

*Working toward*  
**Sustainable Roadways**

November 2024



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**Roads** provide a window into the character of a community. What the right-of-way looks like tells the story of the place, how decisions are made and what is important. With an eye to the future, road rights-of-way also provide places to experiment with specific, safely designed projects to reduce our carbon footprint, repair the environment and project a new community brand.

Because - the effect of a warming climate is here. As scientists predicted, storms are more intense, droughts more frequent, glaciers are melting, and temperatures are rising.

This report we will explore how expanding what we expect from rights-of-way could contribute to efforts to create a sustainable future. The project explores technologies that offer potential for creating a transportation option that is more than moving vehicles - it becomes part of a regenerative ecosystem. Rights-of-way that use recycled materials in the pavement, generate renewable energy and support a new system of charging electric vehicles.

Although focused on the Aerozone, these ideas are relevant across Cuyahoga County.

This project was inspired by The Ray ([theray.org](http://theray.org)), a nonprofit in Georgia looking to reimagine an 18 mile stretch of Georgia's I-85, so that there are Zero Deaths, Zero Waste, Zero Carbon, and Zero Impact.

The Ray is implementing new ideas and technologies to create a regenerative mobility ecosystem on The Ray Highway to make and inspire change across the United States. Further, The Ray has embraced the concept of biomimicry, or innovation inspired by nature. As noted on their website:

*“ Similar to biomimicry, the mission of The Ray is to reimagine how we connect our communities, our lives and the world in a way that is safer, more responsive to the climate, more regenerative to the environment, and more capable of generating economic opportunity through innovative ideas and technologies that will transform transportation infrastructure. To achieve these goals, The Ray works with more than three dozen public agencies nationwide to promote, plan, execute and scale net-zero infrastructure projects that will produce safer, cleaner and smarter outcomes in the transportation and energy sectors.”*



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The **Ohio Aerospace Institute** and **Great Lakes Biomimicry** thank the following people for taking the time to meet and/or join in project team meetings.

Srinivas Allena, PhD, PE	Cleveland State University	s.allena@csu.edu
Chris Alvarado	Cuyahoga County Director of Regional Collaboration	calvarado@cuyahogacounty.us
Devo Bavishi	Ace Taxi	devo@acetaxi.com
Maria Benovic	C&S Companies	mhenovic@cscos.com
Evan Blomquist	The Ray	evan@theray.org
Trisha Brown	Great Lakes Biomimicry	<a href="mailto:Trishabrown@glbiomimicry.org">Trishabrown@glbiomimicry.org</a>
Mark Carpenter	Ohio Department of Transportation	mark.carpenter@dot.state.oh.us
Mary Kay Costello	City of Fairview Park	marykay.costello@fairviewpark.org
Nichole English	Cuyahoga County Public Works	nenglish@cuyahogacounty.us
Marie Fechik-Kirk	Northeast Ohio Regional Sewer District	fechik-kirkm@neorsd.org
Jeff Filarski	Chagrin Valley Engineering, North Olmsted Engineer	<a href="mailto:filarski@cvelimited.com">filarski@cvelimited.com</a>
Mike Foley	Cuyahoga County Office of Sustainability	<a href="mailto:mfoley@cuyahogacounty.us">mfoley@cuyahogacounty.us</a>
Kristin Hall	Cuyahoga Soil & Water Conservation District	khall@cuyahogaswcd.org
Olwen Huxley	C&S Companies	<a href="mailto:OHuxley@cscos.com">OHuxley@cscos.com</a>
Corey Johnson	C&S Companies	CSJohnson@cscos.com
Valerie Katz	Cuyahoga County Office of Sustainability	<a href="mailto:vkatz@cuyahogacounty.us">vkatz@cuyahogacounty.us</a>
Elizabeth Lehman	Cleveland Hopkins Airport	elehman@clevelandairport.com
Tim Lewis	Ace Taxi	<a href="mailto:tim@acetaxi.com">tim@acetaxi.com</a>
Matt Madzy	City of Berea	mmadzy@cityofberea.org
Hrishue Mahalaha	Aerozone Alliance	hmalalaha@aerozonealliance.org
Paul Marnecheck	City of Brook Park	pmarnecheck@cityofbrookpark.com
Kim McGreal	Cleveland Hopkins Airport	<a href="mailto:kmcgreal@clevelandairport.com">kmcgreal@clevelandairport.com</a>
Dan Meaney	Cuyahoga County Planning Commission	dmeaney@cuyahogacounty.us
Rachel Novak	Cuyahoga County Planning Commission	rnovak@cuyahogacounty.us
Sarah O'Keefe	City of Cleveland Sustainability	<a href="mailto:sokeefe@clevelandohio.gov">sokeefe@clevelandohio.gov</a>
Santos Ramos	DriveOhio	santos.ramos@dot.ohio.gov
Gertrudis Ramos	Alternalite	<a href="mailto:gramos@alternalite.com">gramos@alternalite.com</a>
Laura Rogers	The Ray	laura@theray.org
Tom Sorge	Ohio Department of Transportation	<a href="mailto:Tom.Sorge@dot.ohio.gov">Tom.Sorge@dot.ohio.gov</a>
Carol Thaler	Great Lakes Biomimicry	<a href="mailto:cthaler@glbiomimicry.org">cthaler@glbiomimicry.org</a>
Max Upton	City of North Olmsted	<a href="mailto:uptonm@north-olmsted.com">uptonm@north-olmsted.com</a>
Beau Williams	Cleveland Hopkins Airport	<a href="mailto:bwilliams@clevelandairport.com">bwilliams@clevelandairport.com</a>
Tim Ward	necoTECH	Tward@necotech.com
Beverly West	The Ray	beverly@theray.org
Cliff Wood	Prairie Wind Group	cliff.wood@prairiewindgroup.com
Jason Ziss	Kurtz Brothers	jasonz@kurtz-bros.com



