Vista Sands Solar

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Quantum Energy

VISTA SANDS
1,315.6 MWAC SOLAR PROJECT
PORTAGE COUNTY, WISCONSIN

Avoided Emissions and Public Health, Ecosystem, and Economic Impact Report

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Dr. Daniel Howard is a seasoned energy analyst with extensive experience in environmental impact assessment and energy systems modeling. As the lead researcher at Quantum Energy, he has spearheaded numerous projects focusing on the integration of renewable energy sources into existing grids. Daniel holds a Ph.D. in Environmental Engineering, and his expertise lies in leveraging advanced simulation platforms to evaluate the public health and ecosystem benefits of sustainable energy projects. Daniel has been a research fellow for the National Science Foundation, United States Environmental Protection Agency, and United States Agency for International Development. His work has been instrumental in informing policy and guiding the development of sustainable energy infrastructure.

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Matt Maher Peterson is the Chief Technology Officer at Quantum Energy where he leads the software development of innovative energy analysis tools. Matt has 10+ years of experience leading the development of sustainability-focused analytics platforms and is the named inventor for three patents in the energy and resource management space, including U.S. Patent Numbers 11595076, 10564802, and 11169657. He has a strong background in physics and mathematics, with degrees from Western Washington University. His dedication to advancing sustainable energy solutions is reflected in his leadership and numerous successful projects in the field.

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EXECUTIVE SUMMARY

Expected Impacts from Integrating Vista Sands Solar into the MISO Balancing Authority

Doral Renewables, LLC ("Doral") is developing the Vista Sands Solar Project ("Project") in Portage County, Wisconsin and engaged Quantum Energy ("Quantum") to evaluate the potential grid-level emissions reductions and corresponding life-cycle scale public health, ecosystem, and economic impacts to aid decision-makers and stakeholders in their evaluation of the environmental and other merits of the proposed Project. This report is a comprehensive assessment of the expected impacts from integrating Vista Sands Solar into the MISO balancing authority.

Overview of Quantum Energy and TotalView Impact Analytics

The TotalView Energy Platform™ ("TotalView") is a new impact analytics platform developed by Quantum Energy, an impact analytics software firm, and funded by the National Science Foundation Energy Technologies Portfolio. TotalView is a novel automated quantification tool that can provide a suite of comprehensive impact analytics for utility-scale renewable energy projects to enable optimized decision-making for project siting, procurement, and investment decisions as well as for other portfolio management purposes, such as voluntary or compliance-based ESG reporting.

Specifically, the platform quantifies the avoided grid level emissions and public health, ecosystem and economic benefits caused by an existing or proposed renewable project. It is the world's first impact analytics platform to integrate energy system optimization and life cycle assessments and is differentiated from other carbon accounting platforms by considering many other avoided externalities (e.g. particulate matter) beyond carbon emissions.

The simulation model is technology, megawattage and locationally specific and is proven highly accurate (within 1% of backtested EIA data). The platform also includes an automated data integration pipeline that retrieves all required data for electric grid simulations from data reported to the U.S. Energy Information Administration databases, checks this data for completeness and consistency, and then stores it in a data warehouse. The impact analytics directly map to leading sustainability reporting regulations such as the Corporate Sustainability Reporting Directive section ESRS E2.

Overview of Vista Sands Solar Project Impact Analytics Assessment

Using the TotalView Energy Platform, Quantum Energy's analysis simulates hourly grid-level changes in generation and air pollutant emissions. These simulations were validated against data from the U.S. Energy Information Administration to ensure accuracy. Public health, ecosystem, and economic impacts were estimated using reliable life cycle impact assessment methodologies and datasets.

In its first year of operation, Vista Sands Solar is projected to generate approximately 2,296 GWh of electricity.

This will lead to significant emissions reductions, estimated to save 2,485 disability-adjusted life years and preserve over five potentially disappeared fractions of species, resulting in approximately $630 million in economic gains in addition to the direct, indirect, and induced economic benefits.

The scope of this report evaluates the broader impacts and benefits of the project and does not address site specific mitigation or adaptation efforts. Doral's evaluation of and plans for vegetative and ecosystem management efforts are additive to the broader benefits assessed herein.

The analysis shows that the solar project will lead to substantial reductions in both local and global air pollutants. Local benefits include reductions in particulate matter, human toxicity emissions, and photochemical oxidants, which will improve air quality and health outcomes for communities surrounding Vista Sands Solar and within the MISO balancing authority. Global benefits primarily stem from reductions in carbon emissions, contributing to climate change mitigation efforts. While there is not a coal or natural gas plant immediately adjacent to the Vista Sands project, in Wisconsin there are approximately 4,000 MW of coal fired power plants and 6,000 MW of natural gas fired power plants. Cumulatively, these sources provided approximately 73% of electric generation within Wisconsin in 2022.[1] Therefore, there is substantial potential for the reduction in air pollutants as a result of Vista Sands becoming operational.

Balancing the immediate local considerations with the broader public health and environmental benefits is essential for informed decision-making. The extensive public health and ecosystem benefits of Vista Sands Solar highlight the project's potential to deliver long-term advantages for both local and regional populations by delivering a new source of environmentally responsible energy generation.

In conclusion, the Vista Sands Solar project offers a substantial net positive outcome by significantly enhancing both public health and ecosystem quality and delivering substantial positive economic impacts in year one, and cumulatively through the project's lifespan in Wisconsin and beyond. By considering the holistic impacts, stakeholders can appreciate the proposed project's contributions to local and regional communities and ecosystems in Wisconsin.

1 U.S. Energy Information Administration https://www.eia.gov/state/?sid=WI

INTRODUCTION

A Broader Picture of Clean Energy Impacts

In an era marked by escalating environmental challenges and the imperative for sustainable energy solutions, the development of renewable energy projects plays a pivotal role. However, the development of renewable energy projects is difficult, with over 80% facing significant delays or outright failure.[2] Despite these challenges, the transition to safe, affordable and reliable renewable energy is essential, especially for mitigating grid-level emissions and their associated impacts on public health, ecosystems, and the economy.

2 Susskind, L., Chun, J., Gant, A., Hodgkins, C., Cohen, J., & Lohmar, S. (2022). Sources of opposition to renewable energy projects in the United States. *Energy Policy*, 165, 112922.

Environmental Impact Statements (EISs) for renewable energy projects typically focus on site-specific impacts like land use changes and effects on wildlife habitats. While these assessments are important, they often overlook the broader implications of integrating renewable energy into the grid. This oversight can obscure the significant public health and ecosystem benefits that arise from emissions reductions at a regional and national scale.

For Vista Sands Solar, potential site-specific impacts include temporary disturbances to local ecosystems and visual changes to the landscape. These concerns must be reasonably addressed, but it is also vital to consider the substantial public health and ecosystem benefits caused by emissions reductions. By displacing fossil fuel-based electricity generation, solar energy can significantly reduce greenhouse gas and air pollutant emissions, leading to profound positive impacts on public health and ecosystem resilience.

Fossil fuel combustion for electricity generation emits pollutants that contribute to serious health issues, including respiratory diseases, cardiovascular ailments, cancer, and premature mortality. A recent Harvard study highlighted that particulate matter emissions from fossil fuel combustion cause approximately 355,000 deaths annually in the U.S., which is approximately 1 in 8 deaths nationwide.[3]

The adoption of solar energy through projects like Vista Sands Solar has the potential to significantly improve air quality and public health outcomes by reducing harmful greenhouse gas and air pollutant emissions. The health benefits of improved air quality extend far beyond the immediate vicinity of the project, providing substantial gains to the region and society at large.

Additionally, the ecological benefits of reduced emissions are substantial. Emissions from fossil fuels contribute to acid deposition and eutrophication, which degrade soil quality and aquatic ecosystems, leading to biodiversity loss and impaired ecosystem services. The shift to clean energy sources, which have negligible operational emissions, helps mitigate these stressors, supporting ecosystem resilience and preserving natural habitats over the lifespan of the project.

This report expands conventional EISs by examining the potential grid-level emissions reductions attributable to Vista Sands Solar. Through highly accurate simulations and comprehensive life cycle impact assessments, this study quantifies the anticipated emissions reductions and evaluates their impacts on public health, ecosystems, and the economy.

This report is organized into five sections for clarity and coherence:

1. The Introduction offers an overview of the current state of renewable energy projects and their impacts.
2. The Methodology section details the modeling platform and the analytical approaches used.
3. The Project section provides a concise overview of Vista Sands Solar, including its objectives and scope.
4. The Results section presents the forecasted avoided emissions and the corresponding public health, ecosystem, and economic benefits of Vista Sands Solar in year one of project operations.
5. The Conclusions section summarizes the key findings and discusses the significant takeaways from the analysis.

