide ($SO_2$), particulate matter with an aerodynamic diameter less than or equal to 10 microns ($PM_{10}$), particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), and lead[1].

Numerous scientific studies published over the past 50 years point to the harmful effects of air pollution (CARB 2019a). As explained above, the AAQS are designed to prevent these effects (CARB 2019a). The adverse health effects associated with air pollution are diverse and include (SCAQMD 2017):

- Premature mortality
- Cardiovascular effects
- Increased health care utilization (hospitalization, physician and emergency room visits)
- Increased respiratory illness and other morbidity (symptoms, infections, and asthma exacerbation)
- Decreased lung function (breathing capacity)
- Lung inflammation
- Potential immunological changes
- Increased airway reactivity to a known pharmacological agent exposure - a method used in laboratories to evaluate the tendency of airways to have an increased possibility of developing an asthmatic response
- A decreased tolerance for exercise
- Adverse birth outcomes such as low birth weights

The evidence linking these effects to air pollutants is derived from population-based observational and field studies (epidemiological) as well as controlled laboratory studies involving human subjects and animals. There have been an increasing number of studies focusing on the mechanisms (that is, on learning how specific organs, cell types, and biomarkers are involved in the human body's response to air pollution) and specific pollutants responsible for individual effects. Yet the underlying biological pathways for these effects are not always clearly understood (SCAQMD 2017).

Although individuals inhale pollutants as a mixture under ambient conditions, the regulatory framework and the control measures developed are pollutant-specific for six major outdoor pollutants covered under Sections 108 and 109 of the Clean Air Act. This is appropriate, in that different pollutants usually differ in their sources, their times and places of occurrence, the kinds of health effects they may cause, and their overall levels of health risk. Different pollutants, from the same or different sources, oftentimes occur together. Evidence for more than additive effects has not been strong and, as a practical matter, health scientists, as well as regulatory officials, usually must deal with one pollutant at a time in adopting AAQS (SCAQMD 2017).

1 Lead is not evaluated herein as it is not estimated in the models utilized in this analysis.

**Ozone (O3).** $O_3$ is a strong-smelling, pale blue, reactive, toxic chemical gas consisting of three oxygen atoms. It is a secondary pollutant formed in the atmosphere by a photochemical process involving the sun's energy and $O_3$ precursors. These precursors are mainly $NO_x$ and ROG. The maximum effects of precursor emissions on $O_3$ concentrations usually occur several hours after they are emitted and many miles from the source. Meteorology and terrain play major roles in $O_3$ formation, and ideal conditions occur during summer and early autumn on days with low wind speeds or stagnant air, warm temperatures, and cloudless skies. $O_3$ exists in the upper atmosphere $O_3$ layer (stratospheric $O_3$) and at the Earth's surface in the troposphere (ground-level $O_3$).[2] The $O_3$ that the U.S. Environmental Protection Agency (EPA) regulate as a criteria air pollutant is produced close to the ground level, where people live, exercise, and breathe. Ground-level $O_3$ is a harmful air pollutant that causes numerous adverse health effects and is thus considered "bad" $O_3$. Stratospheric, or "good," $O_3$ occurs naturally in the upper atmosphere, where it reduces the amount of ultraviolet light (i.e., solar radiation) entering the Earth's atmosphere. Without the protection of the beneficial stratospheric $O_3$ layer, plant and animal life would be seriously harmed.

$O_3$ in the troposphere causes numerous adverse health effects; short-term exposures (lasting for a few hours) to $O_3$ at levels typically observed in Ohio can result in breathing pattern changes, reduction of breathing capacity, respiratory symptoms, worsening of lung disease leading to premature death, increased susceptibility to infections, inflammation of and damage to the lung tissue, and some immunological changes (EPA 2013, CARB 2019b). These health problems are particularly acute in sensitive receptors such as the sick, older adults, and young children.

Inhalation of $O_3$ causes inflammation and irritation of the tissues lining human airways, causing and worsening a variety of symptoms. Exposure to $O_3$ can reduce the volume of air that the lungs breathe in and cause shortness of breath. $O_3$ in sufficient doses increases the permeability of lung cells, rendering them more susceptible to toxins and microorganisms. The occurrence and severity of health effects from $O_3$ exposure vary widely among individuals, even when the dose and the duration of exposure are the same. Research shows adults and children who spend more time outdoors participating in vigorous physical activities are at greater risk from the harmful health effects of $O_3$ exposure. While there are relatively few studies of $O_3$'s effects on children, the available studies show that children are no more or less likely to suffer harmful effects than adults. However, there are a number of reasons why children may be more susceptible to $O_3$ and other pollutants. Children and teens spend nearly twice as much time outdoors and engaged in vigorous activities as adults. Children breathe more rapidly than adults and inhale more pollution per pound of their body weight than adults. Also, children are less likely than adults to notice their own symptoms and avoid harmful exposures. Further research may be able to better distinguish between health effects in children and adults. Children, adolescents and adults who exercise or work outdoors, where $O_3$ concentrations are the highest, are at the greatest risk of harm from this pollutant (CARB 2019b).

A number of population groups are potentially at increased risk for $O_3$ exposure effects. In the ongoing review of $O_3$, the EPA has identified populations as having adequate evidence for increased risk from $O_3$ exposures include individuals with asthma, younger and older age groups, individuals with reduced intake of certain nutrients such as Vitamins C and E, and outdoor workers. There is suggestive evidence for other potential factors, such as variations in genes related to oxidative metabolism or inflammation, gender, socioeconomic status, and obesity. However further evidence is needed (SCAQMD 2017).

The adverse effects reported with short-term $O_3$ exposure are greater with increased activity because activity increases the breathing rate and the volume of air reaching the lungs, resulting in an increased amount of $O_3$

[2] The troposphere is the layer of the Earth's atmosphere nearest to the surface of the Earth. The troposphere extends outward about 5 miles at the poles and about 10 miles at the equator.

reaching the lungs. Children may be a particularly vulnerable population to air pollution effects because they spend more time outdoors, are generally more active, and have a higher specific ventilation relative to their body weight, compared to adults (SCAQMD 2017).

