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<tr><td colspan="4">Request for Research Funding for FY 2022-2023</td></tr>
<tr><td colspan="4">SPR Subpart B Project: TEO-23-15</td></tr>
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<tr><td>Proposed Title</td><td colspan="3">Wireless Power Transfer (WPT) Technology Testing and Understand the Impact on Roadway Materials</td></tr>
<tr><td>Justification</td><td colspan="3">
As electric vehicle (EV) adoption increases, so does the need for charging infrastructure. Different types of charging technologies are available to address multiple use cases. Currently, there are multiple mature and widely deployed wired charging technologies. Wireless power transfer (WPT) as a method to recharge EVs has been a focal point of research and development and is an emerging technology. There are three types of WPT systems:

“Static” WPT is installed in a parking space and charges the vehicle only while parked.
“Quasi-dynamic” WPT is a natural extension of static technology in which vehicles are charged while they are stopped, but not necessarily parked. This can include applications such as charging at a stop-light or taxi charging while waiting in a queue.
“Dynamic” WPT (DWPT) takes this concept even farther and provides power to the vehicle while it is travelling down the road. Fully dynamic WPT has the potential to infinitely extend the useable range of EVs.

Installing the coils and other equipment associated with the WPT systems may impact the pavement structure and performance of pavement materials over a length of time. This project is intended to test the impact of both WPT coils and pavement materials on each other. The State Materials Office (SMO) testing facility would provide a suitable location for testing of interaction between roadways surfaces/materials and WPT components, and the maintenance operations for both. The installed WPT system on the SMO facility could also be used for testing and piloting both static and low-speed quasi-dynamic WPT use cases.
Project Objectives:
Objective 1: Installation and Maintenance Testing of Static and Quasi-dynamic WPT Systems
There is not much information currently available on the impact of installing and maintaining WPT infrastructure within roadways. The impacts of this installation go both ways, with impacts to the roadway surface from WPT installation and operation as well as to the WPT system from roadway installation and maintenance. The controlled nature of the SMO facility could provide a testbed for performing various maintenance operations on both the WPT system and the roadway, measuring the impacts that these operations have on roadway characteristics and WPT system performance.

Install WPT coils in various types of roadway surfaces including concrete and asphalt, with a variety of aggregate mixtures that could be found in different locations within Florida for typical roadways
Measure the material characteristics with and without WPT hardware immediately after installation/construction. This will allow a comparison of the impact WPT coils have on different roadway materials, including:

Material strength (e.g., resistance to cracking)
Material hardness/density (e.g., resistance to rutting)
Material surface roughness (e.g., international roughness index)

Measure the material characteristics after operating WPT systems for an extended period under full power. This will identify any changes to different material properties that are caused by the operation of the WPT system (e.g., the strong magnetic field), and identify which materials are most and least affected by WPT systems. Characteristics to measure include:

Impact on material strength
Impact on material hardness/density
Impact on surface roughness

Operate WPT systems in various roadway materials and measure the following parameters to identify which are best suited for use in WPT applications:

Impact on system tuning parameters (i.e., coil inductance)
Efficiency of the coils and losses into material
Impact on coupling coefficient to the secondary coil (caused by geometric/shape changes)