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## Advances in Pavement Recycling and New Materials

A circular economy is part of a sustainable economy. In a circular economy, when a product reaches the end of its life, its materials are kept within the economy wherever possible through recycling. Similarly, waste products are used rather than discarded. Contributing to the circular economy value chain means participating in a system that aims to minimize resource consumption, waste generation, and environmental impact while maximizing the efficient use and reuse of materials throughout their lifecycle.

How roads are constructed could contribute to a circular economy. Advances in using recycled materials and waste products are influencing the road construction industry.

### Ohio

- The [Northeast Ohio Regional Sewer District \(NEORS\)](#) is exploring ways that the residuals created as part of the wastewater treatment process could be used as a material in concrete pavement. “Residuals” is the term commonly used to identify grit, screenings, skimmings and biosolids removed from the wastewater at publicly owned treatment centers and ash from biosolids incinerators.

NEORS has conducted detailed chemical analysis of the residuals. In 2024, they released a request for proposals regarding the future use of residuals. Contact Marie Fechik-Kirk for more information. [fechik-kirkm@neorsd.org](mailto:fechik-kirkm@neorsd.org)

- Srinivas Allena, PhD, PE., is an Assistant Professor of Environmental Engineering at [Cleveland State University](#). Dr. Allena's main research interests are in the development of innovative structural materials including ultra-high-performance concrete and engineered cementitious composites, performance-based design of advanced concrete materials, repair and rehabilitation of transportation infrastructure, concrete durability and shrinkage, concrete sustainability, and smart sensors for structural health monitoring. [s.allena@csuohio.edu](mailto:s.allena@csuohio.edu)
- [necoTECH \(necotech.com\)](#) of Delaware Ohio is pioneering sustainable infrastructure solutions. They are dedicated to revolutionizing the infrastructure industry through innovative and sustainable technologies. Their mission is to provide eco-friendly solutions that not only meet the highest standards of quality and performance but also contribute to a greener and more sustainable future.

**necoTECH**

necoTECH started with award-winning recycled plastics in asphalt roads and has been expanding ever since. They are utilizing more advanced equipment, and creating eco-friendly materials to improve performance, increase safety, and to make our infrastructure more sustainable for decades to



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come. They specialize in creating sustainable asphalt mixes by incorporating reclaimed tires and reclaimed asphalt pavement (RAP) into our balanced mix designs.

necoTECH is currently partnering with The Shelly Company in Columbus to produce their sustainable asphalt products. The company is looking to grow operations into Northeast Ohio in 2025. Tim Ward [tward@necotech.com](mailto:tward@necotech.com)

## Netherlands

- **VolkerWessels**, an infrastructure construction and real estate development company in the Netherlands has developed a 100% recycled **Plastic Road**. This new road design is lightweight, with a fraction of the construction time, virtually maintenance free and three times the expected life span. **Plastic Road** consists of 100% recycled material, is the ideal sustainable alternative to conventional road structures.

A pilot **PlasticRoad** cycle path represents the first step in the journey towards more sustainable roads. It will allow the **PlasticRoad** partnership to test this initiative's technical and economic feasibility.

- Cycle Path in Zwolle, Netherlands
  - <https://blog.wavin.com/en-gb/plastic-road-launch>
  - <https://www.orbia.com/this-is-orbia/news-and-stories/plastic-road/>



To tackle both plastic pollution and flooding risk, VolkerWessels, a Dutch construction group, is producing the next generation of sustainable infrastructure: roads made from recycled plastic with a hollow core to detain flood water.



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## Colorado

- Pitkin County
  - Pitkin County Launches New Program to Pave Colorado Roads with Asphalt Made from Recycled Plastic
    - <https://pitkincounty.com/CivicAlerts.aspx?AID=695>

### Pitkin County Launches New Program to Pave Colorado Roads with Asphalt Made from Recycled Plastic

**Aspen, CO (Sep 25th, 2024)** – Pitkin County is proud to announce the launch of a groundbreaking new diversion program aimed at recycling 25 tons of plastic film annually. In an effort with local municipalities, this innovative program will help address both plastic waste and infrastructure needs by using recycled plastic film to replace virgin polymers in asphalt mixtures.



