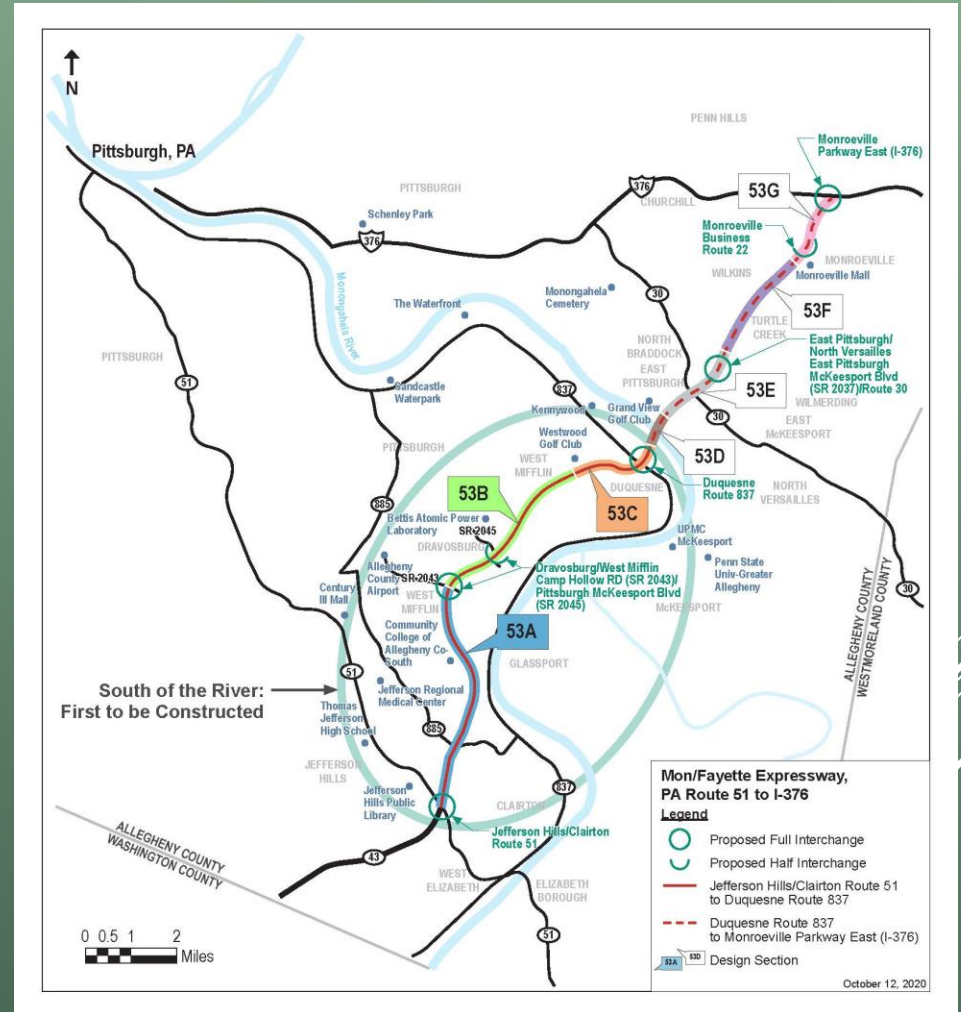


# PENNSYLVANIA TURNPIKE MON-FAYETTE EXPRESSWAY TEST BED

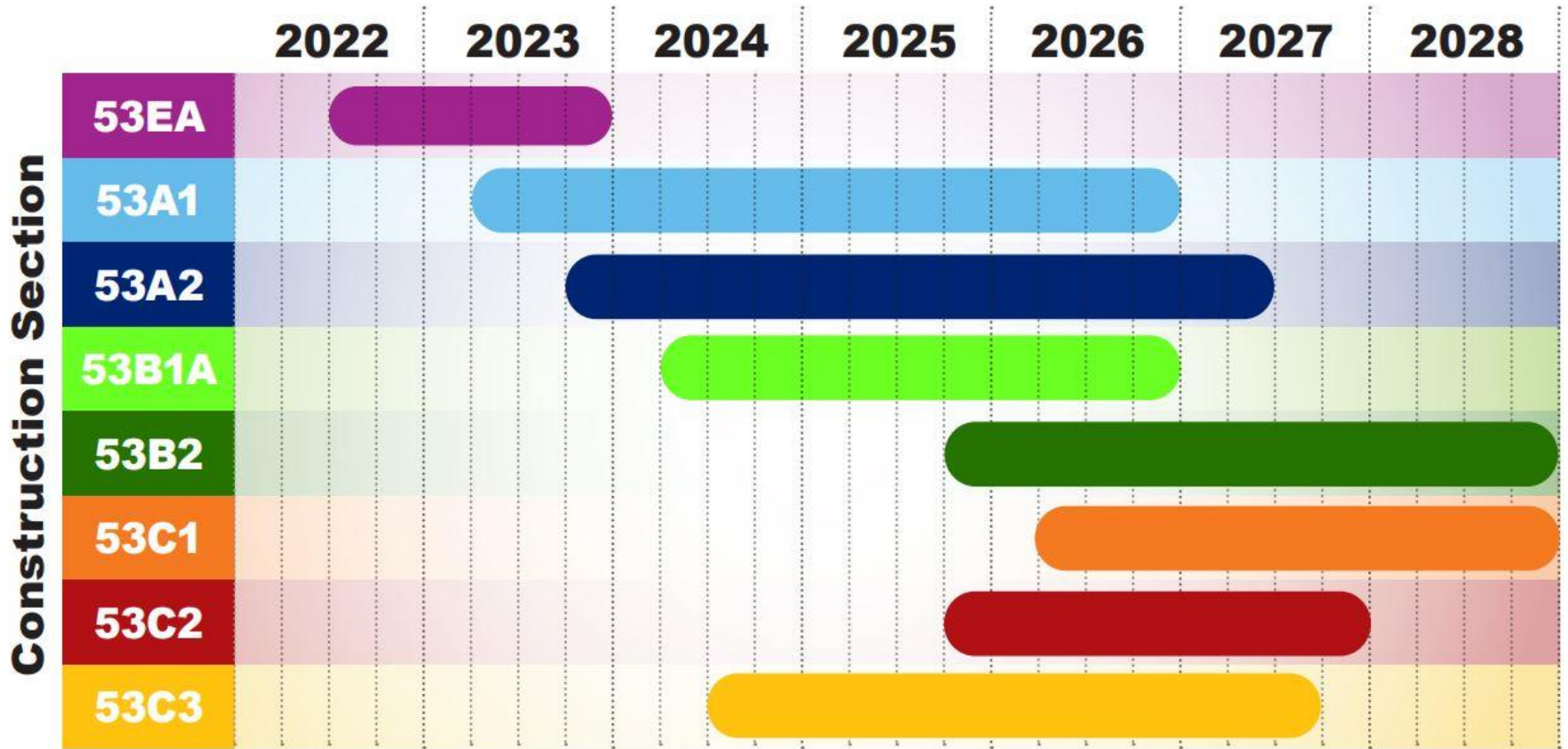


# UPCOMING RESEARCH PROJECTS ON THE MON-FAYETTE EXPRESSWAY

- ❖ Digital Twin
- ❖ Absorptive Noise Walls
- ❖ Energy Harvesting Geogrids
- ❖ Electrified Roadways Strategic Plan