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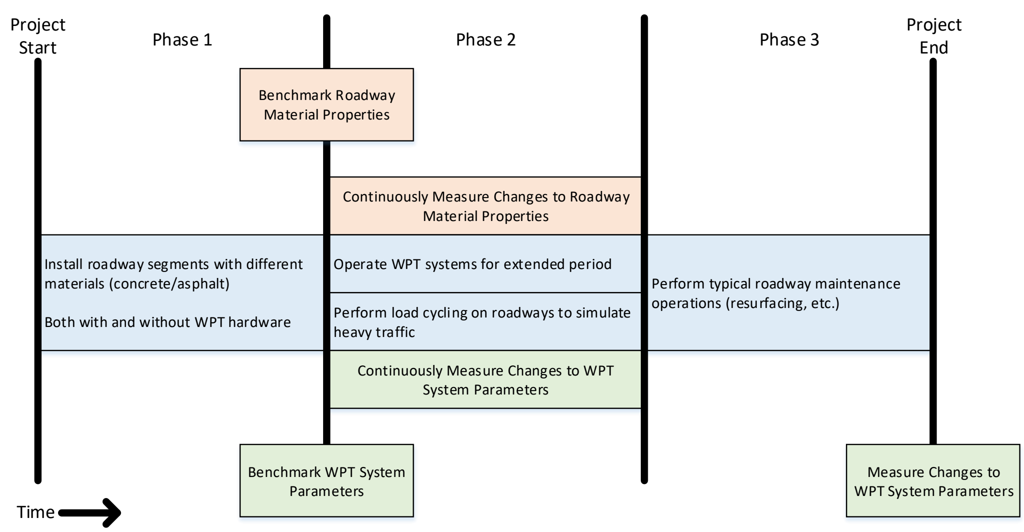
- Measure system parameters after operating WPT systems for an extended period under full power. This will identify any changes to the material caused by the presence of a WPT system and the operation of the WPT system itself. Characteristics to measure include:
  - Impact on system tuning parameters (i.e., coil inductance)
  - Efficiency of the coils and losses into material
  - Impact on coupling coefficient to the secondary coil (caused by geometric/shape changes)
- Perform load cycling on the roadway cycle (e.g., simulate years of heavy vehicle traffic) and then measure the impact this has on WPT system parameters including:
  - Impact on system tuning parameters (i.e., coil inductance)
  - Efficiency of the coils and losses into material
  - Impact on coupling coefficient to the secondary coil (caused by geometric/shape changes)
- Perform the relevant types of maintenance operations on the different roadway materials. Following these maintenance activities, measure the WPT system parameters to see how they were impacted. Maintenance operations may include:
  - Milling and overlay (e.g., replace top two inches of surface)
  - Hot-in-place recycling
  - Application of seal coating
  - Application of asphalt rejuvenator
  - Sealing cracks with hot rubberized bitumen sealant

  WPT system parameters to monitor include:
  - Impact on system tuning parameters (i.e., coil inductance)
  - Efficiency of the coils and losses into material
  - Impact on coupling coefficient to the secondary coil (caused by geometric/shape changes)
- Other information will also be gained relating to the process of installing WPT systems into roadways, including:
  - Identifying the best construction methods
  - Proving out the technical feasibility of the WPT technology
  - Identifying installation pitfalls, unexpected costs, and other deployment difficulties
  - Determining feasible layout(s) for WPT equipment along roadway



Objective 2: Static WPT Testing

Static WPT is a more mature technology that can be deployed at locations with very limited space. A static WPT pilot project at the SMO facility would provide for the opportunity to become familiar with and test the technology. A vehicle or a small fleet of vehicles (2~3) would be identified that could be electrified and equipped with WPT charging equipment. The ground side infrastructure could either be installed in the general parking area or in a dedicated WPT testing space. Ideally the fleet would consist of multiple vehicle types so that interoperability could be tested (e.g., sedans and trucks).