**Volatile Organic Compounds (VOCs).** The primary health effects of VOCs result from the formation of $O_3$ and its related health effects. High levels of VOCs in the atmosphere can interfere with oxygen intake by reducing the amount of available oxygen through displacement. Carcinogenic forms of hydrocarbons, such as benzene, are considered TACs. There are no separate health standards for VOCs as a group.

**Nitrogen Dioxide (NO2).** $NO_2$ is a brownish, highly reactive gas that is present in all urban atmospheres. The major mechanism for the formation of $NO_2$ in the atmosphere is the oxidation of the primary air pollutant nitric oxide (NO), which is a colorless, odorless gas. $NO_x$ plays a major role, together with ROG, in the atmospheric reactions that produce $O_3$. $NO_x$ is formed from fuel combustion under high temperature or pressure. In addition, $NO_x$ is an important precursor to acid rain and may affect both terrestrial and aquatic ecosystems. The two major emissions sources are transportation and stationary fuel combustion sources such as electric utility and industrial boilers. $NO_2$ can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections (EPA 2016).

A large body of health science literature indicates that exposure to $NO_2$ can induce adverse health effects. The strongest health evidence, and the health basis for the AAQS for $NO_2$, is results from controlled human exposure studies that show that $NO_2$ exposure can intensify responses to allergens in allergic asthmatics. In addition, a number of epidemiological studies have demonstrated associations between $NO_2$ exposure and premature death, cardiopulmonary effects, decreased lung function growth in children, respiratory symptoms, emergency room visits for asthma, and intensified allergic responses. Infants and children are particularly at risk because they have disproportionately higher exposure to $NO_2$ than adults due to their greater breathing rate for their body weight and their typically greater outdoor exposure duration. Several studies have shown that long-term $NO_2$ exposure during childhood, the period of rapid lung growth, can lead to smaller lungs at maturity in children with higher compared to lower levels of exposure. In addition, children with asthma have a greater degree of airway responsiveness compared with adult asthmatics. In adults, the greatest risk is to people who have chronic respiratory diseases, such as asthma and chronic obstructive pulmonary disease (CARB 2019c).

**Carbon Monoxide (CO).** CO is a colorless, odorless gas formed by the incomplete combustion of hydrocarbon, or fossil fuels. CO is emitted almost exclusively from motor vehicles, power plants, refineries, industrial boilers, ships, aircraft, and trains. In urban areas, such as the Project location, automobile exhaust accounts for the majority of CO emissions. CO is a nonreactive air pollutant that dissipates relatively quickly; therefore, ambient CO concentrations generally follow the spatial and temporal distributions of vehicular traffic. CO concentrations are influenced by local meteorological conditions—primarily wind speed, topography, and atmospheric stability. CO from motor vehicle exhaust can become locally concentrated when surface-based temperature inversions are combined with calm atmospheric conditions, which is a typical situation at dusk in urban areas from November to February. The highest levels of CO typically occur during the colder months of the year, when inversion conditions are more frequent.

Carbon monoxide is harmful because it binds to hemoglobin in the blood, reducing the ability of blood to carry oxygen. This interferes with oxygen delivery to the body's organs. The most common effects of CO exposure are fatigue, headaches, confusion and reduced mental alertness, and light-headedness, dizziness due to inadequate oxygen delivery to the brain. For people with cardiovascular disease, short-term CO exposure can further reduce their body's already compromised ability to respond to the increased oxygen demands of exercise, exertion, or stress. Inadequate oxygen delivery to the heart muscle leads to chest pain and decreased exercise tolerance. Unborn babies whose mothers experience high levels of CO exposure during pregnancy are at risk of adverse developmental effects. Unborn babies, infants, elderly people, and people with anemia or with a history of heart or respiratory disease are most likely to experience health effects with exposure to elevated levels of CO (CARB 2019d).

**Sulfur Dioxide ($SO_2$).** $SO_2$ is a colorless, pungent gas formed primarily from incomplete combustion of sulfur-containing fossil fuels. The main sources of $SO_2$ are coal and oil used in power plants and industries; as such, the highest levels of $SO_2$ are generally found near large industrial complexes. In recent years, $SO_2$ concentrations have been reduced by the increasingly stringent controls placed on stationary source emissions of $SO_2$ and limits on the sulfur content of fuels.

$SO_2$ is an irritant gas that attacks the throat and lungs and can cause acute respiratory symptoms and diminished ventilator function in children. When combined with particulate matter (PM), $SO_2$ can injure lung tissue and reduce visibility and the level of sunlight. $SO_2$ can worsen asthma resulting in increased symptoms, increased medication usage, and emergency room visits.

Controlled human exposure and epidemiological studies show that children and adults with asthma are more likely to experience adverse responses with $SO_2$ exposure, compared with the non-asthmatic population. Effects at levels near the one-hour standard are those of asthma exacerbation, including bronchoconstriction accompanied by symptoms of respiratory irritation such as wheezing, shortness of breath and chest tightness, especially during exercise or physical activity. Also, exposure at elevated levels of $SO_2$ (above 1 parts per million (ppm)) results in increased incidence of pulmonary symptoms and disease, decreased pulmonary function, and increased risk of mortality. The elderly and people with cardiovascular disease or chronic lung disease (such as bronchitis or emphysema) are most likely to experience these adverse effects (CARB 2019e).

$SO_2$ is of concern both because it is a direct respiratory irritant and because it contributes to the formation of sulfate and sulfuric acid in PM (NRC 2005). People with asthma are of particular concern, both because they have increased baseline airflow resistance and because their $SO_2$-induced increase in resistance is greater than in healthy people, and it increases with the severity of their asthma (NRC 2005). $SO_2$ is thought to induce airway constriction via neural reflexes involving irritant receptors in the airways (NRC 2005).