## Estimated Construction Durations



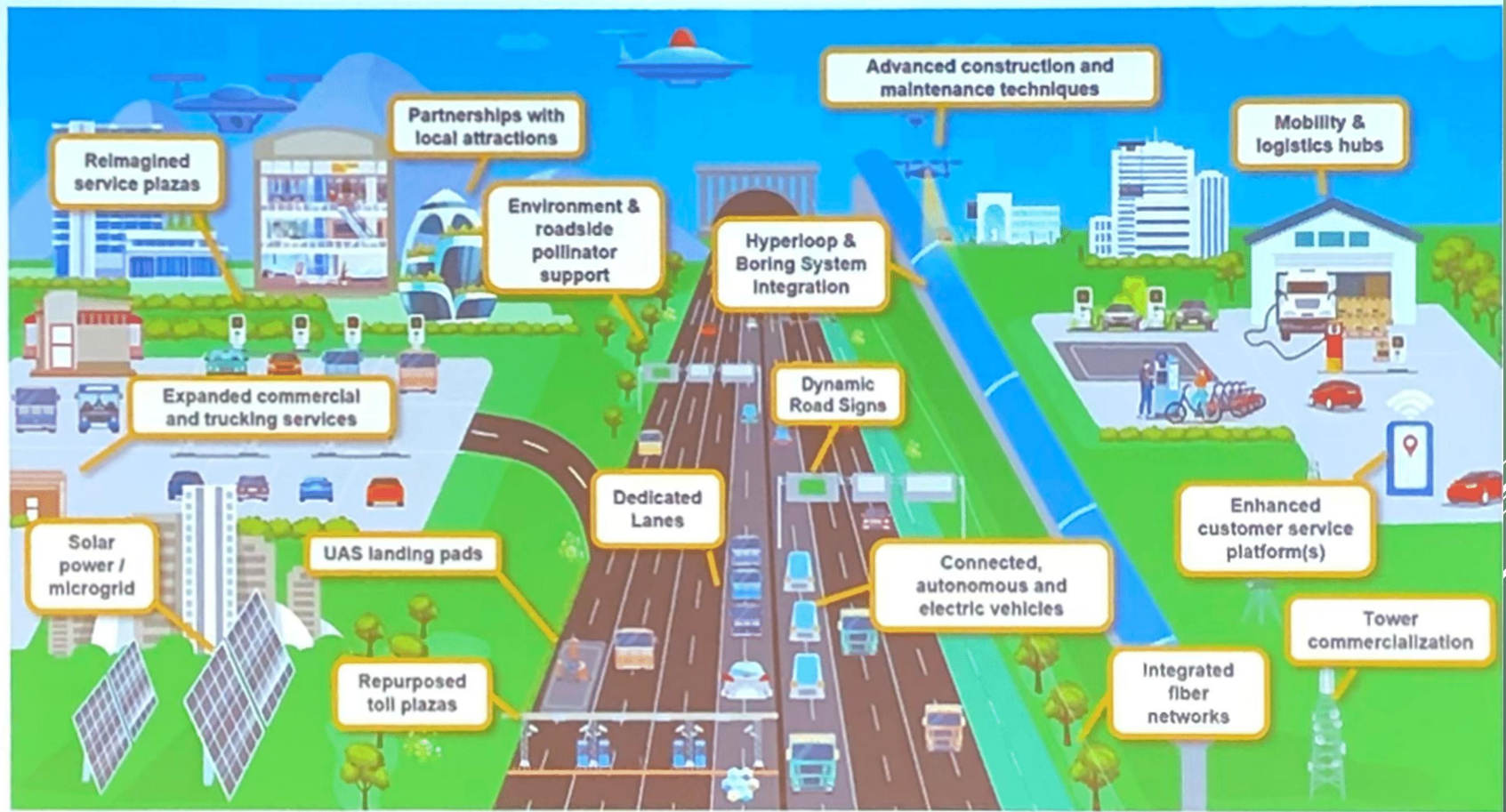
# DIGITAL TWIN



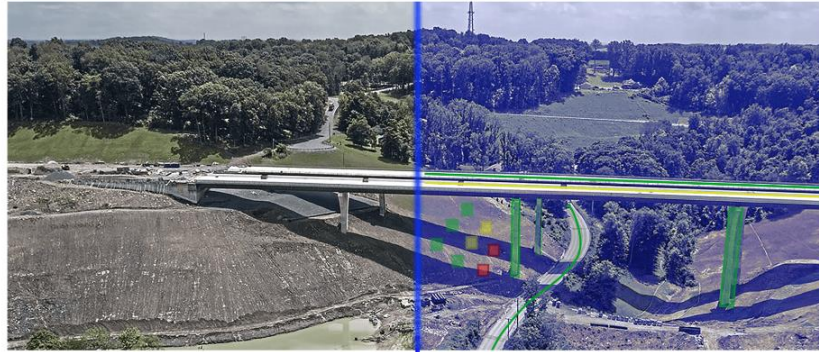
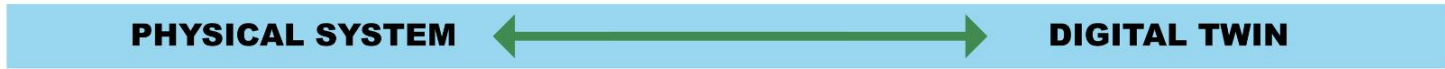


# MOTIVATION

## Reimagining The PA Turnpike



# CAPABILITIES



DIGITALIZE	SENSING		INTEGRATE	MODEL	VISUALIZE
LIDAR & RGB 	PAVEMENTS 	STRUCTURES 	DATA INGESTION & INTEGRATION 	ML-BASED 	OPERATIONAL CONTROL 