While recognizing the importance of site-specific environmental assessments, this report emphasizes the broader benefits of renewable energy initiatives. It advocates for a more holistic approach to environmental impact assessments in the renewable energy sector.

By integrating these broader considerations, this report aims to provide a balanced and comprehensive perspective that assesses the value of renewable energy projects like Vista Sands Solar in achieving a sustainable and healthier future.

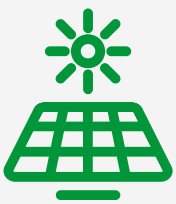
3 Vohra, K., Vodonos, A., Schwartz, J., Marais, E. A., Sulprizio, M. P., & Mickley, L. J. (2021). Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: Results from GEOS-Chem. *Environmental research*, 195, 110754.

METHODOLOGY

Energy System Optimization and Life Cycle Assessment

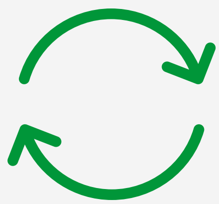
TOTALVIEW ENERGY PLATFORM

Three-step Approach



Grid Simulation

Changes to grid-level generation



Life Cycle Emissions Inventory

Changes to life cycle emissions to air, soil and water

Impact Assessment

Changes to public health, ecosystem, and economic impacts

The platform utilized for this analysis is Quantum's TotalView Energy Platform (TotalView), funded by the National Science Foundation Energy Technologies Portfolio, under Award Number 2230578. TotalView is a perfect foresight, partial equilibrium, energy system optimization and scenario analysis model. The model simulates electricity grid interaction on an hourly basis, as well as grid-level life cycle emissions and corresponding public health, ecosystem and economic impacts of those grid-level emissions.

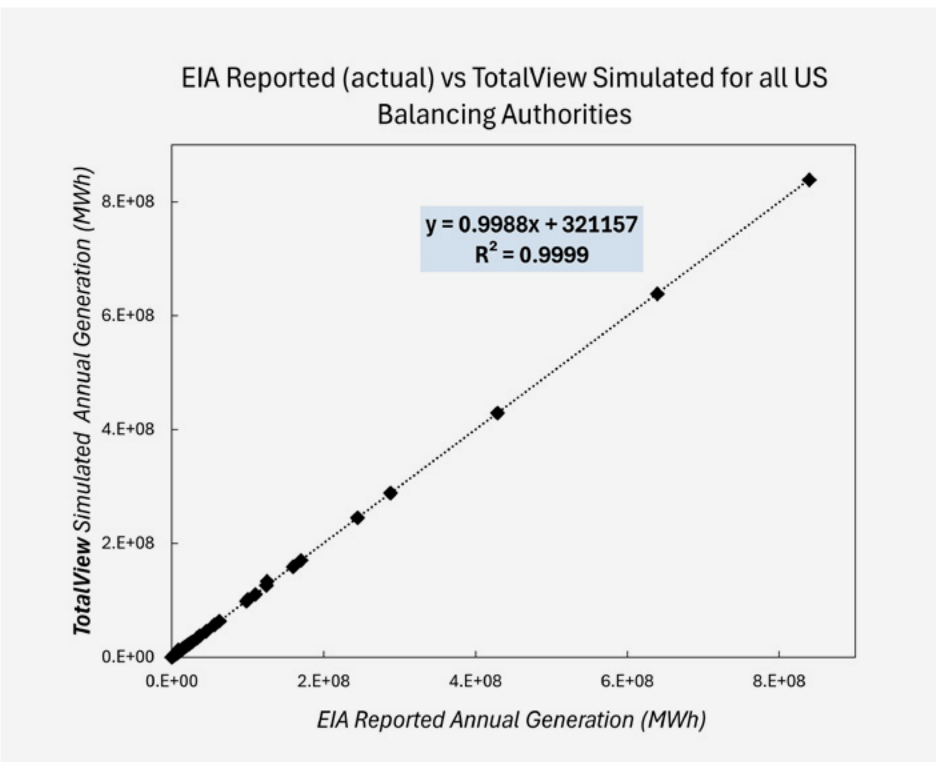
TotalView has three core modules: an electricity dispatch module, an emissions module, and an impact module. These three modules allow for a three-step approach of assessing the impacts to the grid when a new energy project is added:

1. Changes to grid-level generation
2. Changes to life cycle emissions to air, soil and water
3. Changes to public health, ecosystem, and economic impacts

METHODOLOGY
STEP 1

Grid Simulation

In the electricity dispatch module, electricity grid generation for a given balancing authority or power market is simulated on an hourly basis for the most recent complete year. The results of the TotalView Energy platform are then back tested against the reported generation to the U.S. Energy Information Administration (EIA) Ndatabase to ensure accuracy within 1%. The figure below displays our results for comparing the generation simulated by TotalView with the generation reported to the EIA for all 69 balancing authorities in the US for the 2023 year. Across all balancing authorities, the TotalView simulations were well within 1% of the reported generation. The model results produced a coefficient of determination (R-squared, a statistical measure of the goodness of fit) 0.9999.



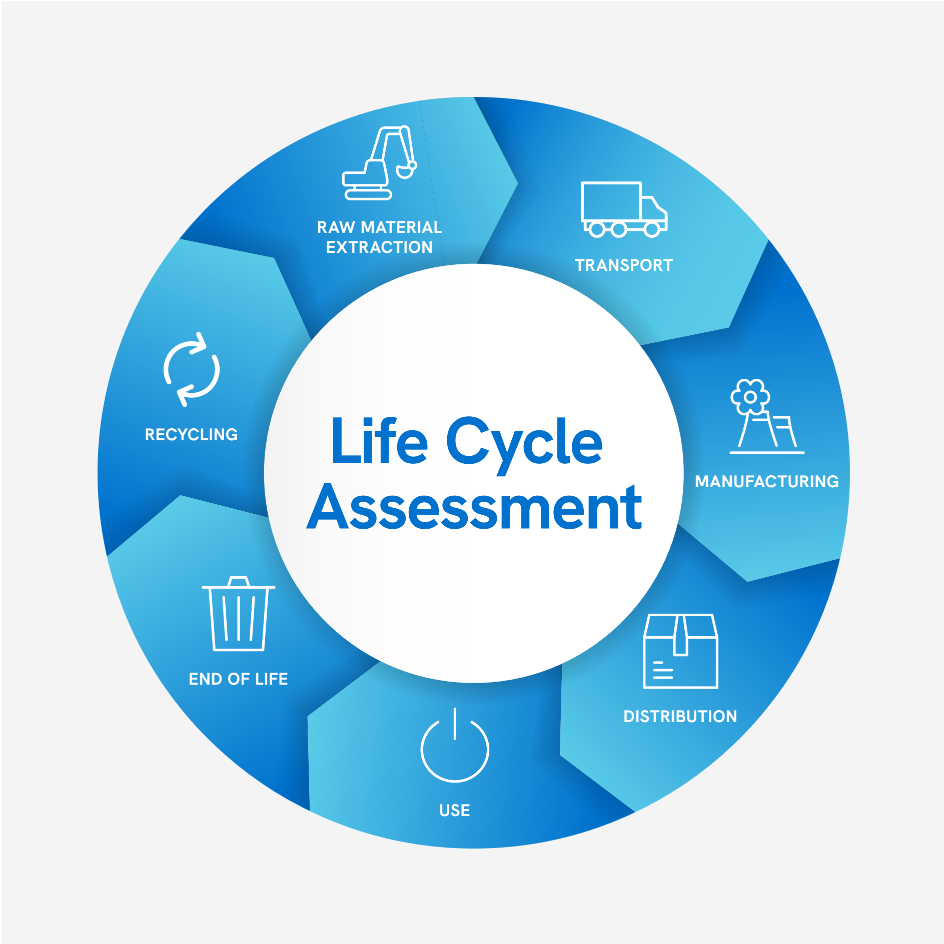
After the TotalView simulation results have been backtested to ensure accuracy, the new energy project under consideration is added into the grid mix and the model is re-run to analyze the changes in generation and grid dynamics each hour based on the hourly forecasted generation of the project, known as the 8760 profile, provided by the project developer. To establish confidence intervals, 8760 profiles with a minimum generation probability of 50% (P50), 90% (P90) and 95% (P95) are utilized to assess generation and grid dynamics changes under the different profiles.

