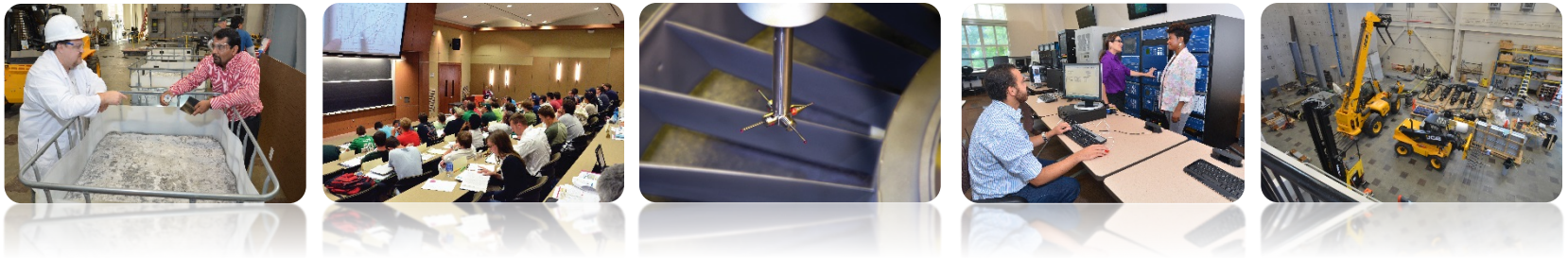

Solutions for Curbside-Charging Electric Vehicles for Planned Urban Growth

UNC CHARLOTTE
Energy Production and Infrastructure Center

PI & Presenter: Professor Robert Cox

DE-EE008472 | TI091

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Overview

Timeline

- Project start date: 10/1/18
- Project end date: 12/31/21
- ~45% complete

Budget

- Total project funding:
  - DOE share: $942,757.00
  - Cost share: $942,757.00
- Budget Period 1:
  - DOE share: $426,181
  - Cost share: $569,190
- Budget Period 2:
  - DOE share: $354,380
  - Cost share: $223,817
- Budget Period 3:
  - DOE share: $162,196
  - Cost share: $149,750
- Expended (as of 3/31/2020):
  - DOE share: $315,030.24
  - Recipient share: $288,040.07

Barriers Addressed

- ~90% of charging expected to occur at home; only about 50% of vehicles have access to dedicated off-street parking
- Installing dedicated curbside EVSEs can be challenging, both in terms of cost and access
- Limited understanding of the ability to integrate EVSEs into existing street light infrastructure

Partners

UNC CHARLOTTE
Energy Production and Infrastructure Center

CCOG
Centralina Council of Governments

EATON

DUKE ENERGY

Project Objectives

Project Objectives

- Develop, deploy, and test a protype EVSE that can be retrofit into existing streetlight infrastructure
  - Prototype includes hardware, software, enclosure, and integration
- Understand the market need for such retrofit EVSEs
- Document the challenges associated with installing retrofit EVSEs into streetlights:
  - Technical (i.e. control, power, etc.)
  - Policy (i.e. permitting, right-of-way, etc.)

Impact on Addressing Barriers

- Detailed study of existing streetlight infrastructure in the Charlotte metro region
  - How scalable is the solution, technically?
- Comparing policy issues associated with retrofit solution vs. dedicated EVSE
  - Does the solution streamline implementation?
- Developing a commercialization-ready EVSE to address market need

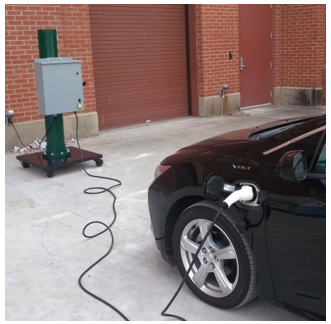
VTO TI Goals Addressed

- Success means:
  - Greater use of domestic electricity for fuel **(National security)**
  - EVSE products made in the USA **(Economic growth)**
  - Lower cost/more accessible charging solutions **(Affordability for business and consumers)**
  - Greater access to diverse fuel set **(Reliability/resiliency)**

Project Approach: Task Development

Prototype Development

- Hardware
  - Enclosure design
  - Cable management
  - Attachment
- Software
  - Development
  - Testing
- Integration & testing



Community Engagement

- Secure partnership for pilot
- Manage permitting & related issues
- Engage community stakeholders & users

Techno-Economic Analysis

- Understand market potential
- Understand technical integration issues:
  - Power-system impacts
  - Streetlamp integration issues

Project Approach: Prototype Development Tasks

Technical development has four phases:

Prototype Engineering (Task 1)

Development of basic requirements & specifications

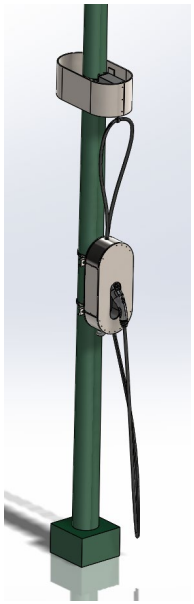
Off-Grid Development and Testing (Task 4)