PROJECT DIGITAL DELIVERY DATA 	GEOTECH 	WATER 	DATA MANAGEMENT 	PHYSICS-BASED SIMULATION 	AR - VR 



**PITT** SWANSON ENGINEERING



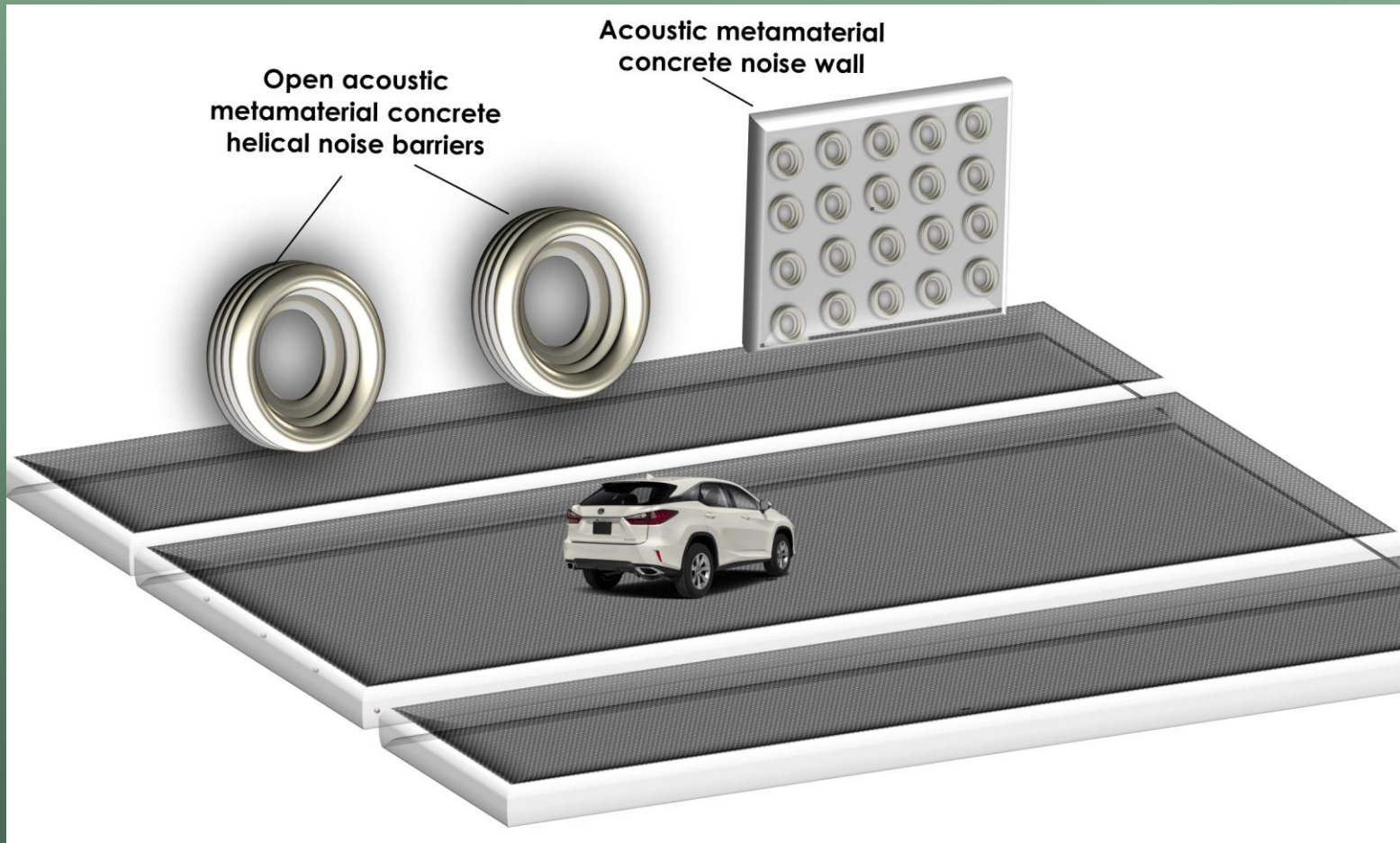


# OVERVIEW OF RESEARCH

- ▶ Digital Twin Model Creation and Development
- ▶ Sensor Installation
- ▶ Data Analysis and Validation
- ▶ Long Term Maintenance