METHODOLOGY
STEP 2

Life Cycle Emissions Inventory

As the generation changes are being quantified at multiple confidence intervals, the emissions module performs a life cycle emissions inventory at the grid-level to simulate system-level changes to emissions and resource use. The life cycle emissions inventory is part of the life cycle impact assessment process, which looks at emissions and resource use across the entire life cycle of a technology, including mining the raw materials, processing the materials, manufacturing the product, shipping the product, using the product and disposing or recycling of the product.

The industry leading life cycle impact assessment method for energy technologies, ReCiPe 2016,[4] is utilized in the TotalView Energy Platform. In the first step, a baseline grid-level life cycle emissions inventory is assessed, and then in the second step the changes to grid-level life cycle emissions and resource depletion are assessed due to a new project being added to the grid. The changes in emissions and resource use are then quantified in each of the standard life cycle impact categories and grouped into emissions to air, water, and soil.



4 Huijbregts, M. A., Steinmann, Z. J., Elshout, P. M., Stam, G., Verones, F., Vieira, M., ... & Van Zelm, R. (2017). ReCiPe2016: a harmonised life cycle impact assessment method at midpoint and endpoint level. *The International Journal of Life Cycle Assessment*, 22, 138-147.

STANDARD REPORTING METRICS

Avoided Emissions and Resource Use

Emissions to Air

Air pollutants that increase air quality concentrations, leading to human exposure and public health impacts

Emissions to Water

Pollutants that increase freshwater or marine pollutant concentrations, leading to freshwater or marine ecosystem quality impacts

Emissions to Soil

Pollutants that increase soil pollutant concentrations, leading to terrestrial ecosystem impacts

Resource Use

Metals, minerals, land, and water used in the production and operation of the electricity system

Emissions to Air

The emissions to air include the following impact categories:

Carbon
Emissions of greenhouse gasses (GHGs) that lead to an increased atmospheric concentration of GHGs.

Particulate Matter
A complex mixture of organic and inorganic substances with a diameter of less than 2.5 µm. This includes primary PM2.5 aerosols as well as secondary PM2.5 aerosols that are formed in the air from emissions of sulfur dioxide (SO_2), ammonia (NH_3), nitrogen oxides (NO_x) and other elements.

Human Toxicity
Carcinogenic and non-carcinogenic substances that have human toxicological effects via human exposure by air, drinking water or accumulation in the human food chain. These substances include benzene emissions, which cause blood disorders, neurological issues, reproductive issues, immune system

disorders, leukemia and other cancers.[5]

Photochemical Oxidants
Primary and secondary aerosols formed as a result of photochemical reactions of NOx and non-methane volatile organic compounds (NMVOCs) that cause respiratory illness and even death.

Ionizing Radiation
Radionuclides emitted into the air that cause ionizing radiation, leading damaged DNA molecules.

Ozone Depletion
Ozone depleting substances that have chlorine or bromine groups in their molecules that interact with ozone in the stratosphere, leading to damage to human health as a result of increased UVB-radiation.

Emissions to Water

The emissions to water include the following impact categories:

Freshwater Ecotoxicity
Chemicals emitted into the environment that have ecotoxicological effects and are transported to freshwater ecosystems.

Marine Ecotoxicity
Chemicals emitted into the environment that have ecotoxicological effects and are transported to marine ecosystems.

Freshwater Eutrophication
Nutrient emissions, such as phosphorus and nitrogen, transported to freshwater ecosystems that increase nutrient uptake by organisms and species and lead to relative loss of species.

Marine Eutrophication
Nutrient emissions, such as phosphorus and nitrogen, transported to marine ecosystems that increase nutrient uptake by organisms and species and lead to relative loss of species.

Emissions to Soil

The emissions to soil include the following impact categories:

Terrestrial Acidification
Inorganic substances, nitrogen oxides (NOx), ammonia (NH3) and sulfur dioxide (SO2), that are transported to soil and cause a change in acidity and affect terrestrial species.

Terrestrial Ecotoxicity
Chemicals emitted into the environment that have ecotoxicological effects and are transported to terrestrial ecosystems.

Resource Use

Resource use is also typically considered in life cycle impact assessment, including the following impact categories:

Non-renewable Energy Resources
Assessment of increases in fossil fuel extraction causing increases in extraction costs due to a change in production technique or to sourcing from a costlier location (assuming least cost sources are extracted first).

Life Cycle Land Transformation
Assessment of relative species impact, whether loss or avoided loss, due to land use locally and globally including land transformation, land occupation and land relaxation based on change of land cover and the new use of the land. In the case of TotalView, this is assessed for any activities across the value chain of changes to power generation on the grid, including infrastructure production and fuel extraction. This land transformation metric is an upper bound of the extent of life cycle land transformation and does not include the mitigation efforts by the project developer to reduce and reverse local land use impacts.

Material Resources
Assessment of increases in extraction of a mineral resource leading to an overall decrease in ore grade, causing an increase in ore production costs for mineral extraction.

5 United States Environmental Protection Agency, 2012. https://www.epa.gov/sites/default/files/2016-09/documents/benzene.pdf

METHODOLOGY
STEP 3

Impact Assessment

After the changes to emissions are quantified in each life cycle impact category, the changes to emissions are traced down epidemiological and ecosystem impact pathways to assess impacts to human health as well as ecosystem quality and biodiversity. These impacts are assessed using the widely accepted ReCiPe 2016 methodology.

Impact pathways causing damages to public health, including emissions to air, are:

+ Climate change
+ Particulate matter
+ Human toxicity (cancerous)
+ Human toxicity (non-cancerous)
+ Photochemical oxidants
+ Ionizing radiation
+ Ozone depletion
+ Water depletion

Impact pathways causing damages to terrestrial ecosystem quality, including emissions to soil, are:

+ Climate change
+ Terrestrial ecotoxicity
+ Photochemical oxidants
+ Acidification
+ Land use
+ Water depletion

Impact pathways causing damages to freshwater ecosystem quality, including emissions to freshwater, are:

+ Climate change
+ Freshwater ecotoxicity
+ Eutrophication
+ Water depletion

Impact pathways causing damages to marine ecosystem quality, including emissions to oceans, are:

+ Marine ecotoxicity
+ Eutrophication

Public health impacts are quantified in terms of disability-adjusted life years (DALYs). A DALY is a time-based measure and standard metric used by the World Health organization to assess the overall burden of disease borne by individuals in different populations. "One DALY represents the loss of the equivalent of one year of full health. DALYs for a disease or health condition are the sum of the years of life lost due to premature mortality (YLLs) and the years lived with a disability (YLDs) due to prevalent cases of the disease or health condition in a population."[6]

Ecosystem impacts are quantified in terms of potentially disappeared fraction of species (PDF). A PDF is the standard unit of measurement in life cycle impact assessment for measuring ecosystem quality impacts. A PDF "reflects the potential extinction of species, within a specific time associated with resource uses or emissions, which are leading to habitat losses or degradation."[7]

As a final step, health economics, and natural resource economics are applied to financially value the costs or benefits of these changes to emissions and impacts on the economy.[8] The economic impacts presented in this study are in addition to the direct, indirect and induced economic impacts analyzed in the economic impact report prepared by Strategic Economic Research, LLC for the Vista Sands Project.[9] The economic impact report prepared by Strategic Economic Research, LLC looks at the direct economic benefits such as spending on construction labor and services, indirect economic benefits such as construction spending on materials and solar photovoltaic (PV) equipment, as well as induced benefits such as local spending by employees working directly or indirectly on the project.

6 World Health Organization, Global Health Observatory, 2024. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/158

7 International Corporate Governance Framework Biodiversity Action Toolkit, 2023. https://www.icgn.org/sites/default/files/2024-04/3.%20Biodiversity%20Action%20Toolkit.pdf

8 United States Environmental Protection Agency, 2024. https://www.epa.gov/environmental-economics/mortality-risk-valuation

9 Strategic Economic Research, 2024. *Economic Impact & Land Use Analysis of the Vista Sands Solar Project*. https://apps.psc.wi.gov/ERF/ERFview/viewdoc.aspx?docid=488070

Impact Pathway Descriptions

Particulate matter has been traced to 355,000 deaths per year in the United States,[10] which equates to approximately 1 in 8 deaths in the U.S. The following section describes the steps involved with the particulate matter impact pathway in language that is intended for a general audience.

Let's consider a clean energy project that is developed in Wisconsin. Each hour that the project produces electricity, the electricity will be delivered to the MISO balancing authority. That clean electricity will offset electricity that would have otherwise been needed from other generators in the MISO balancing authority, such as from natural gas or coal generators. This, in turn, reduces emissions each hour that combustion-based electricity sources are offset.