**Particulate Matter ($PM_{10}$ and $PM_{2.5}$).** Particulate matter pollution consists of very small liquid and solid particles floating in the air, which can include smoke, soot, dust, salts, acids, and metals. Particulate matter can form when gases emitted from industries and motor vehicles undergo chemical reactions in the atmosphere. $PM_{2.5}$ and $PM_{10}$ represent fractions of particulate matter. $PM_{10}$ consists of particulate matter that is 10 microns or less in diameter, which is about 1/7 the thickness of a human hair. Major sources of $PM_{10}$ include crushing or grinding operations; dust stirred up by vehicles traveling on roads; wood-burning stoves and fireplaces; dust from construction, landfills, and agriculture; wildfires and brush/waste burning; industrial sources; windblown dust from open lands; and atmospheric chemical and photochemical reactions. $PM_{2.5}$ consists of particulate matter that is 2.5 microns or less in diameter, which is roughly 1/28 the diameter of a human hair. $PM_{2.5}$ results from fuel combustion (e.g., from motor vehicles and power generation and industrial facilities), residential fireplaces, and woodstoves. In addition, $PM_{2.5}$ can be formed in the atmosphere from gases such as sulfur oxides ($SO_x$), $NO_x$, and ROG. Air pollutants formed through chemical reactions in the atmosphere are referred to as secondary pollutants.

A number of adverse health effects have been associated with exposure to both $PM_{2.5}$ and $PM_{10}$. For $PM_{2.5}$, short-term exposures (up to 24-hours duration) have been associated with premature mortality, increased hospital admissions for heart or lung causes, acute and chronic bronchitis, asthma attacks, emergency room visits, respiratory symptoms, and restricted activity days. These adverse health effects have been reported primarily in infants, children, and older adults with preexisting heart or lung diseases. In addition, of all of the common air pollutants, $PM_{2.5}$ is associated with the greatest proportion of adverse health effects related to air pollution, both in the United States and world-wide based on the World Health Organization's Global Burden of Disease Project. Short-term exposures to $PM_{10}$ have been associated primarily with worsening of respiratory diseases, including asthma and chronic obstructive pulmonary disease, leading to hospitalization and emergency department visits (CARB 2017).

Long-term (months to years) exposure to $PM_{2.5}$ has been linked to premature death, particularly in people who have chronic heart or lung diseases, and reduced lung function growth in children. The effects of long-term exposure to $PM_{10}$ are less clear, although several studies suggest a link between long-term $PM_{10}$ exposure and respiratory mortality. The International Agency for Research on Cancer published a review in 2015 that concluded that PM in outdoor air pollution causes lung cancer (CARB 2017).

People with influenza, people with chronic respiratory and cardiovascular diseases, and older adults may suffer worsening illness and premature death as a result of breathing PM. People with bronchitis can expect aggravated symptoms from breathing PM. Children may experience a decline in lung function due to breathing in $PM_{10}$ and $PM_{2.5}$ (EPA 2009).

PM encompasses a physically and chemically diverse class of ambient air pollutants of both anthropogenic and biological origin. The PM standard is the only NAAQS that does not target a specific chemical or family of chemical species (NRC 2005). The range of human health effects associated with ambient PM levels or demonstrated in laboratory studies has expanded from earlier concerns for total mortality and respiratory morbidity to include cardiac mortality and morbidity, blood vessel constriction, stroke, premature birth, low birth weight, retarded lung growth, enhancement of allergic responses, reduced resistance to infection, degenerative lesions in the brain, and lung cancer (EPA 2004).

**Ammonia (NH3).** Health effects of inhaled ammonia observed at levels exceeding naturally-occurring concentrations are generally limited to the respiratory tract, the site of direct contact with ammonia (EPA 2016a). Short-term inhalation exposure to high levels of ammonia in humans can cause irritation and serious burns in the mouth, lungs, and eyes. Chronic exposure to airborne ammonia can increase the risk of respiratory irritation, cough, wheezing, tightness in the chest, and impaired lung function in humans. Studies in experimental animals similarly indicate that breathing ammonia at sufficiently high concentrations can result in effects on the respiratory system. Animal studies also suggest that exposure to high levels of ammonia in air may adversely affect other organs, such as the liver, kidney, and spleen.

## Greenhouse Gases

A greenhouse gas (GHG) is any gas that absorbs infrared radiation in the atmosphere; in other words, GHGs trap heat in the atmosphere. GHGs include carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride ($SF_6$), and nitrogen trifluoride ($NF_3$). Some GHGs, such as $CO_2$, $CH_4$, and $N_2O$ are emitted into the atmosphere through natural processes and human activities. Of these gases, $CO_2$ and $CH_4$ are emitted in the greatest quantities from human activities. Manufactured GHGs, which have a much greater heat-absorption potential than $CO_2$, include fluorinated gases, such as HFCs, PFCs, and $SF_6$, which are associated with certain industrial products and processes.

$CO_2$ is a naturally occurring gas and a by-product of human activities and is the principal anthropogenic GHG that affects the Earth's radiative balance. Natural sources of $CO_2$ include respiration of bacteria, plants, animals, and fungus; evaporation from oceans; volcanic out-gassing; and decomposition of dead organic matter. Human activities that generate $CO_2$ are from the combustion of fuels such as coal, oil, natural gas, and wood and changes in land use.

$CO_2$ is the primary GHG contributing to recent climate change. Climate change refers to any significant change in measures of climate—such as temperature, precipitation, or wind patterns—lasting for an extended period of time (decades or longer). Globally, climate change has the potential to affect numerous environmental resources through uncertain impacts related to future air temperatures and precipitation patterns. Signs that global climate change has occurred include warming of the atmosphere and ocean, diminished amounts of snow and ice, rising sea levels, and ocean acidification (IPCC 2014).

## Air Pollutant Emissions Assessment

To estimate the air pollutant emission benefits of the project, the United States Environmental Protection Agency's (US EPA) AVoided Emissions and geneRation Tool (AVERT) was utilized (EPA 2022a). The AVERT model is a statistical tool that uses historical data to identify which fossil fuel resources would be displaced by new renewables or energy efficiency. Based on site specific generation profiles, the tool estimates the air emissions that would be avoided by displacing specific power plants on the grid. The model accounts for reductions in $SO_2$, oxides of nitrogen ($NO_X$), $CO_2$, $PM_{2.5}$, VOCs, and Ammonia ($NH_3$). The AVERT model produces hourly level results at the county level for all included pollutants and can be aggregated up to various levels of granularity.