## Virginia

- Chesterfield County
  - MacRebur, The Plastic Road Company of Lockerbie Scotland has partnered with local officials to resurface roads in Richmond and Chesterfield County Virginia. The materials used in the resurfacing are manufactured from a mix of recycled polymers, designed to modify asphalt and reduce deformation failures or increase stiffness.
    - <https://www.macrebur.com/#top>



### Sustainability



#### Safe for use

Our products are rigorously tested to ensure they are safe for both humans and the environment.



#### ISO accredited

We provide real world accredited carbon savings. All carbon data noted is verified in accordance with ISO 14064-3.



#### Sustainable technologies

By extending part of the Bitumen in the mix, our products reduce fossil fuel usage, leading to a reduction in carbon footprint.



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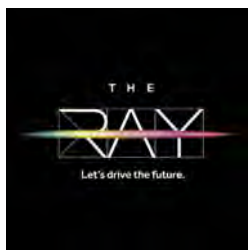
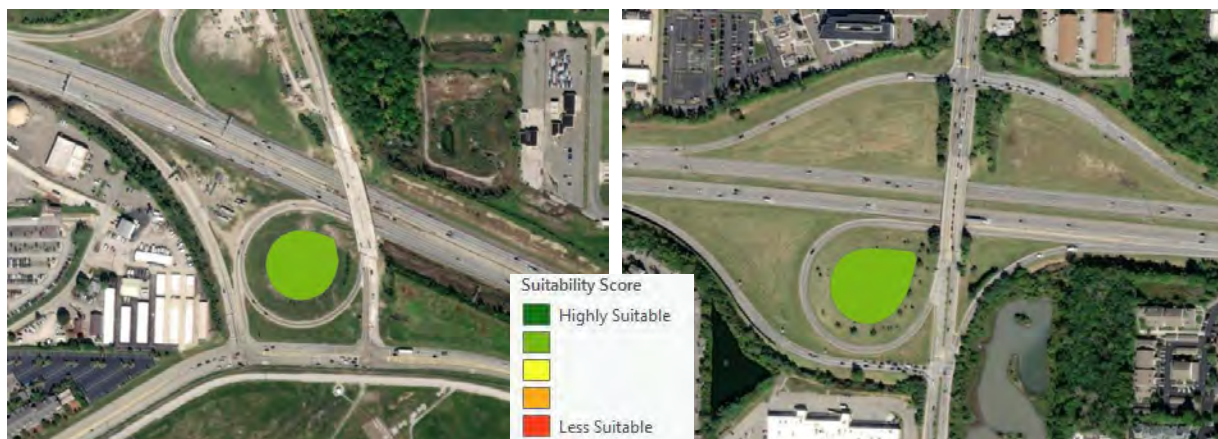


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## Generating Solar Power

Generating renewable, solar power in strategic locations within, and adjacent to, Cuyahoga County's interstate and state highways could be an innovative way to expand access to alternative energy, educate passersby and increase biologic diversity.

To continue growth in solar installations, The Ray generated GIS data that evaluates sites within and near highway rights-of-way for their potential for generating solar energy. The data is available from Cuyahoga County Planning Commission. Please contact Dan Meaney at [dmeaney@cuyahogacounty.us](mailto:dmeaney@cuyahogacounty.us)



The Ray is a proving ground for the evolving ideas and technologies that will transform the transportation infrastructure of the future, and it starts on 18 miles of West Georgia's I-85, and the land and communities surrounding it.



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## Generating Solar Power in the Aerozone

To provide a foundation for considering the construction of right-of-way solar, in the Aerozone, a local company, Prairie Wind Group, LLC, was brought in to prepare a detailed analysis of the technical, financial, jurisdictional and end use potential of two sites:

- Southwest portion of the cloverleaf at Great Northern Boulevard and I-480
- Cleveland owned land north of I-480 and south of the Hopkins Airport rental car facilities

Please see an overview of the information below. Prairie Wind's full report on these sites is attached to this report.