Source: Power supplies
Load: EV Simulators
Location: Lab (UNCC)

On-Grid Development and Testing (Task 5)

Source: Direct-to-grid
Load: Real EV
Location: Lab (Duke)

Field Test Deployment and Evaluation (Tasks 6 & 7)



Publicly available charging

Project Approach: Timeline

2019				2020				2021			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 1: Prototype Engineering											
Task 2: Community Engagement & Pilot Site Determination											
Task 3: Techno-economic analysis of market uptake & infrastructure needs											
			Task 4: Off-Grid Development								
					Task 5: On-Grid Development						
					Task 6: Field Test Deployment						
								Task 7: Field Testing and Evaluation			
									Task 8: Commercialization		

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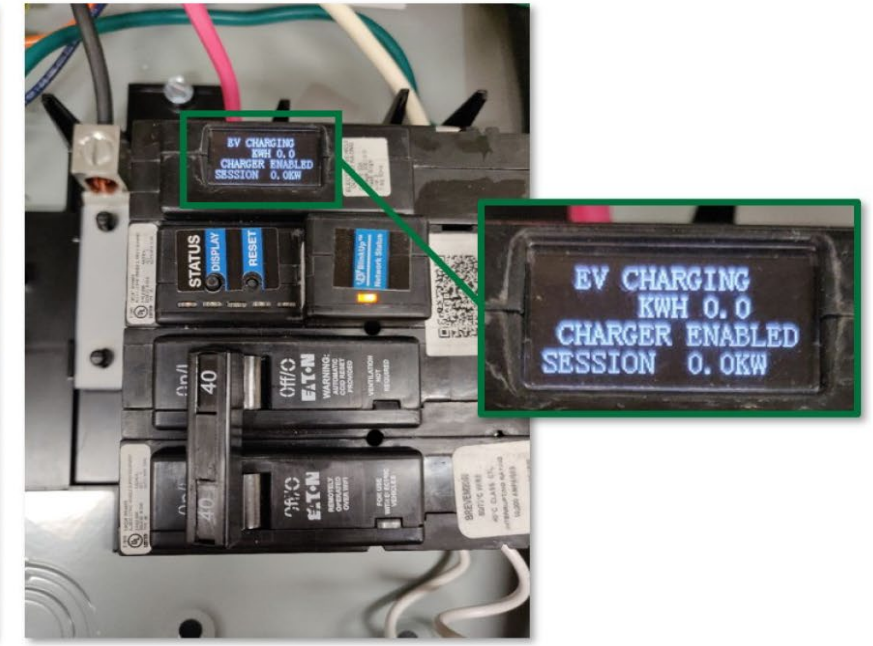
Project Approach: Milestones

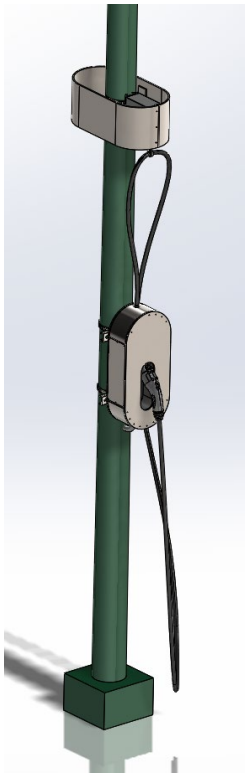
Milestone	Description	Type	Target Date	Status
Prototype Engineering	Design specs & requirements	Technical	7/19	Complete
Prototype Engineering	Detailed design package	Technical	9/19	Complete
Techno-economic analysis	Report on market potential	Technical	12/19	Complete
Community	Selection of field demo partners	Go/No-Go	12/19	Complete
Off-Grid development	Complete laboratory testing	Technical	4/20	Complete
Field test deployment	Complete final site design	Technical	8/20	In-progress
Field test deployment	Complete commissioning of field demo	Technical	12/20	Not started
On-grid development	Complete testing at Duke Energy Mt. Holly	Technical	10/20	Not started
Cost-effectiveness determination	Determine cost-effectiveness of solution	Go/No-Go	10/20	In-progress
Field test launch	Field test initiated	Technical	1/21	Not started
Commercialization strategy	Determination of likely manufacturer and strategy	Technical	11/21	In-progress
Field test effectiveness	Field test evaluated	Go/No-Go	12/21	Not started

Project Approach: Enabling Technology

- The key enabling technology is the Energy Management Circuit Breaker (EMCB) from Eaton
- Breaker occupies 4 positions in a standard cabinet
- Key features
  - Solid-state disconnect
  - WiFi addressable
  - Provides full monitoring and control
- Two versions of the breaker to be on the market:
  - EMCB: Simple breaker
  - EMCB-EV: Includes additional Level 2 EVSE feature set
- Metering accuracy greater than required for utility-grade metering