# ABSORPTIVE NOISE WALLS





# MOTIVATION

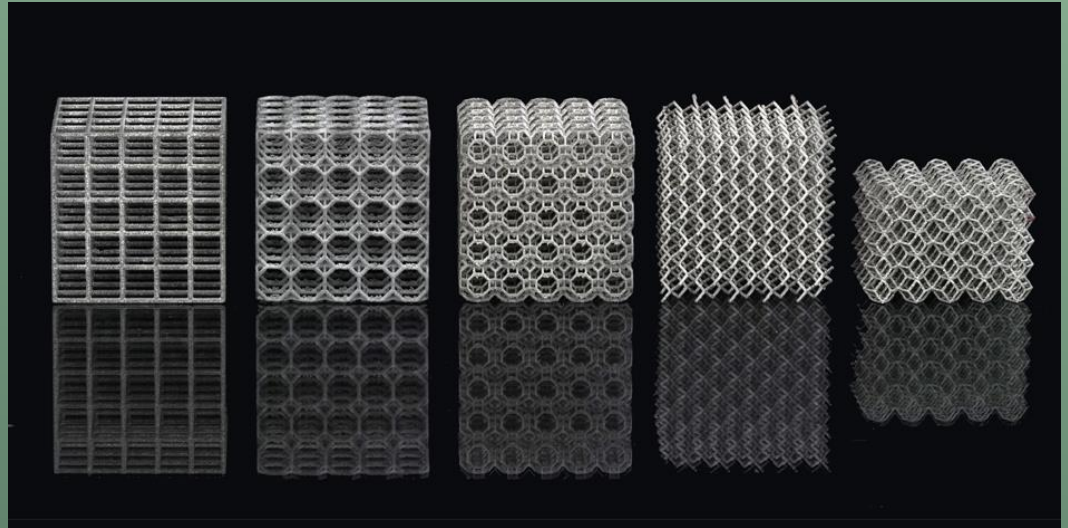
- Nitrogen oxide (NO) and nitrogen dioxide (NO<sub>2</sub>), even in small amounts, can be dangerous to human health
- Vehicles are not only a major source of emissions but also the main contributors to noise pollution
- Can we counter both NO<sub>x</sub> and noise pollution in urban areas?

**Our solution:** A multifunctional sustainable sound barrier with both noise cancellation and NO<sub>x</sub> reducing functionalities

# COMPONENTS OF THE NOISE WALL

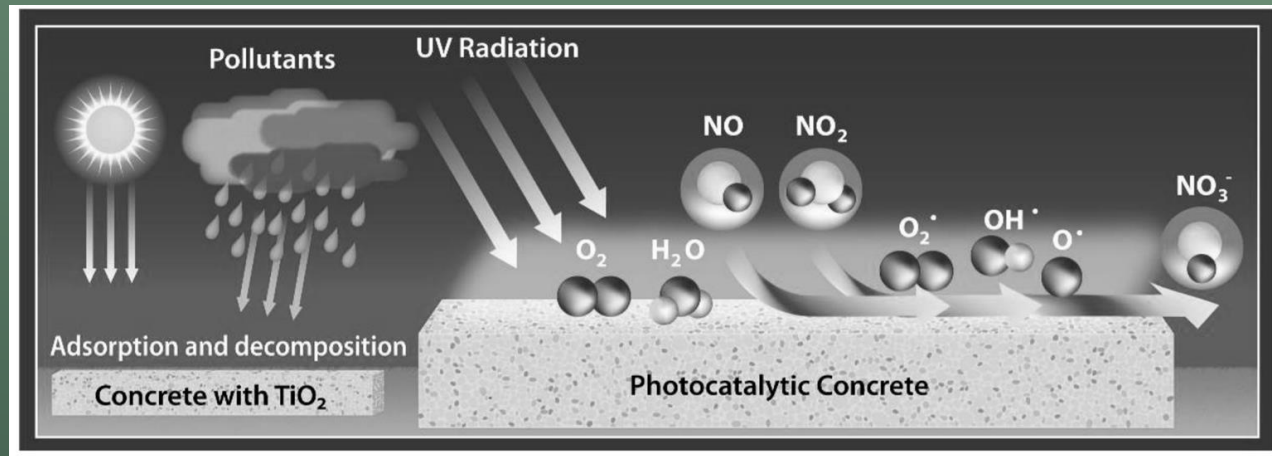
## Acoustic Metamaterial

Acoustic metamaterials are artificial structures that can manipulate the propagation of acoustic waves



## Photocatalysis

TiO<sub>2</sub> coatings on top of mortar or concrete results in a very high reduction in NO<sub>x</sub> concentration