AVERT's Statistical Module uses hourly "prepackaged" data from EPA's Air Markets Program Data (AMPD) and National Emissions Inventory to perform statistical analysis on actual behavior of past generation, heat input, $PM_{2.5}$, $SO_2$, $NO_x$, $CO_2$, VOCs, and $NH_3$ emissions data given various regional demand levels. (AVERT's Statistical Module can also analyze user-modified data created in AVERT's Excel-based Future-Year Scenario Template). AVERT's Statistical Module produces regional data files that are input files used in AVERT's Excel-based Main Module.

AVERT's Main Module prompts users to select one of 14 AVERT regional data files and enter energy impacts [megawatt-hour (MWh) or megawatt (MW)] from a selection of options. The AVERT Main Module calculates emissions impacts based on the hourly electric generating unit information in the regional data files and the impacts entered into the tool. The emission rates generated from AVERT estimate the magnitude of emission impacts within an AVERT region for six categories: onshore wind energy, offshore wind energy, rooftop-scale photovoltaic installations, utility-scale photovoltaic installations, portfolio EE programs, and baseload EE programs.

## Health Benefits Assessment

To estimate the health benefits of the project, the US EPA's CO–Benefits Risk Assessment (COBRA) screening model was used to explore how changes in air pollution from clean energy policies and programs, including energy efficiency and renewable energy, can affect human health at the county, state, regional, or national levels (EPA 2021). COBRA also estimates the economic value of the health benefits associated with clean energy policies and programs to compare against program costs. COBRA can map and visually represent the air quality, human health, and health-related economic benefits from reductions in emissions of $PM_{2.5}$, $SO_2$, $NO_X$, $NH_3$, and VOCs that result from clean energy policies and programs.

COBRA estimates changes in total annual ambient concentrations of $PM_{2.5}$, including primary $PM_{2.5}$ emissions and the formation of secondary $PM_{2.5}$ from precursor pollutants, such as $SO_2$, $NO_x$, $NH_3$, and VOCs. COBRA then uses a series of health impact functions, taken from the peer-reviewed epidemiological literature, to estimate how changes in outdoor air quality result in changes in the incidence of a variety of health outcomes (e.g., premature mortality, heart attacks, asthma exacerbation, lost workdays). Finally, COBRA multiplies the change in incidence for each health outcome by a monetary value specific to that outcome. COBRA outputs the Health Effects and Valuation Results which includes a table of nationwide results as COBRA calculates health benefits in all counties in the contiguous United States due to the transport of outdoor air pollutants between counties and states. Accordingly, results are available for a particular state or county and are also provided in map form. Both the table and the map provide county-level changes in air quality (e.g., total annual average $PM_{2.5}$ concentration in $\mu g/m^3$), incidence of each health endpoint, and associated economic values. COBRA provides estimates on changes in mortality, infant mortality, nonfatal heart attacks, respiratory hospital admissions, cardiovascular hospital admissions, acute bronchitis, emergency room visits, work loss days, and asthma exacerbation.

## Social Cost of Carbon

EPA and other federal agencies use estimates of the social cost of carbon (SC-$CO_2$) to value the climate impacts of rulemakings. The SC-$CO_2$ is a measure, in dollars, of the long-term damage done by a ton of carbon dioxide ($CO_2$) emissions in a given year (EPA 2016b). This dollar figure also represents the value of damages avoided for a small emission reduction (i.e., the benefit of a $CO_2$ reduction).

The SC-$CO_2$ is meant to be a comprehensive estimate of climate change damages and includes, among other things, changes in net agricultural productivity, human health, property damages from increased flood risk and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning (EPA 2016b). However, it does not currently include all important damages. The IPCC Fifth Assessment report observed that SC-$CO_2$ estimates omit various impacts that would likely increase damages. The models used to develop SC-$CO_2$ estimates do not currently include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature because of a lack of precise information on the nature of damages and because the science incorporated into these models naturally lags behind the most recent research. Nonetheless, current estimates of the SC-$CO_2$ are a useful measure to assess the climate impacts of $CO_2$ emission changes.

The timing of the emission release (or reduction) is key to estimation of the SC-$CO_2$, which is based on a present value calculation. The integrated assessment models first estimate damages occurring after the emission release and into the future, often as far out as the year 2300 (EPA 2016b). The models then discount the value of those damages over the entire time span back to present value to arrive at the SC-$CO_2$. For example, the SC-$CO_2$ for the year 2020 represents the present value of climate change damages that occur between the years 2020 and 2300 (assuming 2300 is the final year of the model run); these damages are associated with the release of one ton of $CO_2$ in the year 2020. The SC-$CO_2$ will vary based on the year of emissions for multiple reasons. In model runs where the last year is fixed (e.g., 2300), the time span covered in the present value calculation will be smaller for later emission years—the SC-$CO_2$ in 2050 will include 40 fewer years of damages than the 2010 SC-$CO_2$ estimates. This modeling choice—selection of a fixed end year—will place downward pressure on the SC-$CO_2$ estimates for later emission years. Alternatively, the SC-$CO_2$ should increase over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater levels of climatic change. The SC-$CO_2$ was used to estimate the economic benefits of the displacement of $CO_2$ emissions from the project.

### National Ambient Air Quality Standards (NAAQS) Assessment

The Clean Air Act Amendments of 1970 instruct the EPA to set primary NAAQS to protect public health, and secondary NAAQS to protect plants, forests, crops and materials from damage due to exposure to the following criteria air pollutants: $O_3$, $NO_2$, CO, $SO_2$, $PM_{10}$, $PM_{2.5}$, and lead.