### **Great Northern Boulevard and I-480**



- Site (8.32 acres)
  - 2.32 acres used for solar or 28%
- Solar field/array
  - System size- 922kWdc
  - Annual production- 1,238MWh (enough energy to power 103 homes)
  - 1,576 Solar Panels
  - Native pollinator habitat planted
- Deal structure
  - Third-party investor owns, insures, & maintains asset
  - 25-year lease with ODOT
- Financials
  - Total project cost- \$1,659,528
  - Cash purchase- IRR 12.4%; payback 6.6 years, or
  - Investor PPA (\$0.08/kWh; 25-yr term w/ 2.5% annual escalator)- IRR 14.1 payback 5.8 years



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## Property South of Car Rental Facility & North of I-480 East of Grayton Road, West of Rocky River Drive



- Site (21.98 acres)
  - 9.43 acres used for solar or 42%
- Solar field/array
  - System size- 3,800kWdc
  - Annual production- 4,939MWh (enough energy to power 412 homes)
  - 6,496 Solar Panels
  - Native pollinator habitat planted
- Deal structure
  - Third-party investor owns, insures, & maintains asset
  - 25-year lease with City of Cleveland
- Financials
  - Total project cost- \$6,840,288
  - Cash purchase- IRR 12.0%; payback 5.9 years, or
  - Investor PPA (\$0.08/kWh; 25-yr term w/ 2.5% annual escalator)- IRR 13.7; payback 6.8 years



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## **Solar Installations + Fighting Global Biodiversity Collapse**

While producing renewable, clean energy, solar installations offer sites to address another ecological crisis, global biodiversity collapse. With prior planning and partnerships between solar developers, operators, biologists and environmentalists, solar sites can tackle two challenges at the same time.



Ramsey, Minnesota



Catrin Einhorn, “Solar Farms Have a Superpower Beyond Clean Energy”, New York Times, September 6, 2024, <https://www.nytimes.com/2024/09/05/climate/solar-power-pollinators-wildlife.html?searchResultPosition=1>



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## Native Plants

Locally, the Cuyahoga Soil and Water Conservation District is an expert on native plants for our region. Native plants are adapted to our climate and require less water or fertilizer (if any). Their roots often extend deep into the ground preventing soil erosion while providing organic matter to the soil. Native plants attract insects and wildlife and increase diversity in our landscape all while reducing the threat of non-native plant species. Cuyahoga SWCD offers a variety of information and resources. Contact Kristen Hall at [khall@cuyahogaswcd.org](mailto:khall@cuyahogaswcd.org).



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## Electric Vehicle Charging

In full electric mode, an electric car produces zero tailpipe emissions, dramatically lowering smog and greenhouse gas emissions even when considering electricity generation. Cleaner cars mean cleaner air and better health and are an important element of a sustainable roadway corridor.

Electric vehicles can be charged at home or at public chargers. There's no doubt it takes longer to charge an EV than it does to pump gas, but EV charging is arguably easier and cleaner. Since charging typically happens when you're sleeping or not using your EV, charging time makes little difference.



The only time it matters is on road trips, or if you can't charge at home. In these cases, prior planning is required to find access to public charging options.

With electric vehicles offering 250 -300 miles of range, most electric vehicle owners can charge once or twice a week. Websites and apps like ChargePoint.com, ChargeFinder.com and ElectrifyAmerica.com provide useful information.

Car manufacturers are betting on the electric vehicle market. The Edison Electric Institute surveyed car manufacturers to determine each company's targets for manufacturing electric vehicles. As noted here, collectively, manufacturers announced electric vehicle sales targets for 2030 to be 48% of all vehicles sold. A strong indication that the private market is preparing for a significant consumer switch to a preference for electric vehicles.

**Table 1. EEI Analysis of Projected EV Sales in 2030 by Vehicle Manufacturer**

Manufacturer	EEI estimated light-duty vehicle sales in U.S. in 2030	Manufacturer announced EV sales targets in 2030*	Estimated EV sales in 2030
BMW	420,000	50%	210,000
Ford	2,150,000	40%	860,000
General Motors	2,580,000	50%	1,290,000
Honda	1,660,000	40%	664,000
Hyundai-Kia	1,650,000	50%	825,000
Jaguar Land Rover	120,000	100%	120,000
Mazda	370,000	25%	92,500
Mercedes	370,000	100%	370,000
Nissan	1,230,000	40%	492,000
Stellantis	2,010,000	50%	1,005,000
Subaru	680,000	40%	272,000
Tesla	880,000	100%	880,000
Toyota	2,540,000	30%**	762,000
Volkswagen	720,000	55%	396,000
Volvo	140,000	100%	140,000
<b>Total</b>	<b>17,520,000</b>	<b>48%</b>	<b>8,378,500</b>

\*Percentages are based on most recently announced sales targets for EVs.