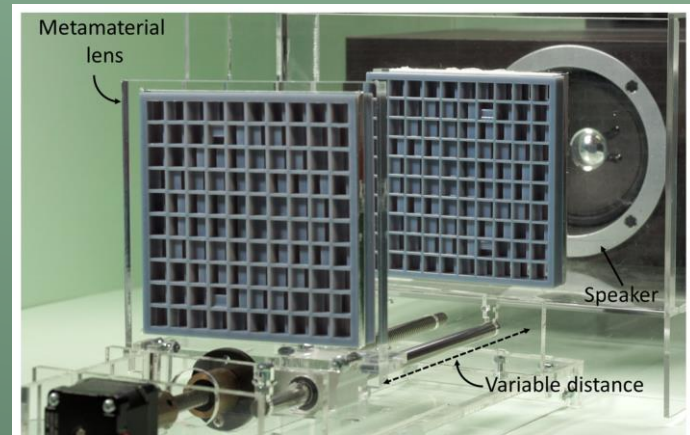


# OVERVIEW OF RESEARCH

**Phase 1:** Investigating various potential designs for the acoustic concrete-based metamaterial wall

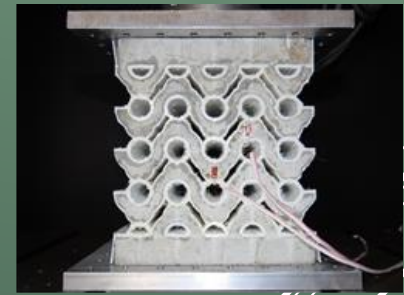
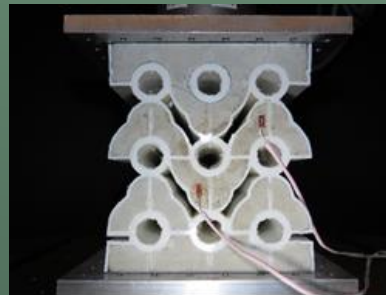
**Phase 2:** Fabricating large-scale prototypes of the optimal design identified at Phase 1

A final design to be deployed for road demonstrations on a designated section of the Mon-Fayette Expressway in an upcoming Phase 3.