The TotalView Energy Platform simulates these hourly changes to the grid-level generation, including taking into account patterns of curtailment, and uses highly accurate predictive analytics to determine the reduction in emissions caused by the clean energy project. Then, using the industry standard life cycle impact assessment methodologies, the following steps are performed. See the figure below for an illustration of these steps:

Step 1
The reductions in emissions are mapped to reductions in air quality concentrations of air pollutants.

Step 2
The reductions in air quality concentrations are mapped to reductions in human exposure.

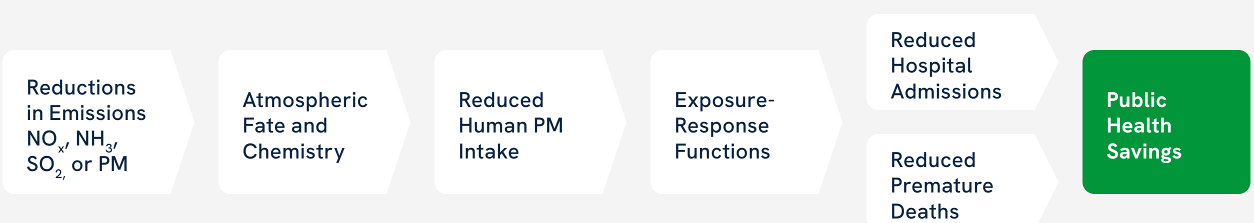
Steps 3 & 4
The reductions in human exposure are then mapped to changes in disease incidence using epidemiological exposure-response functions,[11] including asthma, lower respiratory infections, lung cancer, ischemic heart disease, cerebrovascular disease and cardiopulmonary disease, which result in lower hospital admissions and premature mortality.

As a final step, industry-standard health economics and natural resource economics are applied to financially value the changes in disease incidence.

In the case of the Wisconsin clean energy project example, each hour that project is producing electricity, it is also reducing emissions in the MISO balancing authority. Those emissions reductions, the majority of which are upwind of densely populated areas, reduce the amount of particulates and other pollutants that are in the air and end up in millions of people's lungs. The correlation between the reduction in pollutant exposure and the reduction in disease incidence has been studied

EMISSIONS TO AIR

Particulate Matter Impacts



Huijbregts et al., "ReCiPe 2016 v1.1 A harmonized life cycle impact assessment method at midpoint and endpoint level," 2016.

10 Vohra, K., Vodonos, A., Schwartz, J., Marais, E. A., Sulprizio, M. P., & Mickley, L. J. (2021). Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: Results from GEOS-Chem. *Environmental research*, 195, 110754.

11 Cohen, A. J., Brauer, M., Burnett, R., Anderson, H. R., Frostad, J., Estep, K., ... & Forouzanfar, M. H. (2017). Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *The lancet*, 389(10082), 1907-1918.

very thoroughly in epidemiology and has strong data-driven consensus, and thus the disease incidence reductions that will happen due to the reductions in pollutant exposure can be assessed. Health economics has established the financial benefits of reduction in hospital admissions and premature mortality, which are then used to financially value the benefits of the pollution reductions caused by the clean energy project.[12]

Particulate matter emissions are emissions to air which lead to human exposure. There are also emissions that are transported and accumulate in soil and affect terrestrial ecosystems.

The figure below depicts the terrestrial acidification impact pathway.

EMISSIONS TO SOIL

Terrestrial Acidification Impacts

Huijbregts et al., "ReCiPe 2016 v1.1 A harmonized life cycle impact assessment method at midpoint and endpoint level," 2016.

There are also emissions that are transported and accumulate in water and affect freshwater and marine ecosystems. The figure below depicts the freshwater ecotoxicity impact pathway.

EMISSIONS TO WATER

Freshwater Ecotoxicity Impacts

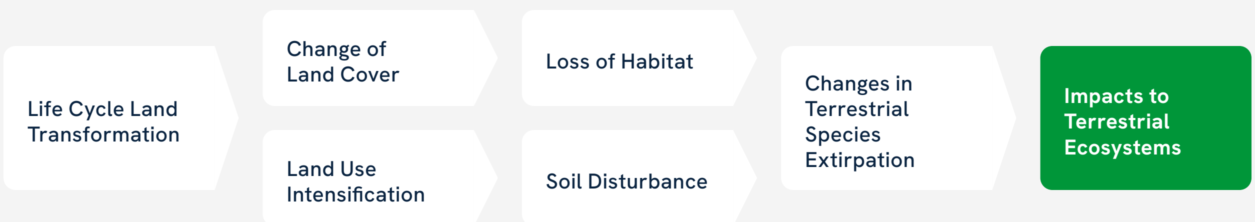
Huijbregts et al., "ReCiPe 2016 v1.1 A harmonized life cycle impact assessment method at midpoint and endpoint level," 2016.

12 https://www.epa.gov/environmental-economics/mortality-risk-valuation

Life cycle impact assessment also looks at resource use. The life cycle of land use includes land transformation, land occupation and land relaxation, all of which affect terrestrial ecosystems. The figure below depicts the impact pathway for the life cycle of land use.

RESOURCE USE

Life Cycle Land Transformation



Huijbregts et al., "ReCiPe 2016 v1.1 A harmonized life cycle impact assessment method at midpoint and endpoint level," 2016.

PROJECT

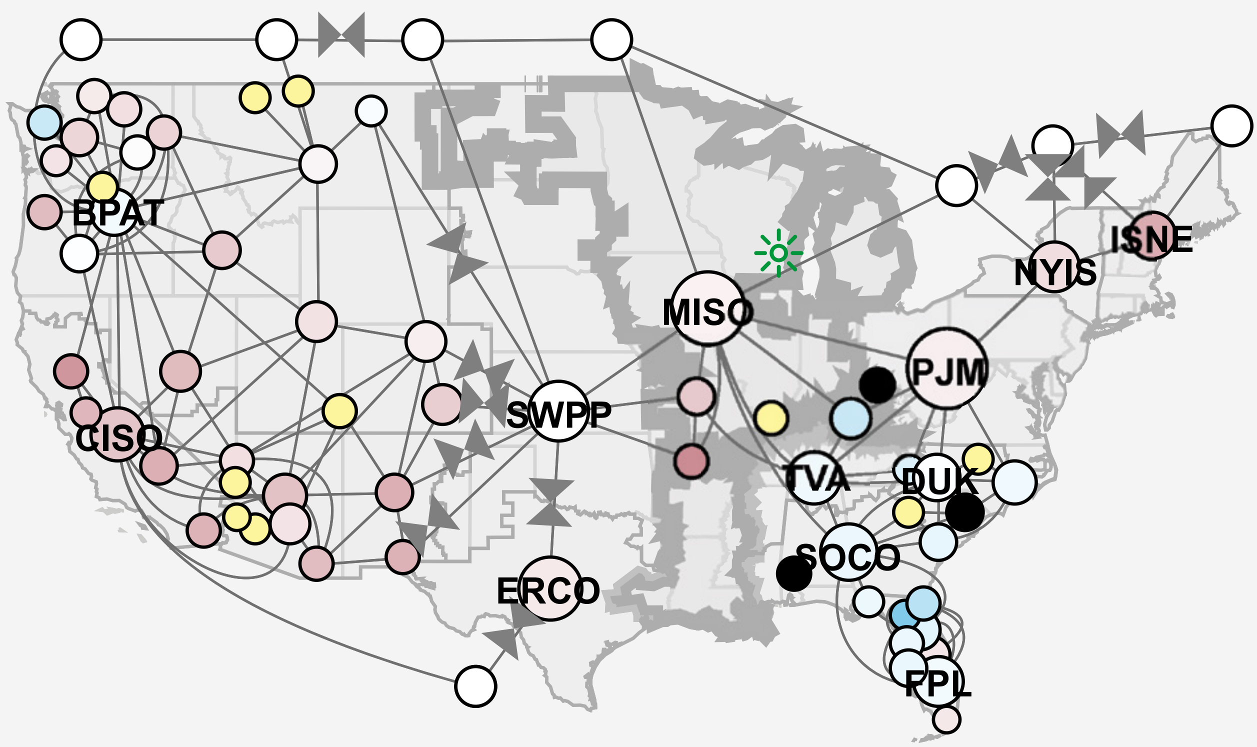
Vista Sands Solar

The proposed Vista Sands Solar project is a 1,315.6 MWAC ground mounted single axis tracker PV system located in Portage County, Wisconsin. The project's location is in the jurisdiction of the MISO balancing authority.