## Electric vehicle registrations in Ohio are growing

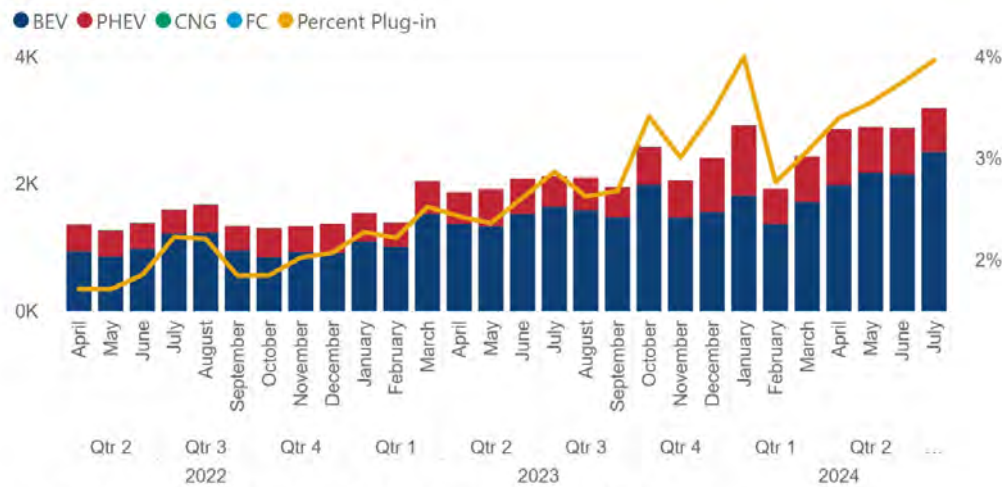


Figure 4: New AFV Registrations by Month in Ohio (as of July 2024)  
Source: DriveOhio

## Where does charging occur and how long does it take?

Location	Charging Type Considered	Time Available to Charge
Home (single-family homes and multi-family dwellings)	Level 1, Level 2	Overnight (approx. 12 hours)
Workplaces	Level 2	Work day (approx. 8 hours)
Public Level 2	Level 2	Approx. 2+ hours
Public DC Fast Charging	DCFC	Approx. 15-45 minutes

### Level 1

120-volt, alternating current (AC) power. Charging station and conventional electric outlets

### Level 2

240-volt, AC power, requires installation of 240-volt circuit (like for a household dryer)

### DC Fast Charging

Converts AC electricity to direct current(DC)



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## How much does it cost?



While battery-powered cars don't emit greenhouse gases from tailpipes, they aren't completely "zero-emission" even if that's their official label. There are still emissions created when the cars are built, when manufacturers create the cars' large batteries, and when they charge. However, electric vehicles are a step in the right direction toward lowering carbon emissions.



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**Building roads is complicated.** To start, there are federal and state regulations, rules about the process, a system at NOACA that a 5-county region uses to decide where to spend federal dollars, local community's priorities and a supply chain that supports the way roads are built now.

Rethinking roads will be a long process, but it doesn't mean don't start.

What can a person do?

- Organize, find like-minded people in your community
- Share your vision with your elected officials and planning commission
  - Ask what the plans are for supporting public electric vehicle charging
  - Bring examples of these ideas being used in other places
  - Ask them to ask questions at NOACA (Northeast Ohio Areawide Coordinating Agency) and the Ohio Department of Transportation about road construction financing and pavement specifications
  - Raise awareness of local businesses that are ready to help, Alternalite, Ace Taxi, C& S Companies, Kurtz Brothers and Prairie Wind
- Meet with your community's engineer
  - Ask where new pavement formulations that include recycled materials can be tested
  - Ask if the city has considered hiring a contractor that is using residuals from NOERSD in their pavement.
  - Ask them what is possible now, what changes in regulations are required
  - Ask if any of DriveOhio's work to advance smart mobility in Ohio is relevant to community goals
  - Enlist their support to talk with elected officials
- Enlist the help of the Cuyahoga County Planning Commission and the Cuyahoga Soil & Water Conservation District
- Enlist of help of the Aerozone if your community is in proximity to Cleveland Hopkins Airport and NASA Glenn Research Center
- Learn from the Institute for Sustainable Infrastructure (<https://sustainableinfrastructure.org>)
- Consistently attend city council and planning commission meetings and ask questions
- Weigh in on your community's master plan
- Look for aspirational language in any community publication and make the connection to the ideas of a sustainable roadway
- Expect push-back
- Remember Margaret Mead's thought: Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it is the only thing that ever has.



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October 22, 2024

Mrs. Carol Thaler  
Co-Director, Great Lakes Biomimicry  
22800 Cedar Point Road  
Brook Park, OH 44142

**RE: Professional services for the Great Lakes Biomimicry- Sustainable Roadway project.**

On behalf of the Prairie Wind Group Team, we thank you for this opportunity to participate in this project to provide professional services as described in our 10/3/2024 subcontract agreement (OAI-ARPA-24112). We believe all Statement of Work tasks are completed in fulfillment of subject subcontract agreement.

Prairie Wind Group is a solar consulting and development company. It is from the perspective of a developer that the analysis that follows is offered.