Modular metamaterial panel

acoustic

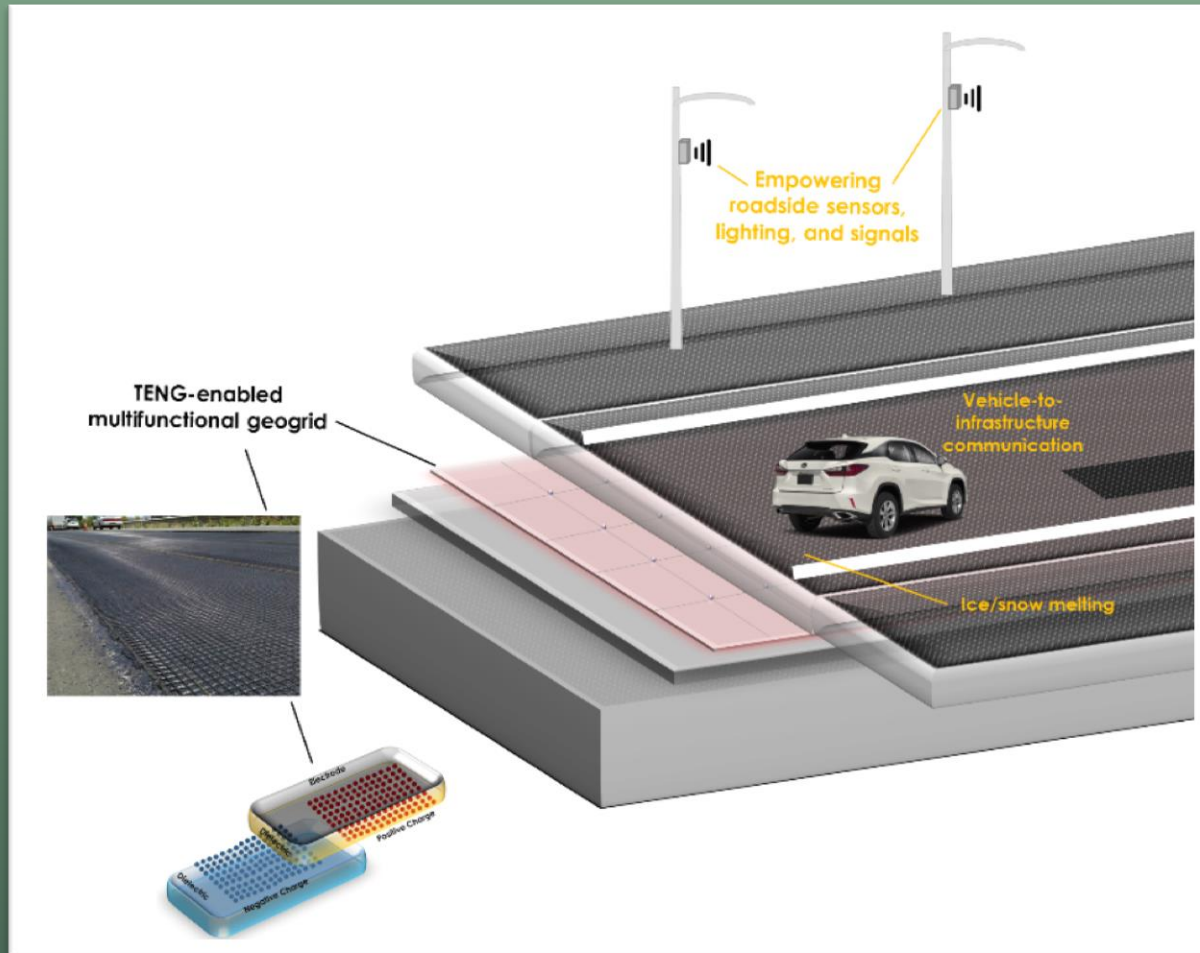


Metamaterial concrete



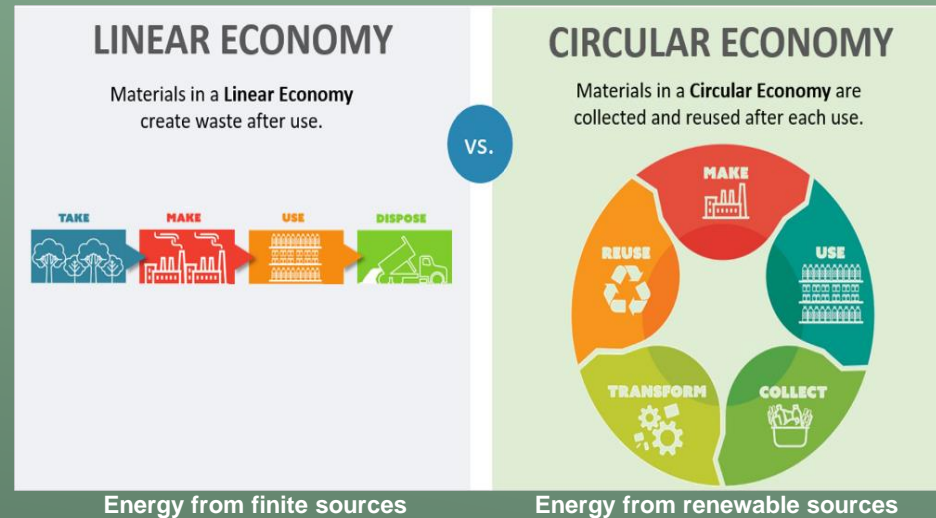


# ENERGY HARVESTING GEOGRID



# MOTIVATION

- Utilize sustainable resources
- Create renewable energy sources
- In the last 70 years, an estimated 6.3 billion tons of plastic has been produced worldwide



**Our solution:** Incorporating innovative, renewable and clean energy harvesting technologies with recyclable materials to improve the sustainability of civil infrastructure systems

# ENERGY HARVESTING GEOGRIDS

- An alternative scalable solution is to use plastic wastes for manufacturing in form of geogrids
- Huesker Group has introduced the world's first asphalt reinforcement geogrid - ecoLine - made from 100% recycled polyethylene terephthalate (PET) yarns



World's first asphalt reinforcement geogrid made from 100% recycled PET by Huesker Group, Germany



# POTENTIAL BENEFITS

1. Energy harvesting for roadside devices with different energy demands ( $\sim 500 \text{ W/m}^2$ )
2. A multifunctional digital pavement system
3. Enhancing pavement performance

Device	Typical Energy Demand
Wireless Sensor Networks	0. 1 $\mu$ W to 200 mW
LED Traffic Signal Bulbs	8-12 W/unit
LED Blinker Traffic Warning Signs (e.g. Tapco BlinkerSign)	77 mW
Passive Infrared Sensor	0.85 mW
Radar Sensor	912 mW

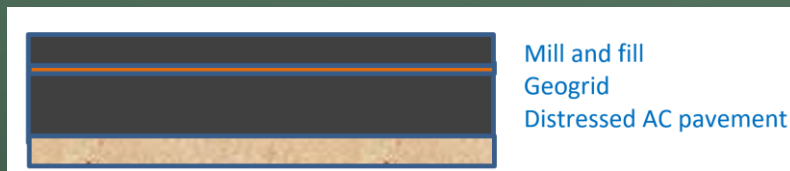
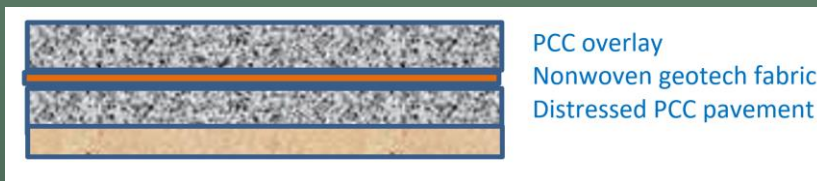
# OVERVIEW OF RESEARCH

## Phase 1:

1. Numerical study and deflection analysis of pavement systems with different pavement designs
2. Creating a suite of designs for the smart TENG geogrids using various types of polyethylene-based materials
3. Experimental study using concrete beams with embedded smart geogrids