The TotalView Energy Platform was utilized to simulate the forecasted generation changes, emissions changes and corresponding public health, ecosystem and economic impact estimated to be achieved by the first year of operation of Vista Sands Solar. Modeling these impacts beyond the first year of operation introduces uncertainty, because as the MISO grid mix of generation sources evolves, the changes to generation and emissions caused by Vista Sands Solar will also evolve. However, there is a high level of certainty that each consecutive year of proposed project operations would still result in substantial net benefits for public health, ecosystem health and economic impacts.

1,315.6 MWAC SOLAR PROJECT

MISO Balancing Authority Grid Simulation



1,315.6 MWAC Ground Mounted PV Single Axis Tracker

RESULTS

Vista Sands First Year Avoided Emissions and Impacts

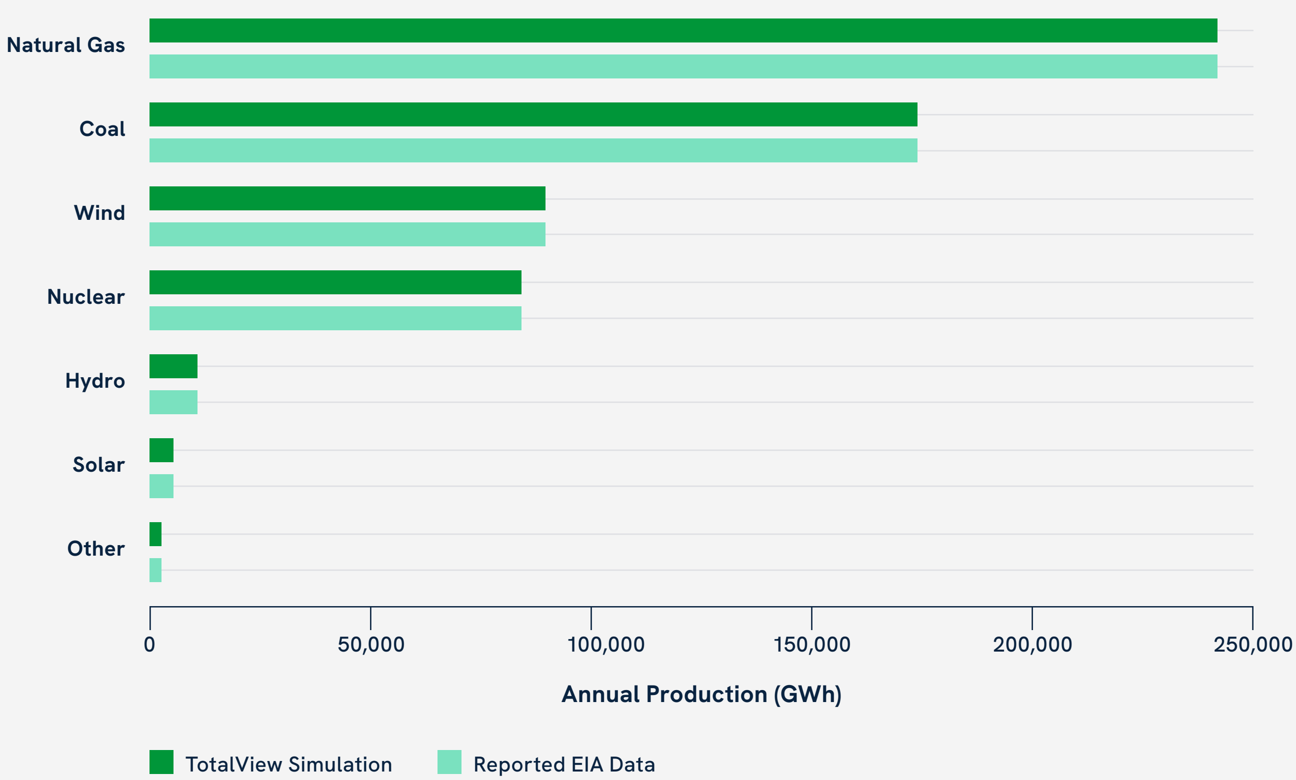
The forecasted generation changes, avoided emissions and corresponding public health, ecosystem and economic impacts caused by the first year of operation of Vista Sands Solar are presented below.

Generation Changes

The TotalView simulation results for the MISO balancing authority in 2023 were compared to the reported generation data from the EIA for the same year. The TotalView simulation closely matched the EIA data, with discrepancies well within 1%, indicating high accuracy in the model's simulation capabilities.

MISO GENERATION

Simulation Accuracy within 1%

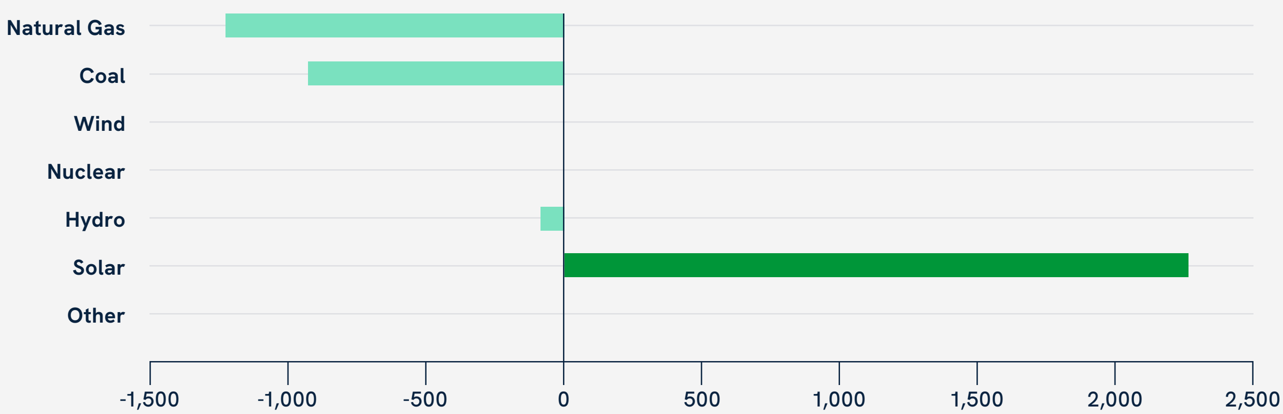


In its first year, the Vista Sands Solar project is projected to generate approximately 2,296 GWh, at a 50% confidence interval (P50), 2,142 GWh at a 90% confidence interval (P90), and 2,099 GWh at a 95% confidence interval (P95). These projections highlight the project's potential to contribute significantly to the region's energy mix.

The following figure presents the forecasted first year changes to the MISO power system caused by Vista Sands Solar. Solar generation increases by 2,296 GWh (P50), **resulting in an estimated reduction of 1,216 GWh in natural gas generation, a reduction of 950 GWh in coal generation, and a reduction of 117 GWh in hydroelectric generation**.