The federal Clean Air Act requires that the EPA reassess, at least every five years, whether adopted standards are adequate to protect public health based on current scientific evidence. The EPA is required to rely on the advice of an independent scientific panel, the Clean Air Scientific Advisory Committee. Reviewing the NAAQS is a lengthy undertaking and includes the following major phases: planning, integrated science assessment, risk/exposure assessment, policy assessment, and rulemaking (EPA 2018a). During the integrated science assessment, a comprehensive review, synthesis, and evaluation of the most policy-relevant science is conducted, including key science judgments that are important to inform the development of the risk and exposure assessments (EPA 2018a). Then, the risk/exposure assessment draws upon information and conclusions presented in the integrated science assessment to develop quantitative characterizations of exposures and associated risks to human health or the environment associated with recent air quality conditions and with air quality estimated to just meet the current or alternative standard(s) under consideration (EPA 2018a). Scientific review during policy assessment development, and the NAAQS review process in general, is thorough and extensive.

Federal law requires that all states attain the NAAQS. Failure of a state to reach attainment of the NAAQS by the target date can trigger penalties, including withholding of federal highway funds (CARB 2019a). The Clean Air Act gives U.S. EPA up to 18 months to act on a redesignation request. The area is not officially redesignated until U.S. EPA provides an opportunity for public comment and publishes the final action in the Federal Register. Only then is the area relieved of all requirements for nonattainment areas, including the requirement for new or modified facilities to obtain emissions offsets. This analysis will discuss how the potential air quality benefits of the project would support future compliance with the NAAQS.

# 3 Emissions Assessment

The AVERT desktop tool was downloaded and run to estimate the displacement of air pollutant emissions resulting from the project. As the project is located in Ohio, the Mid-Atlantic regional data file for 2021 was downloaded as the applicable dataset. Under the Step 2 Energy Scenario, the Utility Scale PV Capacity was set to 110 MW consistent with the project description. This scenario was run to evaluate changes to energy generators and air pollutant emissions. The annual regional impacts from AVERT are presented in Table 1 and the annual impact data for the County are shown in Table 2.

## Table 1. Annual Regional Emission Impacts

| | Original | Post Change | Change |
|---|---|---|---|
| Fossil Fuel Generation (MWh) | 471,892,370 | 471,677,160 | -215,200 |
| Heat Input (MMBtu) | 4,067,759,160 | 4,065,738,430 | -2,020,720 |
| **Total Emissions from Fossil Generation Fleet** | | | |
| $SO_2$ (lb) | 362,455,710 | 362,240,150 | -215,560 |
| $NO_x$ (lb) | 249,763,550 | 249,615,530 | -148,030 |
| *Ozone season $NO_x$ (lb)* | *103,492,430* | *103,423,430* | *-69,000* |
| $CO_2$ (tons) | 318,474,520 | 318,312,310 | -162,210 |
| $PM_{2.5}$ (lb) | 37,434,300 | 37,413,710 | -20,590 |
| VOCs (lb) | 7,026,370 | 7,021,990 | -4,370 |
| $NH_3$ (lb) | 8,077,370 | 8,071,930 | -5,450 |
| **AVERT-derived Emission Rates:** | **Average Fossil** | — | **Marginal Fossil** |
| $SO_2$ (lb/MWh) | 0.768 | — | 1.002 |
| $NO_x$ (lb/MWh) | 0.529 | — | 0.688 |
| *Ozone season $NO_x$ (lb/MWh)* | *0.477* | — | *0.658* |
| $CO_2$ (tons/MWh) | 0.675 | — | 0.754 |
| $PM_{2.5}$ (lb/MWh) | 0.079 | — | 0.096 |
| VOCs (lb/MWh) | 0.015 | — | 0.020 |
| $NH_3$ (lb/MWh) | 0.017 | — | 0.025 |

**Notes:** MWh = megawatt-hours; MMBtu = million British thermal units; lb = pound; $SO_2$ = sulfur dioxide; $NO_x$ = oxides of nitrogen; $CO_2$ = carbon dioxide; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; VOCs = volatile organic compounds; $NH_3$ = ammonia.
Ozone season is defined as May 1 - September 30. Ozone season emissions are a subset of annual emissions.
Negative numbers indicate displaced generation and emissions.