	Testing Objectives: • Gauge user acceptance and ease of use for the technology • Identify up-time, reliability, and effectiveness of the WPT charging technology • Test interoperability of a common ground side charging infrastructure with multiple vehicle types including cars and trucks **Objective 3: Quasi-Dynamic WPT Testing** Quasi-dynamic WPT charges vehicles when they are stopped for a brief period but not parked. The equipped vehicle(s) could be moved through the queue stopping at each charging location for a short time, and many aspects of charging could be tested through this process. **Testing Objectives:** • Measure the amount of energy vs. stopped time at each queue location • Determine positional accuracy requirements for charging • Identify difficulty aligning vehicle and stopping in correct locations • Test multiple positional feedback systems, including paint/striping, lights, dashboard displays, audible alerts, etc. • Identify ideal spacing between charging pads to maximize queue capacity while also supporting easy vehicle positioning and alignment The project will include the following tasks: **Task 1:** Task 1 will be focused on the project development and following sub-tasks. • Literature review of various WPT systems • Stakeholder coordination • Industry maturity and capability review **Task 2:** Task 2 will be focused on test plan development and stakeholder coordination to implement the project. • Develop test plan for testing at State's Material Office facility. • Coordinate with the SMO for testing within the Accelerated Pavement Test facility or other facility. • Outline the test requirements • Coordinate with SMO to understand the availability and characteristics of the test beds • Coordinate with vehicle OEM and WPT system providers and other stakeholders involved in the project **Task 3:** Task 3 will be focused on actual testing. • Conduct testing in coordination with all stakeholders and follow the procedure outlined in the test plan • Validate the test requirements **Task 4:** Distribute test outcomes with the stakeholders • Document test outcomes and share with the FDOT and other identified partners • Develop and deliver presentation to the stakeholders **Task 5:** Mainstreaming Recommendation • The research team will develop a set of recommendations for mainstreaming WPT systems for various modes of transportation • The research team will develop a draft policy for the state agencies to prioritize corridors for facilities for WPT implementation with timeline.
Impact	The project will help FDOT understand the impact of WPT coils that are embedded within the pavement on the pavement mainstream and pavement materials. The project will also test static and quasi-dynamic WPT technologies at the SMO testing facility.
Affected Offices	State Materials Office and State Traffic Engineering and Operations Office
Existing Work	WPT research exist on various topics. However, there is no research done to study the impact of WPT infrastructure and devices embedded within the pavement on the performance of pavement materials.

Keywords Used In Existing Work Search	Wireless Power Transfer, Pavement, Performance		
Related Contracts (Give contract numbers)	N/A		
Funding Request	**Total Cost: $450,000**	**Anticipated Duration**	18-24 months
Project Manager	PM: Tim Ruelke, PE Co-PM: Edith Wong, PE	**Contracting Method**	Anticipated procurement method (e.g., supplement to existing project, RFP to all registered vendors, direct contract with university)
Equipment	**Equipment and Installation Cost:** Objective 1: Grid Side Electronics – $10K Grid Side Coils – $25K Vehicle System – $5K Objective 2: Grid Side System – $10K Vehicle Systems – $10K Objective 3: Grid Side Systems – $20K Vehicle System – $5K	Objective 1: A single grid side electronics system could be swapped between multiple grid side coils to limit the infrastructure requirements of this testing. Multiple grid side coils would be needed so that multiple materials could be tested simultaneously. Objective 2: Estimated equipment needs are a single ground system and two vehicle systems. Objective 3: Estimated equipment needs are two ground systems and a single vehicle system.	
Urgency	1	The need for charging infrastructure will become critical as the ownership of electric vehicles increases. This research will lay the groundwork that will be need for future implementation of wireless electric vehicle charging technologies within the public roadway network to support electric vehicle penetration.	
Implementability	1	This project will implement the WPT system on the roadside and vehicle side and conduct testing. This an implementation only project with evaluation component included in it.	

Project Benefits (Succinct, complete explanation)

EV charging technologies have taken off as more mandates emerge to make the vehicles environmentally more sustainable. WPT systems can help convert to more environmentally friendly vehicles by providing the needed power wirelessly as the vehicles sit idle, or stop for a while, or drive on a segment of roadway equipped with WPT systems. As this technology holds promise to be widely deployed, the impact of the equipment on the pavement materials needs to be carefully studied to understand the impacts. The project findings will help FDOT to understand the interactions between embedded WPT coils and pavement materials.

Project Benefits **(Select all that apply and explain)**	**Quantifiable Benefits (units, dollars, etc…if applicable)**	**Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits**
○ Materials Enhancement	Determine the impact of WPT equipment on pavement performance and maintenance	Ground assembly data, data from pavement monitoring systems
○ Materials Savings	NA	
○ Time Savings	NA	

○ Lives Saved/Injuries Prevented	NA	
○ Other (Explain)	NA	

*Comments should explain and support urgency, financial benefit, and implementability scores