Sincerely,

Cliff Wood  
President,  
Prairie Wind Group, LLC  
(248) 345-2225  
Cliff.wood@prairiewindgroup.com





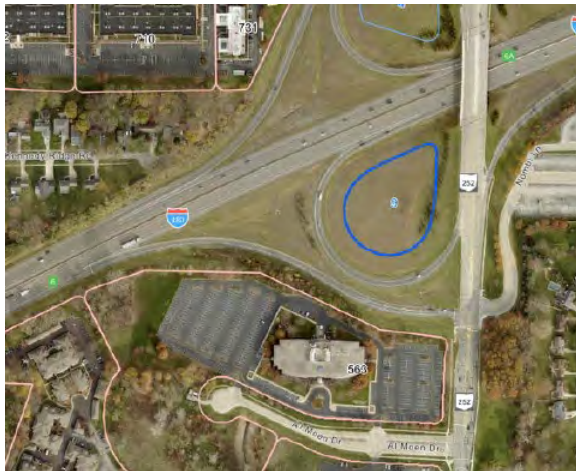
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# FEASIBILITY STUDY

## EXECUTIVE SUMMARY

This feasibility study seeks to answer the following questions: Is it technically and economically feasible to develop the two sites shown below? And, as importantly, who are the potential end users of the solar power and what jurisdictional challenges must be met to affect site development?



#9, ODOT site near Moen (I480 & OH252)



#14, south of Airport rental car facility

## Technical Feasibility

Both sites can host a large ground-mount photovoltaic (PV) system or solar field. PV system metrics and design layouts are shown below. **Method.** PV system design and energy production simulation are done in Helioscope. Please see Exhibit I (#9) and Exhibit II (#14) for full reports.

### PV System Metrics

	DC system size (kW)	AC system size (kW)	AC production (MWh)	Annual yield (kWh/kW)	# solar panels
#9	922.0	830.0	1,238	1,342.3	1,576
#14	3,800	3,150	4,939	1,299.7	6,496



### Economically Feasibility

Given actual cost and revenue data are unavailable; to evaluate economic feasibility and to model investment returns, we must make the following key assumptions:

- Two investment transactions are examined in this Feasibility Study to determine economic and financial feasibility: Cash purchase & investor power purchase agreement (PPA).
- 25-year term, with project commencing in 2025.
- 100% of the solar energy from the arrays is sold to an end user at a PPA rate of \$0.08/kWh, with a 2.5% annual escalator.
- An engineering, procurement, and construction (EPC) contractor can build the systems at \$1.80/Wdc.
- 40% investment tax credit & 40% Federal MACRS, bonus depreciation are realized.
- **Method.** Financial and investment returns are modeled in Energy Tool Base. (Please see Exhibits III & IV for details and other financial/ investment metrics.)

#### Financial & Investment Returns

	Total Project Cost	Total Project Cost/W	Internal Rate of Return (IRR%)	Payback (years)
<b>#9 Cash purchase</b>	\$1,659,528	\$1.80	12.4	6.6
<b>#9 PPA (Investor)</b>	\$1,659,528	\$1.80	14.1	5.8
<b>#14 Cash purchase</b>	\$6,840,288	\$1.80	12.0	5.9
<b>#14 PPA (Investor)</b>	\$6,840,288	\$1.80	13.7	6.8



- **Consultant's notes.** While expected investment returns vary by investor, a typical return expectation is in a range of 8.5%- 12% IRR. Both projects generate strong enough IRR returns to attract a 3<sup>rd</sup> -party investor to invest.

### Potential end users & jurisdiction challenges

- #9, ODOT site, near Moen (I480 & OH 252)
  - Under existing Ohio net metering law, the only grid-tied customer who could use the power is ODOT. Potentially, a grid-tied interconnect could be made via the existing ODOT, highway, lighting system on site.
  - Incorporating an energy storage system (batteries) this site & project offers ODOT an opportunity to install a LED lighting system to light the site and/or electronic signage.
  - Under HB179 (community solar), which our team is working on to enact as law, the power from the site could be potentially sold to community solar subscribers.
- #14, south of Airport car rental facility
  - Given the City of Cleveland owns this property, which arguably is part of the Airport, the potential exists for the power to be sold to Cleveland Hopkins International Airport, under existing Ohio net metering law.
  - In a similar vein, given the City of Cleveland owns the property contiguous to the solar field, where the car rentals and other businesses are located, it's possible the power from the solar field could be sold, under Ohio net metering law, to those businesses.
  - Again, if HB179 is enacted into law, the power could be sold to community solar subscribers.

### SUMMARY

The two sites evaluated in this Feasibility Study are technically capable of hosting a large solar field. And, given the assumptions described above, the projects generate strong financial returns sufficient to attract a 3<sup>rd</sup>- party investor. (It should be noted that it's assumed that neither property owner, ODOT nor the City of Cleveland, would desire to own the solar asset.)