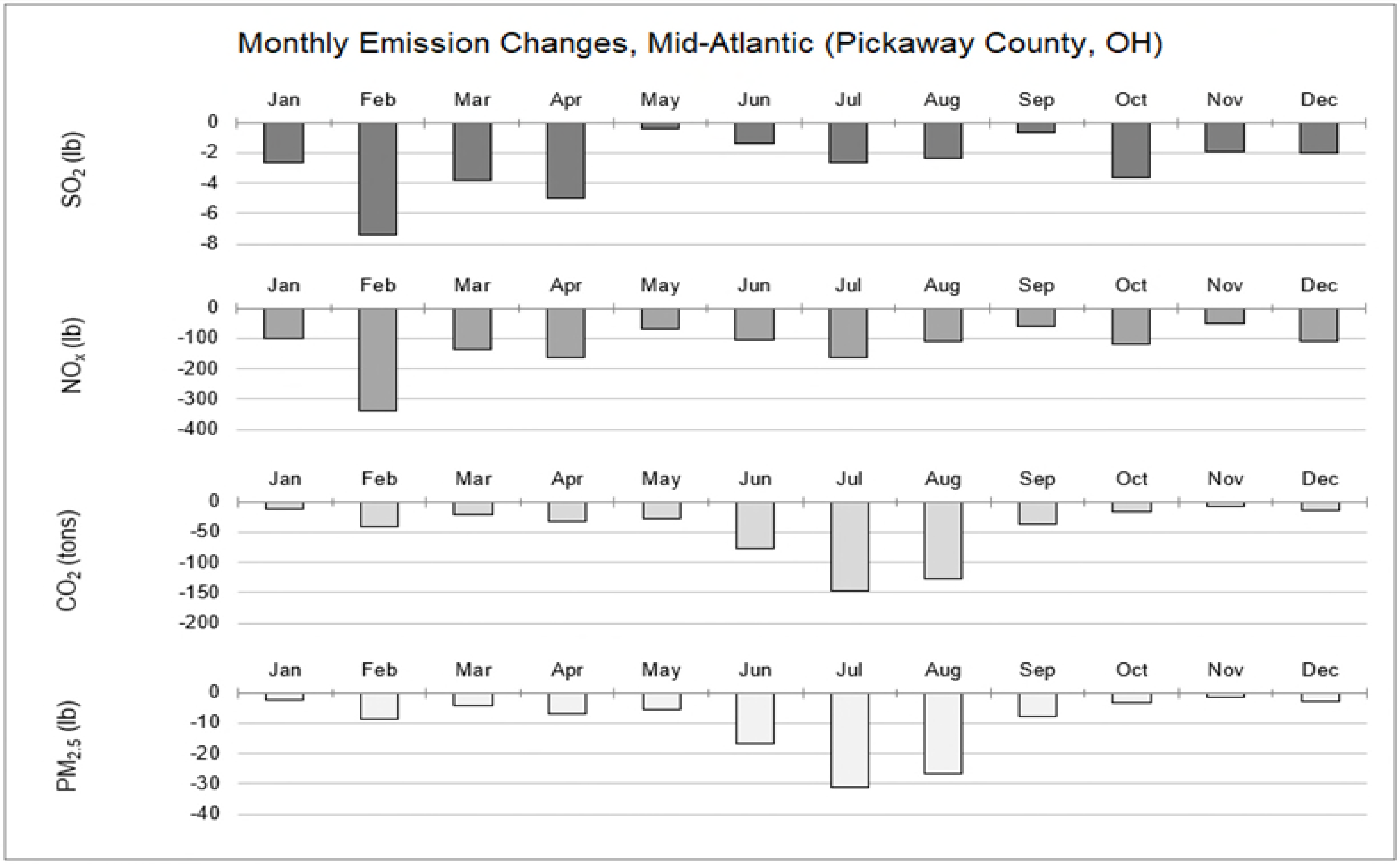
As shown in Table 1, the project would result in a displacement of fossil fuel generation and a resulting decrease in emissions of $PM_{2.5}$, $SO_2$, $NO_x$, $CO_2$, VOCs, and $NH_3$ compared to the 2021 baseline. The largest displacement in emissions is of $SO_2$ due to the predominant generation of energy by coal in the region (EPA 2022b). Emission rate data in the "Average Fossil" column describes the average emission rate associated with fossil-fired plants in the selected AVERT region in the original baseline of the selected year's data. Fossil-fuel emission rates presented in the "Marginal Fossil" column are the change in emissions divided by the change in generation, resulting from the user-specified scenario. Table 2 shows the annual emissions results for the County as provided by AVERT. As shown in Table 2, the largest displacement of emissions in the County is for $NO_x$, it is reasonable to assume that the predominant generation of energy is by natural gas. Figure 1 presents the monthly emission changes in the County for $SO_2$, $NO_x$, $CO_2$, and $PM_{2.5}$. As shown in Figure 1, seasonally, the largest displacement in $SO_2$ and $NO_x$ is during late winter and early spring whereas the largest displacement of $CO_2$ and $PM_{2.5}$ occurs during the summer months.

## Table 2. Annual County Emission Impacts

| | |
|---|---|
| State | OH |
| County | Pickaway County |
| Peak Generation, Post-Change (MW) | 418 |
| Annual Generation, Post-Change (MWh) | 376,100 |
| Annual Change in Generation (MWh) | -800 |
| Annual Change in Heat Input (MMBtu) | -9,470 |
| Annual Change in $SO_2$ (lb) | -30 |
| Annual Change in $NO_x$ (lb) | -1,530 |
| Annual Change in $CO_2$ (tons) | -560 |
| Annual Change in $PM_{2.5}$ (lb) | -120 |
| Annual Change in VOCs (lb) | -10 |
| Annual Change in $NH_3$ (lb) | -60 |
| Ozone Season Change in $SO_2$ (lb) | -10 |
| Ozone Season Change in $NO_x$ (lb) | -510 |
| Ozone Season Change in $PM_{2.5}$ (lb) | -90 |

**Notes:** MW = megawatts; MWh = megawatt-hours; MMBtu = million British thermal units; lb = pound; $SO_2$ = sulfur dioxide; $NO_x$ = oxides of nitrogen; $CO_2$ = carbon dioxide; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; VOCs = volatile organic compounds; $NH_3$ = ammonia.
Negative numbers indicate displaced generation and emissions. All results are rounded to the nearest ten.
Counties are displayed only if they contain power plants.

**Figure 1.** Monthly Emission Changes in Pickaway County, Ohio




**Notes:** $SO_2$ = sulfur dioxide; $NO_x$ = oxides of nitrogen; $CO_2$ = carbon dioxide; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; lb = pound

# 4 Health Benefits Assessment

As discussed in Section 2, the EPA COBRA was used to estimate the potential health benefits of the project based on the displacement of air pollutant emissions. The analysis year of 2023 was selected as it is closest to the baseline year used in the EPA AVERT model run. The state of Ohio was selected for the location. The AVERT model produces an output suitable for COBRA to input for air pollutant emissions benefits. The AVERT output file for COBRA was uploaded. A discount rate of 3% and 7% were selected to display the results of each analysis. There is an ongoing discussion within the federal government about the choice of a discount rate in this context: a 3% discount rate is recommended by EPA, while a 7% is recommended by White House Office of Management and Budget. COBRA assumes changes in adult mortality and non-fatal heart attacks occur over a 20-year period. Table 3 provides the results of the COBRA analysis. The detailed definitions of each health benefit category as shown in the COBRA User Manual is provided in Attachment A. To note from the results, the total health benefits statewide ranged from $841,089 to $2,126,509 due to reductions in mortality, hospital admissions, and other health conditions. It should also be noted that the COBRA quantified health benefits from the project within Pickaway County and results showed statistically relevant reductions in mortality, infant mortality, nonfatal heart attacks, hospital admits, minor restricted activity days, and work loss days.