## Phase 2:

1. Testing the optimized designed from Phase 1 in a large-scale slab specimen



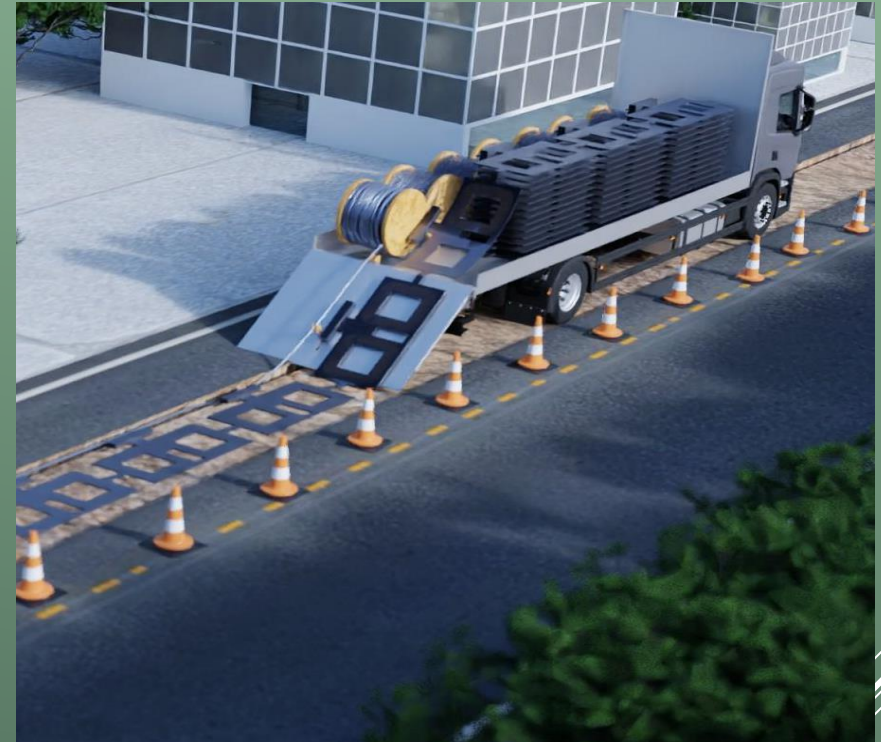
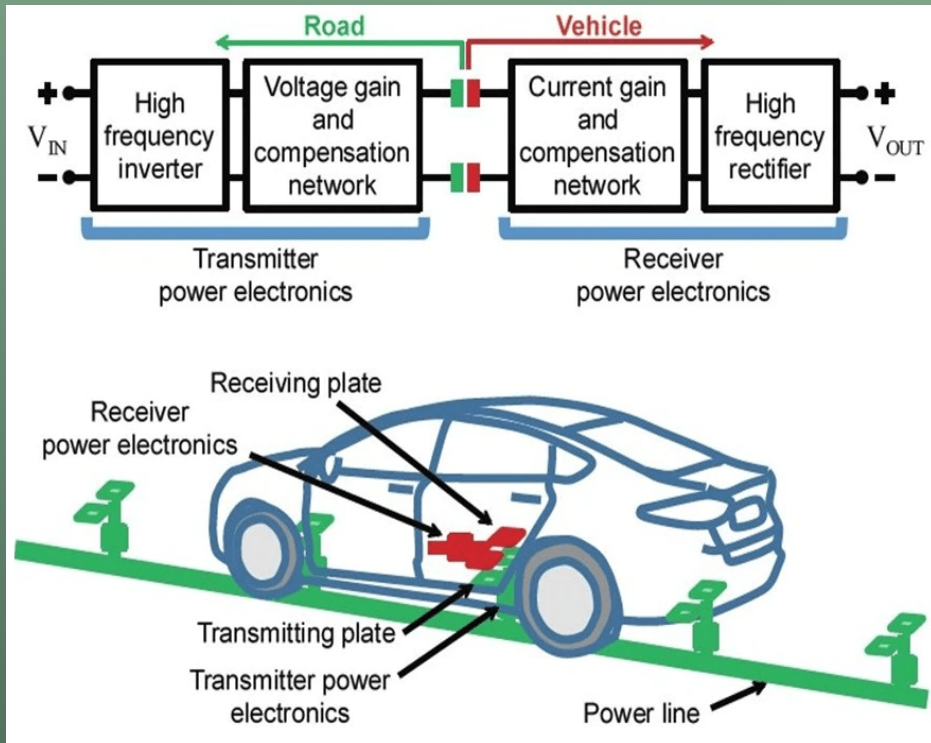
# ELECTRIFIED ROADWAYS



**PITT** | **IRISE**



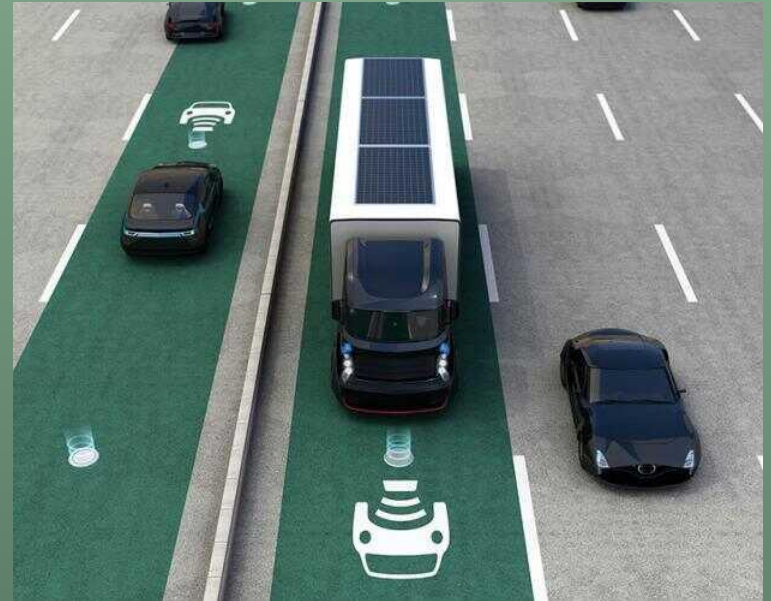




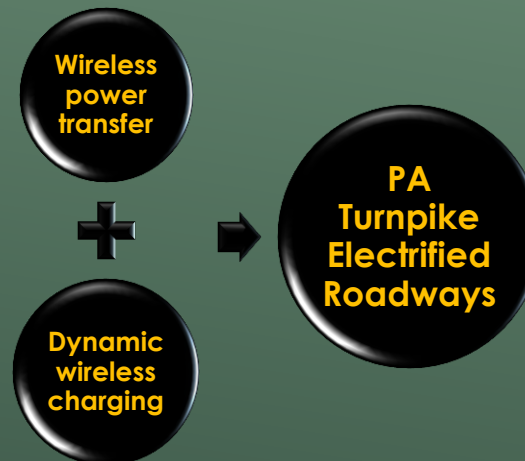
WHAT DOES AN ELECTRIFIED ROADWAY LOOK LIKE?