MISO POWER SYSTEM P50

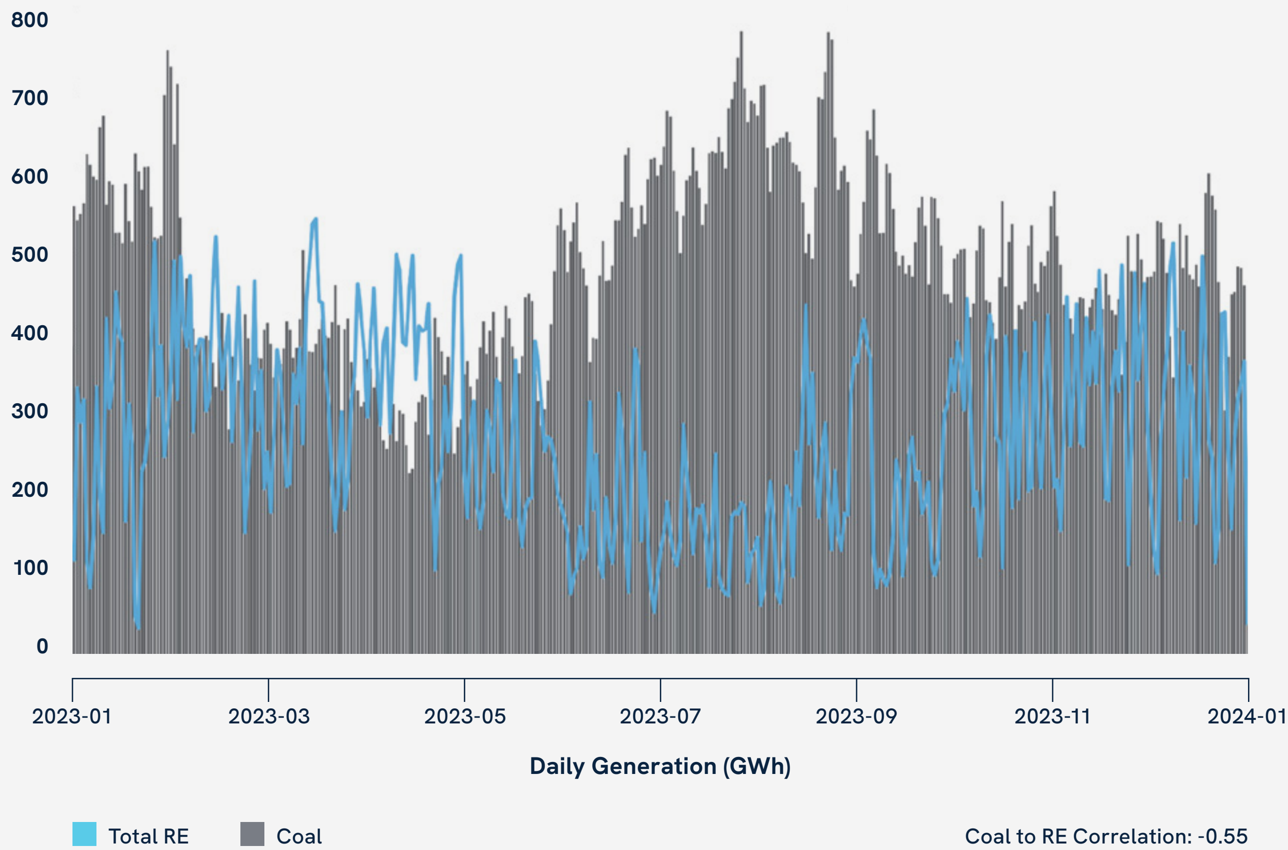
Annual Changes with Vista Sands



Generation Fuel Type	Simulated MISO Generation with Vista Sands (GWh)	Net Change with Vista Sands (GWh)
Natural Gas	240,068	-1,216
Coal	174,034	-950
Wind	91,582	0
Nuclear	87,825	0
Hydro	9,865	-117
Solar	8,657	2,296
Other	4,487	0

COAL AND RE

Daily Coal and RE



Coal generation in the MISO balancing authority is cycled throughout the year. The figure below presents coal generation in the gray bars in the MISO balancing authority for the 2023 year, and variable renewable energy generation overlaid in a blue line. There is a -.55 correlation between variable renewable energy and coal, meaning that as variable renewable energy production increases, coal generation decreases.

Avoided Emissions

The avoided emissions across various life cycle impact categories for the first year are summarized below, with calculations based on the P50, P90, and P95 generation profiles.

The following figure presents the projected avoided emissions to air. The integration of Vista Sands Solar into the MISO power system is expected to reduce reliance on coal and natural gas generation, leading to substantial greenhouse gas and air pollutant emissions reductions.

YEAR 1

Avoided Emissions to Air

Area of Impact	Units	Avoided Emissions P50	Avoided Emissions P90	Avoided Emissions P95
Carbon	Tonnes CO2-Eq	1,624,113	1,516,473	1,486,701
Human Toxicity (Cancerous)	Tonnes 1,4-DCB-Eq	57,393	53,660	52,626
Human Toxicity (Non-cancerous)	Tonnes 1,4-DCB-Eq	823,071	768,920	753,932
Ionising Radiation	MBq Co-60-Eq	1,096	1,048	1,034
Ozone Depletion	Tonnes CFC-11-Eq	0.389	0.363	0.356
Particulate Matter	Tonnes PM2.5-Eq	1,129	1,055	1,034
Photochemical Oxidants (Public Health)	Tonnes NOx-Eq	2,158	2,016	1,976
Photochemical Oxidants (Ecosystems)	Tonnes NOx-Eq	2,244	2,096	2,054

Positive numbers are emissions reductions.

It is important to note that two of the impact categories are related to global air pollutants, carbon and ozone depletion. The other six impact categories are related to local air pollutants.

The Year 1 avoided carbon emissions calculated by TotalView are higher than the avoided carbon emissions calculated by the PVSyst report for a few reasons. The PVSyst report multiplies the expected generation of Vista Sands Solar by the average CO2 intensity per kWh in the MISO balancing authority. That average CO2 intensity includes all generation sources in MISO. However, as modeled and shown above, the Vista Sands Solar project will mostly be offsetting coal and natural gas generation, which has a much higher CO2 intensity than the average MISO CO2 intensity.

The Vista Sands Solar project is primarily offsetting natural gas and coal generation because natural gas and coal make up a large portion of the MISO generation mix. Additionally, there is very little renewable energy curtailment in MISO because wind and solar energy is currently a small portion of the MISO grid mix, so it is not likely that Vista Sands Solar will offset wind or solar generation. Nuclear is also a small portion of the MISO grid mix, and nuclear energy is not cycled, so there are no expected changes to nuclear energy. Bioenergy is limited and expensive, and currently a very small portion of the MISO grid mix, so no significant changes are expected there as well.

By modeling the hourly grid generation changes based on the forecasted hourly Vista Sands Solar production, we can see with more granularity the expected generation that will be displaced, and thus have a much more accurate assessment of the amount of greenhouse gas and air pollutant emissions that will be reduced. The life cycle emissions inventory utilized in TotalView considers all greenhouse gasses across the technology life cycle, rather than just CO2, which makes for a more accurate and more comprehensive CO2-eq reduction assessment.

The following figure presents the Year 1 avoided emissions to water based on the P50, P90 and P95 generation confidence intervals for Vista Sands Solar.

YEAR 1

Avoided Emissions to Water

Area of Impact	Units	Avoided Emissions P50	Avoided Emissions P90	Avoided Emissions P95
Freshwater Ecotoxicity	Tonnes 1,4-DCB-Eq	(4,150)	(3,846)	(3,762)
Marine Ecotoxicity	Tonnes 1,4-DCB-Eq	(3,074)	(2,828)	(2,761)
Freshwater Eutrophication	Tonnes P-Eq	693	648	635
Marine Eutrophication	Tonnes N-Eq	40	38	37

Negative numbers are emissions increases. Emissions increases primarily due solar panel production. Water depletion due to solar panel production.

The avoided emissions to water consider the full life cycle of activities related to solar power production, including mining and panel manufacturing. With regard to the forecasted impacts to freshwater ecotoxicity and marine ecotoxicity, these are attributed to the manufacturing processing of solar panels.

Further, this assessment does not assess current land use, such as the large quantities of fertilizer, pesticides and insecticides in industrial agriculture, and local hydrological changes and or benefits to the project-specific site that may result from the proposed solar installation and it's ecosystem rehabilitation and vegetation management plans. The current land use and impacts of Doral's proposed ecosystem rehabilitation and management plans are addressed in direct the testimony of Jim Okray,[13] as well as the Economic Impact & Land Use Analysis of the Vista Sands Solar Project,[14] the Vegetation Management Plan,[15] and the GRPC Risk Assessment and Conservation Strategy.[16]

The following figure presents the Year 1 forecasted avoided emissions to soil based on the P50, P90 and P95 generation confidence intervals for Vista Sands Solar.

13 Direct Testimony of Jim Okray, 2024. https://apps.psc.wi.gov/ERF/ERFview/viewdoc.aspx?docid=501491

14 Strategic Economic Research, LLC, 2023. https://apps.psc.wi.gov/ERF/ERFview/viewdoc.aspx?docid=488070

15 Stantec Consulting Services Inc., 2024. https://apps.psc.wi.gov/ERF/ERFview/viewdoc.aspx?docid=488004

16 Stantec Consulting Services Inc, 2024. https://apps.psc.wi.gov/ERF/ERFview/viewdoc.aspx?docid=501482

YEAR 1

Avoided Emissions to Soil

Area of Impact	Units	Avoided Emissions P50	Avoided Emissions P90	Avoided Emissions P95
Terrestrial Acidification	Tonnes SO2-Eq	3,260	3,044	2,984
Terrestrial Ecotoxicity	Tonnes 1,4-DCB-Eq	(137)	(127)	(125)

Emissions increases primarily due solar panel production.

The following figure presents the Year 1 forecasted avoided resource use across the grid.

YEAR 1

Avoided Resource Use

Area of Impact	Units	Avoided Resource Use
Life Cycle Land Transformation*	Annual*m2 crop-Eq	(43,467,305)
Water Depletion	Cubic Meters	(1,822,754)
Energy Resources: Non-Renewable, Fossil	Tonnes Oil-Eq	494,371
Material Resources: Metals/Minerals	Tonnes Cu-Eq	(310)

Doral land use mitigation efforts include: 30 species of native grasses planted, reduction in agricultural inputs, vegetative management plan.
*Does not include Vista Sands specific mitigation strategies.