**Table 3. Health Benefits from COBRA**

| Discount Rate | 3% | 7% | 3% | 7% |
|---|---|---|---|---|
| Jurisdiction | Statewide | Statewide | Pickaway | Pickaway |
| $ Total Health Benefits (low estimate) | 942,552 | 841,089 | 2,759 | 2,462 |
| $ Total Health Benefits (high estimate) | 2,126,509 | 1,896,156 | 6,227 | 5,553 |
| $ Mortality (low estimate) | 927,392 | 826,013 | 2,714 | 2,417 |
| $ Mortality (high estimate) | 2,100,030 | 1,870,464 | 6,147 | 5,475 |
| $ Infant Mortality | 5,709 | 5,709 | 15 | 15 |
| $ Nonfatal Heart Attacks (low estimate) | 1,365 | 1,280 | 4 | 4 |
| $ Nonfatal Heart Attacks (high estimate) | 12,683 | 11,897 | 39 | 37 |
| $ Hospital Admits, All Respiratory | 721 | 721 | 2 | 2 |
| $ Hospital Admits, Cardiovascular (except heart attacks) | 1,017 | 1,017 | 3 | 3 |
| $ Acute Bronchitis | 59 | 59 | 0 | 0 |
| Upper Respiratory Symptoms (episodes) | 2 | 2 | 0 | 0 |
| $ Upper Respiratory Symptoms | 73 | 73 | 0 | 0 |
| Lower Respiratory Symptoms (episodes) | 1 | 1 | 0 | 0 |
| $ Lower Respiratory Symptoms | 33 | 33 | 0 | 0 |
| Emergency Room Visits, Asthma | 0 | 0 | 0 | 0 |
| $ Emergency Room Visits, Asthma | 21 | 21 | 0 | 0 |
| Minor Restricted Activity Days | 50 | 50 | 0 | 0 |

**Table 3. Health Benefits from COBRA**

| | | | | |
|---|---|---|---|---|
| $ Minor Restricted Activity Days | 4,354 | 4,354 | 15 | 15 |
| Work Loss Days | 8 | 8 | 0 | 0 |
| $ Work Loss Days | 1,676 | 1,676 | 6 | 6 |
| Asthma Exacerbation (cases) | 2 | 2 | 0 | 0 |
| Asthma Exacerbation, Shortness of Breath (cases) | 1 | 1 | 0 | 0 |
| Asthma Exacerbation, Wheeze (cases) | 1 | 1 | 0 | 0 |
| $ Asthma Exacerbation | 133 | 133 | 0 | 0 |

**Note:** See Attachment A for definitions of each health endpoint.

In addition to the health benefits quantified by COBRA, the AVERT model estimates the reduction in $CO_2$ emissions from the project. As COBRA does not quantify the benefits of the reduction in $CO_2$ emissions, it is necessary to estimate monetary benefits of $CO_2$ reduction using the social cost of carbon. As explained in Section 2, the social cost of carbon is a measure of the economic harm from those impacts, expressed as the dollar value of the total damages from emitting one ton of $CO_2$ into the atmosphere.

The Interagency Working Group on the Social Cost of Greenhouse Gases reported in its 2021 Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, that in 2020 the 3% average discounted rate would be $51 per metric ton of $CO_2$ and in 2025 it would be $56 MT $CO_2$. (Interagency Working Group on the Social Cost of Greenhouse Gases 2021). On January 20, 2021, President Biden issued E.O. 13990 which re-established the IWG and directed it to ensure that SC-GHG estimates used by the U.S. Government (USG) reflect the best available science and the recommendations of the National Academies (2017) and work towards approaches that take account of climate risk, environmental justice, and intergenerational equity. While this is the most robust and credible figure available, it does not yet include all of the widely recognized and accepted scientific and economic impacts of climate change. For that reason, many experts agree this is far lower than the true costs of carbon pollution. However, using the estimate of $51 MT $CO_2$ and the results of the AVERT model, the project would result in an economic benefit of $7,504,885 per year in the Mid-Atlantic region and $25,909 per year in the County.

# 5 NAAQS Assessment

The pollutants of concern in Ohio are $O_3$ and $SO_2$. The state is either in attainment for or in maintenance for the NAAQS for the other criteria air pollutants. When an area does not meet the NAAQS for a pollutant, it is classified it as being in "nonattainment." This classification impacts businesses that want to locate or expand an air pollution source in that area. Once an area has three years of data showing that it meets the standard, the State must petition U.S. EPA to reclassify it as being in attainment.

Ohio EPA monitors the air and analyzes the data to determine compliance with air quality standards. As of February 2018, Ohio EPA has 219 air monitors at 121 monitoring sites that check levels of $SO_2$, lead, $PM_{10}$, $PM_{2.5}$, $NO_2$, CO and $O_3$. Ohio EPA submits data and detailed plans to U.S. EPA to demonstrate compliance and the ability to maintain compliance.

The only pollutants for which there are portions of Ohio designated nonattainment are $O_3$ and $SO_2$. Currently, 15 counties in Ohio are considered nonattainment. The entire state is in attainment for $PM_{2.5}$, $PM_{10}$, $NO_2$, lead, and CO. Pickaway County is currently in attainment for all NAAQS.

When an area is in nonattainment it must prepare actions to reduce emissions to bring the area back into attainment. These actions are presented within the states implementation plan (SIP). SIP actions can take several forms: from the development of plans that will demonstrate how areas not yet attaining NAAQS will attain said standards ("Attainment Demonstration"); to plans that provide for how an area redesignated to attainment from nonattainment will maintain acceptable air quality ("Redesignation Request"). SIPs packages or revisions also are prepared and submitted to U.S. EPA to modify, revise or update existing plans. Additional SIP related documents are also generated when a new or revised standard is promulgated by U.S. EPA. For example, Ohio EPA submits a "Recommended Designations" document with proposed nonattainment boundaries. Counties and the Ohio Environmental Protection Agency spend considerable resources preparing the SIP. As shown in Section 3, the project would result in a displacement of criteria air pollutant emissions, including VOCs and $NO_x$ which lead to the formation of ozone, as well as $SO_2$, which 15 counties of Ohio are in nonattainment for. Therefore, the project would support Ohio's overall SIP in reducing nonattainment pollutants to help meet current and future NAAQS. The project and those like it will help reduce the compliance burden of counties in nonattainment as well as the State.