# MOTIVATION

- Increased sustainability in different modes of transportation
- Increased adoption of EVs
- Required infrastructure and long wait times at charging stations are a customer service concern

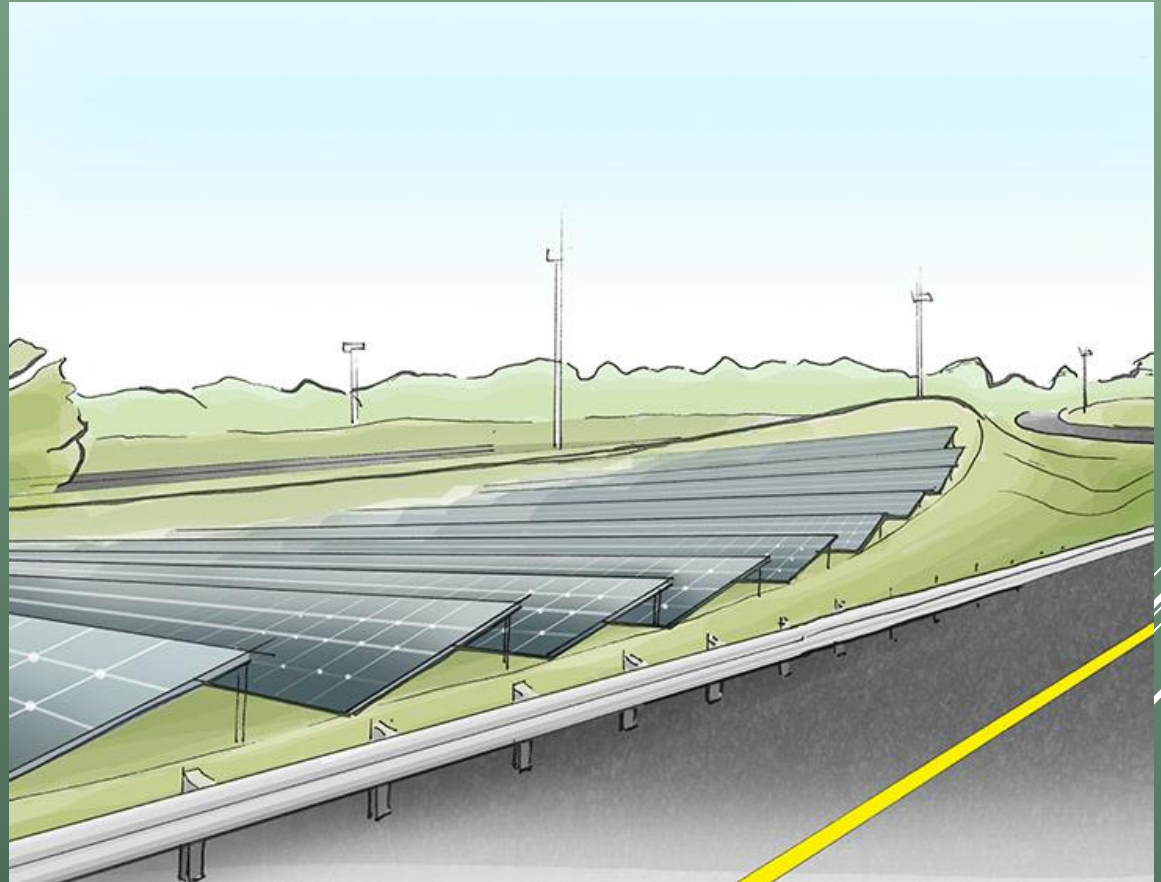


Our solution:



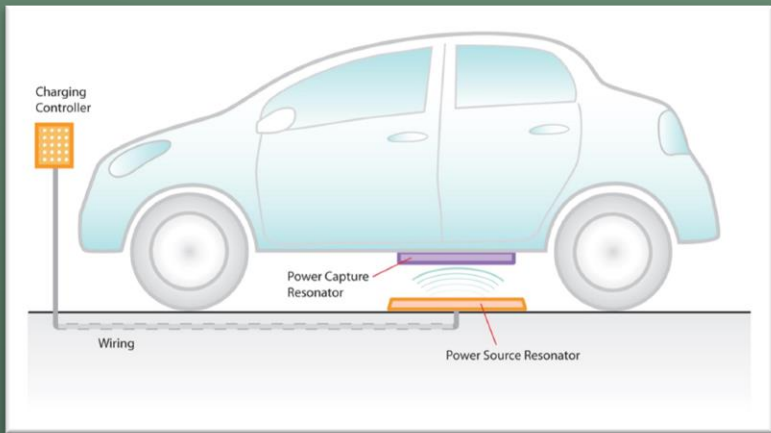
# BUSINESS CASE

- ▶ Additional income from service of charging as well as electric generation
- ▶ Can be done modularly with EV adaption rates
- ▶ Large amount of suitable land for solar





# INDUSTRY PARTNERSHIPS



# DEVELOPING A STRATEGIC PLAN

## Focus areas:

1. Capital Investment.
2. Research and Development.
3. Partnerships
4. Regulation and Policy
5. Operations and Maintenance
6. Strategic Staffing
7. Multimodal
8. Communications





# VISION FOR A SUSTAINABLE ROADWAY 2040



Microgrid/Solar

In-Road Fiber Optic Network

Connected Vehicle Technology

Buried Electric Transmission Lines

Inductive Charging

Silent Wind Plant



- SERVICE PLAZA
- MAINTENANCE FACILITY
- PTC ADMINISTRATIVE BUILDING
- EXIT
- ROADWAY
- MICROGRID/SOLAR
- IN-ROAD FIBER NETWORK
- CONNECTED VEHICLE TECHNOLOGY
- BURIED ELECTRIC TRANSMISSION LINES
- INDUCTIVE CHARGING
- SILENT WIND PLANT





QUESTIONS?