While enactment of HB197 would eliminate the challenge of identifying potential end users, there exists the potential to sell the power from both sites, as described above,

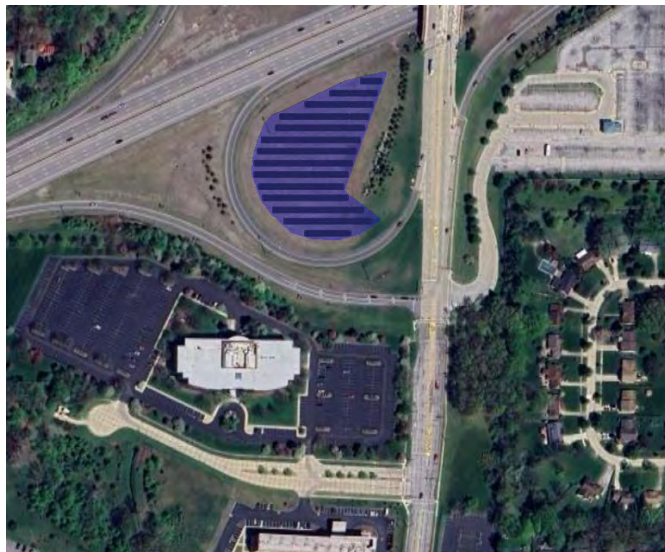


under existing Ohio net metering law. These are projects Prairie Wind Group would gladly pursue as development opportunities.

## FEASIBILITY STUDY

### DETAILED ANALYSIS AND ASSUMPTIONS

#### Technical Feasibility (ODOT) site



System Metrics	
Design	Design 1
Module DC Nameplate	922.0 kW
Inverter AC Nameplate	830.0 kW Load Ratio: 1.11
Annual Production	1.238 GWh
Performance Ratio	84.6%
kWh/kWp	1,342.3

#9, ODOT site near Moen (I480 & OH252)

SITE DETAILS						Available for solar (acres) <sup>[1]</sup>
Owner	Address	Parcel ID	Landuse Class	Parcel (acres)		
State of Ohio	Southwest corner I480 & Rt252	unknown	unknown	8.318		2.32

**Notes:**  
<sup>[1]</sup> Approximately 28% of the 8.32 acres is suitable for solar. The solar field sits atop a hill, with significant elevation drop towards I480. Additionally, the array must be set back (20') from existing trees. The 2.32 acres suitable for solar is flat, with no obstructions or trees and would require little earth work to prepare it for solar field construction.



## Economically Feasibility (ODOT site)

### 3.2 PPA Investor

#### Assumptions and Key Financial Metrics

IRR - Term	14.1%	Net Present Value	\$1,031,827	Payback Period	5.8 Years
ROI	154.6%	PV Degradation Rate	0.50%	Discount Rate	5.0%
Energy Cost Escalation Rate	3.0%	Federal Income Tax Rate	30.0%	State Income Tax Rate	8.0%
Total Project Costs	\$1,950,028				

Years	Project Costs	PPA INCOME	Federal Tax Effect	Total Cash Flow	Cumulative Cash Flow
Upfront	<b>-\$1,659,528</b>	-	-	<b>-\$1,659,528</b>	<b>-\$1,659,528</b>
1	-	\$99,162	\$870,920	\$970,083	<b>-\$689,445</b>
2	-	\$101,133	\$76,471	\$177,604	<b>-\$511,841</b>
3	-	\$103,141	\$45,883	\$149,023	<b>-\$362,818</b>
4	-	\$105,185	\$27,522	\$132,707	<b>-\$230,111</b>
5	-	\$107,268	\$27,522	\$134,789	<b>-\$95,322</b>
6	-	\$109,388	\$13,781	\$123,169	\$27,847
7	-	\$111,548	-	\$111,548	\$139,395
8	-	\$113,747	-	\$113,747	\$253,143
9	-	\$115,987	-	\$115,987	\$369,130
10	-	\$118,267	-	\$118,267	\$487,397
11	-	\$120,589	-	\$120,589	\$607,986
12	-	\$122,954	-	\$122,954	\$730,940
13	-	\$125,361	-	\$125,361	\$856,301
14	-	\$127,811	-	\$127,811	\$984,112
15	-	\$130,306	-	\$130,306	\$1,114,418
16	<b>-\$290,500</b>	\$423,345	-	\$132,845	\$1,247,263
17	-	\$135,431	-	\$135,431	\$1,382,694
18	-	\$138,062	-	\$138,062	\$1,520,756
19	-	\$140,740	-	\$140,740	\$1,661,496
20	-	\$143,466	-	\$143,466	\$1,804,962
21	-	\$146,240	-	\$146,240	\$1,951,202
22	-	\$149,063	-	\$149,063	\$2,100,265
23	-	\$151,936	-	\$151,936	\$2,252,202
24	-	\$154,860	-	\$154,860	\$2,407,062
25	-	\$157,835	-	\$157,835	\$2,564,897
Totals:	<b>-\$1,950,028</b>	\$3,452,827	\$1,062,098	\$2,564,897	-



### 3.1 Cash Purchase

#### Assumptions and Key Financial Metrics

IRR - Term	12.4%	Net Present Value	\$922,524	Payback Period	6.6 Years
ROI	167.4%	PV Degradation Rate	0.50%	Discount Rate	5.0%
Energy Cost Escalation Rate	3.0%	Federal Income Tax Rate	30.0%	State Income Tax Rate	8.0%
Total Project Costs	\$1,659,528				

#### Technical Feasibility (CLE site)

The 9.43 acres suitable for solar can host a 3,800kW (3.8MW) solar field. Below is a photovoltaic (PV) system design and layout, with accompanying system metrics.