The life cycle land transformation impact category considers the entire land use life cycle, including land transformation, land occupation and land relaxation related to all activities required to produce solar panels and operate in the first year of project operations for a project of this size. It also considers land use changes across the entire grid, such as how reductions in natural gas and coal generation lead to reductions in the land used to extract coal and natural gas. For more details on all the impact category calculations, see the ReCiPe 2016[17] life cycle impact assessment methodology.

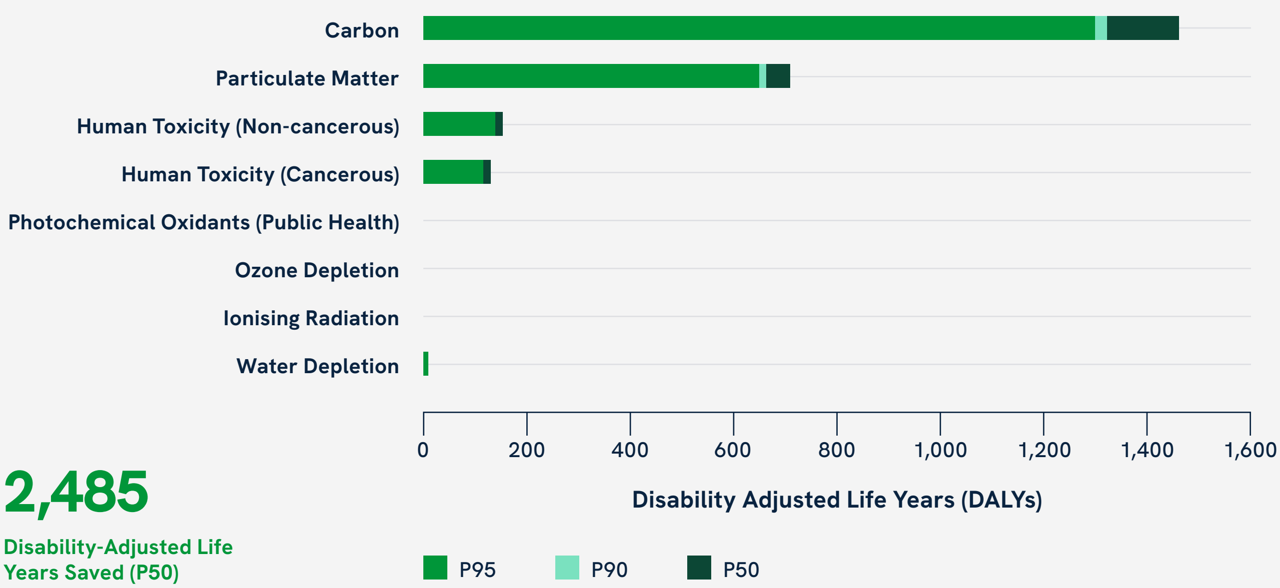
Public Health Impacts

The following figure presents the public health impacts forecasted to be caused by the emissions reductions that Vista Sands Solar will yield in Year 1. It is estimated that in the first year of Vista Sands Solar operation, **2,485 disability-adjusted life years will be saved** due to the reductions of global air pollutants like CO2 as well as local air pollutants like particulate matter and human toxicity emissions. This is equivalent to approximately 1,000 people getting an extra 2.5 years of healthy life with their families.

Note that the greatest benefits come from reductions of carbon emissions, which are global air pollutants and thus the impacts are globally distributed. However, there are also substantial impacts from the reductions in local air pollutants, including particulate matter, cancerous human toxicity emissions and non-cancerous human toxicity emissions, that will provide substantial local public health benefits.

YEAR 1

Human Health Benefits



2,485

Disability-Adjusted Life Years Saved (P50)

17 Huijbregts, M. A., Steinmann, Z. J., Elshout, P. M., Stam, G., Verones, F., Vieira, M., ... & Van Zelm, R. (2017). ReCiPe2016: a harmonised life cycle impact assessment method at midpoint and endpoint level. *The International Journal of Life Cycle Assessment*, 22, 138-147.

Ecosystem Impacts

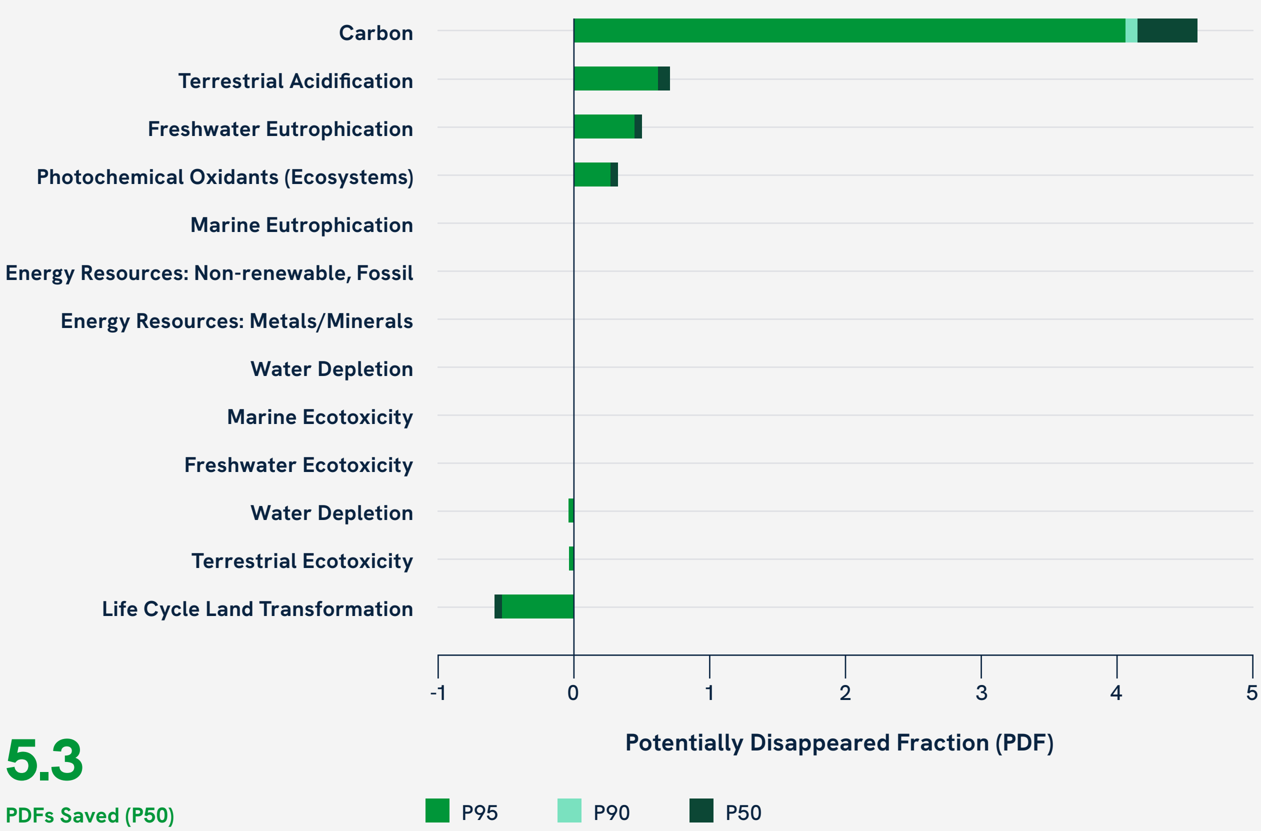
The following figure presents ecosystem quality impacts estimated to be caused by the emissions reductions that Vista Sands Solar will yield in Year 1. It is estimated that in the first year of Vista Sands Solar operation, over **5 potentially disappeared fraction of species will be saved** due to the reductions of global air pollutants like CO2 as well as local terrestrial acidification and freshwater eutrophication air pollutants. These results are a net gain, accounting for the potential negative impacts shown in the figure below.

Note that the majority of benefits come from carbon emissions reductions, which are global air pollutants that create globally dispersed impacts. However, there are also significant ecosystem benefits due to local air pollutant reductions, including terrestrial acidification emissions reductions, freshwater eutrophication emissions reductions and photochemical oxidants emissions reductions, that provide substantial benefits to local species and ecosystems.

There can be negative ecosystem impacts caused by the land transformation life cycle. It is important to note that this measurement does not include any of the land use remediation efforts employed by Vista Sands Solar, and thus represents an upper bound of what the land use impacts could be if there were no remediation efforts.