According to the Solar Energy Industries Association, solar energy can also help states reduce emissions of acid gases and air toxics and can help attain ambient air quality standards for $O_3$ (Solar Energy Industries Association 2014). While solar is generally not a source-based emissions control technology for these pollutants, the addition of solar energy into the electric sector can displace the need for fossil fuel combustion that generates these regulated pollutants. The EPA is not only promulgating new regulations under §111(d), but it is also regularly revising and enforcing existing air regulations. For example, solar energy can offer significant cobenefits when the new $O_3$ and particulate matter standards are implemented, and solar can help meet state emission budgets for pollutants controlled under the Cross State Air Pollution Rule (CSAPR) and the NAAQS.

Similarly, Clark County, Nevada is continually striving to reduce VOC and $NO_x$ through mandatory and voluntary control measures, including the installation and use of renewable energy and energy efficiency measures. As discussed in Clark County's Department of Air Quality (DAQ) Ozone Advance Program Progress Report Update, renewable energy generation annually displaced 217,930 MWh, which equals a reduction of 22,150 pounds of $NO_x$. During the ozone season, renewable energy displaced a total of 14,320 pounds of $NO_x$ in Clark County (DAQ 2019). These concerted efforts on federal, state, and local levels should help Clark County meet and maintain the ozone NAAQS.

# 6 Conclusions

Using the EPA's AVERT tool showed that the project would result in the displacement of $PM_{2.5}$, $SO_2$, $NO_x$, $CO_2$, VOCs, and $NH_3$ emissions regionally as well as locally. The EPA's COBRA tool showed overall health benefits between $841,089 to $2,126,509 due to reductions in mortality, hospital admissions, and other health conditions, with statistically significant reductions in mortality, infant mortality, nonfatal heart attacks, hospital admits, minor restricted activity days, and work loss days. The EPA's COBRA tool and social cost of carbon analysis showed that the displacement of emissions from the project would result in an economic benefit of $7,504,885 per year in the Mid-Atlantic region and $25,909 per year in the County. Finally, the displaced emissions from the project will directly help the County and State reduce its nonattainment pollutants to meet current and future NAAQS as well as potentially reduce regulatory compliance obligations.

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# Attachment A

## COBRA Description of Health Effects and their Economic Values

## Table A1. Description of Health Effects and their Economic Value

| Health Effect | Description |
|---|---|
| Mortality (low estimate) | Low estimate of the number of deaths, based on Krewski et al. (2009) |
| $ Mortality (low estimate) | Low estimate of the economic value of the number of deaths, using Krewski et al. (2009) and a discount rate of 3% or 7% |
| Mortality (high estimate) | High estimate of the number of deaths, based on Lepeule et al. (2012) |
| $ Mortality (high estimate) | High estimate of the economic value of the number of deaths, using Lepeule et al. (2012) and a discount rate of 3% or 7% |
| Infant Mortality | Number of infant deaths |
| $ Infant Mortality | Economic value of the number of infant deaths |
| Nonfatal Heart Attacks (low estimate) | Low estimate of the number of non-fatal heart attacks, based on four acute myocardial infarction (AMI) studies |
| $ Nonfatal Heart Attacks (low estimate) | Low estimate of the economic value of non-fatal heart attacks, based on four AMI studies and a discount rate of 3% or 7% |
| Nonfatal Heart Attacks (high estimate) | High estimate of the number of non-fatal heart attacks, based on Peter et al. (2001) |
| $ Nonfatal Heart Attacks (high estimate) | High estimate of the economic value of non-fatal heart attacks, using Peter et al. (2001) and a discount rate of 3% or 7% |
| Hospital Admits, All Respiratory | Number of respiratory-related hospitalizations |
| Hospital Admits, Asthma | Number of asthma-related hospitalizations |
| Hospital Admits, Chronic Lung Disease | Number of hospitalizations related to chronic lung disease |
| $ Hospital Admits, All Respiratory | Economic value of respiratory-related hospitalizations (total across respiratory-related, asthma-related, and chronic lung disease hospitalizations) |
| Hospital Admits, Cardiovascular (except heart attacks) | Number of cardiovascular-related hospitalizations (ICD codes 390- 409, 411-429); ICD code 410 (nonfatal heart attacks) is counted only in 'Non-fatal Heart Attacks' |
| $ Hospital Admits, Cardiovascular | Economic value of cardiovascular-related hospitalizations |
| Acute Bronchitis | Cases of acute bronchitis |
| $ Acute Bronchitis | Economic value of acute bronchitis cases |
| Upper Respiratory Symptoms | Episodes of upper respiratory symptoms (runny or stuffy nose; wet cough; and burning, aching, or red eyes) |
| $ Upper Respiratory Symptoms | Economic value of episodes of upper respiratory symptoms |
| Lower Respiratory Symptoms | Episodes of lower respiratory symptoms: cough, chest pain, phlegm, or wheeze |
| $ Lower Respiratory Symptoms | Economic value of episodes of lower respiratory symptoms |
| Emergency Room Visits, Asthma | Number of asthma-related emergency room visits |

## Table A1. Description of Health Effects and their Economic Value

| Health Effect | Description |
|---|---|
| $ Emergency Room Visits, Asthma | Economic value of asthma-related emergency room visits |
| Minor Restricted Activity Days | Number of minor restricted activity days (days on which activity is reduced, but not severely restricted – e.g., missing work or being confined to bed is too severe to be MRAD). |
| $ Minor Restricted Activity Days | Economic value of minor restricted activity days |
| Work Loss Days | Number of work days lost due to illness |
| $ Work Loss Days | Economic value of work days lost due to illness |

**Source:** EPA 2021
**Notes:**
* For adult mortality and nonfatal heart attacks, COBRA contains multiple health impact functions that relate $PM_{2.5}$ and each health effect. Therefore, there are high and low estimates of the cases avoided and their economic values for each of these health effects. More details on the underlying health impact functions are available in Appendix C of the user manual. In addition, future costs are calculated using a discount rate (3% or 7%) that you selected before running the scenario.