System Metrics	
Design	Design 1
Module DC Nameplate	3.80 MW
Inverter AC Nameplate	3.15 MW Load Ratio: 1.20
Annual Production	4.939 GWh
Performance Ratio	86.5%
kWh/kWp	1,299.7

- The array consists of 6,496 solar panels sitting on a fix-tilt racking system. Interrow spacing (area between rows) is 17 feet.
- **Native pollinator habitat.** The space between rows and adjacent land would be populated with native pollinator plants.
- Please see Exhibit II for more details about system components, tilt, azimuth, monthly energy production, etc.



## Economically Feasibility (CLE site)

### 3.1 PPA Investor

#### Assumptions and Key Financial Metrics

IRR - Term	13.7%	Net Present Value	\$4,029,672	Payback Period	5.9 Years
ROI	148.5%	PV Degradation Rate	0.50%	Discount Rate	5.0%
Energy Cost Escalation Rate	3.0%	Federal Income Tax Rate	30.0%	State Income Tax Rate	8.0%
Total Project Costs	\$7,944,188				

Years	Project Costs	PPA INCOME	Federal Tax Effect	Total Cash Flow	Cumulative Cash Flow
Upfront	-\$6,840,288	-	-	-\$6,840,288	-\$6,840,288
1	-	\$395,690	\$3,589,783	\$3,985,474	-\$2,854,814
2	-	\$403,555	\$315,200	\$718,755	-\$2,136,059
3	-	\$411,565	\$189,120	\$600,685	-\$1,535,374
4	-	\$419,724	\$113,439	\$533,163	-\$1,002,211
5	-	\$428,033	\$113,439	\$541,472	-\$460,739
6	-	\$436,495	\$56,802	\$493,297	\$32,558
7	-	\$445,113	-	\$445,113	\$477,672
8	-	\$453,889	-	\$453,889	\$931,561
9	-	\$462,826	-	\$462,826	\$1,394,387
10	-	\$471,926	-	\$471,926	\$1,866,313
11	-	\$481,191	-	\$481,191	\$2,347,504
12	-	\$490,625	-	\$490,625	\$2,838,129
13	-	\$500,230	-	\$500,230	\$3,338,360
14	-	\$510,009	-	\$510,009	\$3,848,368
15	-	\$519,963	-	\$519,963	\$4,368,331
16	-\$1,103,900	\$1,633,997	-	\$530,097	\$4,898,428
17	-	\$540,412	-	\$540,412	\$5,438,841
18	-	\$550,912	-	\$550,912	\$5,989,753
19	-	\$561,599	-	\$561,599	\$6,551,352
20	-	\$572,476	-	\$572,476	\$7,123,829
21	-	\$583,546	-	\$583,546	\$7,707,375
22	-	\$594,812	-	\$594,812	\$8,302,187
23	-	\$606,276	-	\$606,276	\$8,908,464
24	-	\$617,942	-	\$617,942	\$9,526,406
25	-	\$629,812	-	\$629,812	\$10,156,218
Totals:	-\$7,944,188	\$13,722,621	\$4,377,784	\$10,156,218	-





### 3.2 Cash Purchase

#### Assumptions and Key Financial Metrics

IRR - Term	12.0%	Net Present Value	\$3,613,691	Payback Period	6.8 Years
ROI	161.5%	PV Degradation Rate	0.50%	Discount Rate	5.0%
Energy Cost Escalation Rate	3.0%	Federal Income Tax Rate	30.0%	State Income Tax Rate	8.0%
Total Project Costs	\$6,840,288				

#### OTHER SITE CONSIDERATIONS (GLINT/GLARE)

Given the site location, near a federally- obligated airport, special attention must be paid to the glint & glare given off by the array as the sun reflects off the glass surface of the solar panels. (Glint is defined as a momentary flash of bright light, where glare is defined as a continuous source of bright light.)

Under FAA policy (14 CFR Part 77), a solar array **cannot** create **any** ocular impact to the ATCT cab (where the air traffic control operators monitor and control air traffic).

**Method.** Prairie Wind Group, LLC uses an FAA recognized application, Forge Solar, to analyze glint & glare and its impact on the air traffic control tower cab (ATCT) and pilots in final approach at Cleveland Hopkins International Airport.

#### Results and analysis:

- The 3.8MW array creates no ocular impact to the ATCT cab.
- The array does create seasonal glint for pilots in their final approach. Under current FAA policy, some level of glint is permissible during a pilot’s final approach.
- Before construction of the solar field, we recommend a discussion with FAA to review the results of the glare/ glint study, especially the glint impacting pilots on final approach.
- Please see Exhibit V for details of glare/glint study.