YEAR 1

Biodiversity Benefits



5.3

PDFs Saved (P50)

Economic Impacts

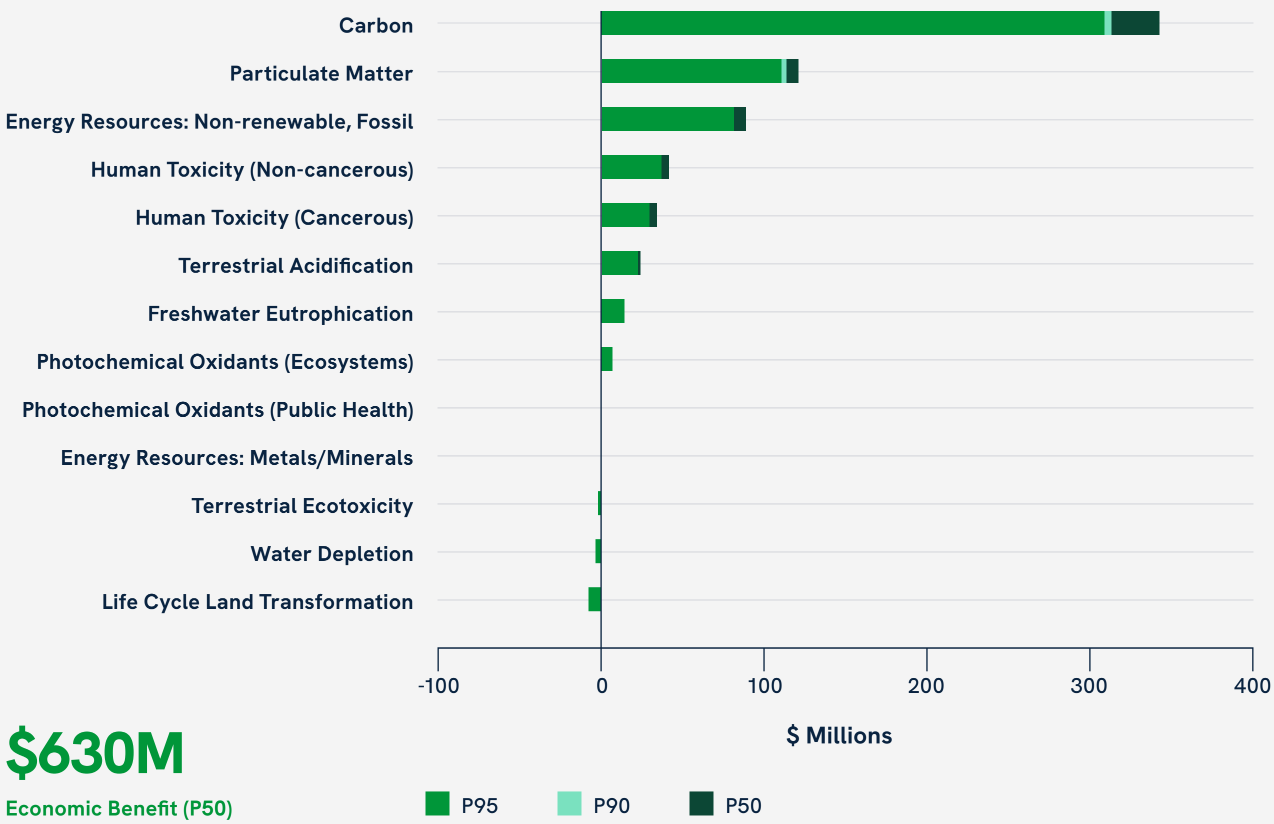
The combined public health and ecosystem benefits are projected to yield approximately $630 million in economic gains in the first year. These savings are primarily attributed to the reduction in healthcare costs and the preservation of ecosystem services.

The following figure presents the estimated net economic savings that would be produced in Year 1 of Vista Sands Solar due to the emissions reductions and corresponding public health and ecosystem benefits.

Note that the largest benefits come from carbon emissions, which are global pollutants. However, there are large economic benefits caused by the reduction of numerous local air pollutants, including particulate matter, cancerous human toxicity emissions, non-cancerous human toxicity emissions, terrestrial acidification, freshwater eutrophication and photochemical oxidant emissions, which will be enjoyed by local and regional communities.

YEAR 1

Economic Savings



$630M

Economic Benefit (P50)

It is important to note the negative economic impacts, such as land use, are far outweighed by the positive economic impacts caused by emissions reductions and the resulting public health and ecosystem benefits. Furthermore, certain negative site-specific impacts related to the life cycle of land use can be mitigated through rehabilitation and ecosystem management strategies, such as planting native species and managing vegetation. Additionally, land use impacts can be mitigated by reducing other inputs to the soil that are not captured in this analysis, such as avoided agricultural inputs. See the project developer's plan for land use mitigation and management for detailed information.

CONCLUSION

Vista Sands Solar Net Benefits for Public Health, Ecosystems, and Economy

The proposed Vista Sands Solar project stands out as a powerful initiative with the potential to protect and enhance public health, improve ecosystem quality, and deliver substantial economic benefits. By reducing harmful greenhouse gas and air pollutant emissions, the project will contribute to a decrease in respiratory and cardiovascular diseases, benefiting community health and increasing the quality of life and life expectancy in the populations surrounding Vista Sands Solar and the MISO balancing authority. Additionally, the improvement in air quality will bolster local ecosystems, fostering biodiversity and resilience against climate change and other environmental stressors.

In its first year alone, Vista Sands Solar is projected to generate 2,296 GWh of clean energy, leading to substantial reductions in air, water, and soil pollutants. These reductions are expected to save approximately 2,485 disability-adjusted life years (DALYs) and preserve over five potentially disappeared fractions (PDFs) of species, yielding to approximately $630 million in economic gains through avoiding these damages. These net gains are in addition to the direct, indirect and induced economic benefits that the project is expected to achieve.

Considering the environmental impacts of any type of land use change is important. In this regard, the proposed Vista Sands Sola project promises to produce substantial measurable and broad reaching benefits by reducing global air pollutants like CO2 and local air pollutants such as particulate matter, human toxicity and photochemical oxidant emissions. This will produce significant public health and environmental improvements, both locally and regionally, and deliver significant economic savings in the project's first year of operations alone, and more throughout the duration of the project's proposed operational life span.

Considering Site-Specific Impacts and Broader Benefits

The scope of this analysis includes quantifying the avoided life cycle emissions that Vista Sands Solar is expected to achieve in its first year of operation, while also accounting for the resources and emissions involved with manufacturing the project infrastructure as well as potential impacts due the life cycle of land use. Outside the scope of this report are how Doral's site-specific ecosystem rehabilitation, vegetation management and hydrologic management plans will mitigate potential land use impacts, and in some cases potentially improve site-specific land use impacts. The impacts of Doral's proposed ecosystem rehabilitation, vegetation management and hydrologic management plans were assessed in the Vegetation Management Plan[18] and GRPC Risk Assessment and Conservation Strategy.[19] These studies, along with other information provided by Vista Sands, found that the reduction of agricultural inputs and water usage associated with irrigation, combined with a reintroduction of a pollinator habitat, would provide numerous additional local benefits that are not quantified in this report.

It is important to note that the public health, ecosystem and economic benefits account for both local and global air pollutants. Reducing global air pollutants, such as CO2 and ozone depleting substances, leads to benefits at a global scale. Reducing local air pollutants, such as particulate matter, human toxicity emissions and photochemical oxidants, produce local benefits that will be enjoyed by the populations surrounding Vista Sands Solar as well as the MISO balancing authority, leading to:

Improved Public Health
Reduced emissions of particulate matter, toxic substances, and other pollutants will lower the incidence of respiratory and cardiovascular diseases, enhancing the quality of life and life expectancy for local and regional populations.

Enhanced Ecosystem Quality
Lower emissions will mitigate acidification, eutrophication, and other stressors on ecosystems, supporting biodiversity and resilience.

Economic Gains
The public health and ecosystem benefits will yield substantial economic savings, reinforcing the project's value as a sustainable energy solution.

A Holistic Perspective

In conclusion, the Vista Sands Solar project offers a substantial net positive outcome by significantly enhancing public health, ecosystem quality, and economic well-being. Recognizing and mitigating site-specific impacts is essential, but the broader benefits of emissions reductions and clean energy generation underscore the local and regional net benefits of advancing renewable energy initiatives. By embracing a balanced and comprehensive view, stakeholders can appreciate the substantial contributions of the Vista Sands Solar project to a healthier, more sustainable future for all.

18 Stantec Consulting Services Inc., 2024. https://apps.psc.wi.gov/ERF/ERFview/viewdoc.aspx?docid=488004

19 Stantec Consulting Services Inc, 2024. https://apps.psc.wi.gov/ERF/ERFview/viewdoc.aspx?docid=501482

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