Project Accomplishments: System Specifications & Design



Current
Beta
Prototype

- Fundamental hardware requirements:
  - Level 2 EVSE
  - Cellular network connectivity
  - NEMA 3R rating
- Requires electrical meter in standalone form
- Minimal footprint
- Cable management system required on pole in most cases
- Accessibility via smart phone using mobile web

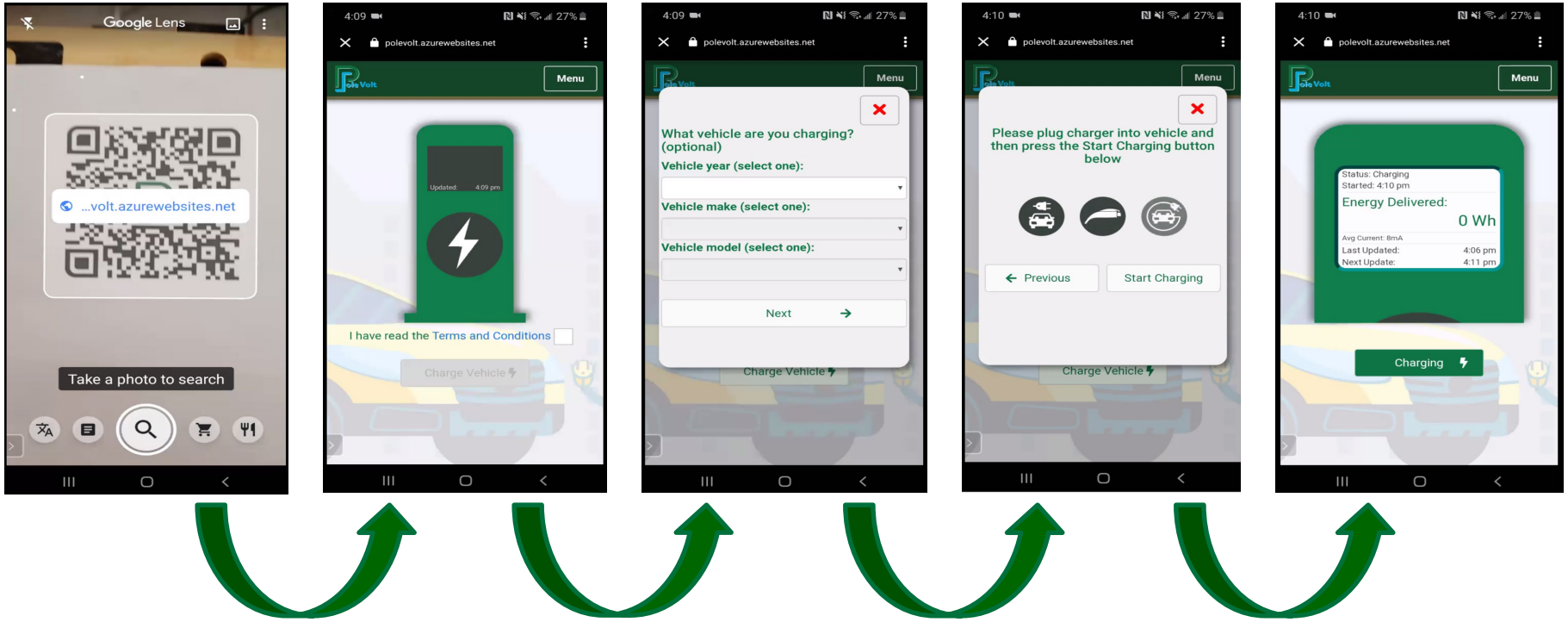
EMCB is essentially an IoT device!

Project Accomplishments: Demonstration and Deployment

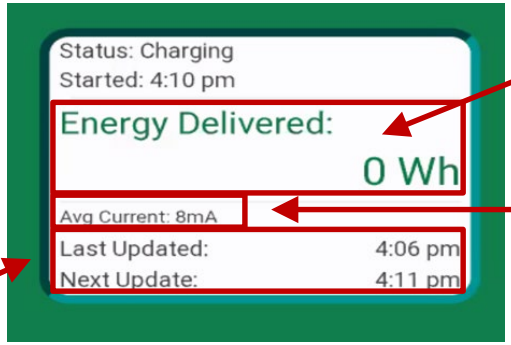
Alpha Prototype

- EMCB-EV not commercially ready until end of 2020
- Prototype stages:
  - *Alpha Prototype*: Uses EMCB & standalone Level 2 EMCB
    - Complete: Deploy 2 units on UNC Charlotte campus for public use in May 2020
  - *Beta Prototype*: Uses EMCB-EV
    - In-Progress: Deploy up to 3 units for public use in City of Charlotte in late 2020/early 2021
    - Working on cable attachment at Duke Mt. Holly
  - *Final Design:*
    - Working with Eaton to develop licensing agreement
    - UNCC to provide design files for manufacture at US-based facility
- ***Original SOPO: Deploy 1 unit in the field***

Project Accomplishments: Prototype Demonstration



- Use of cloud-based infrastructure provides new user experience
- Solution is useful for retrofitting control into existing EVSEs



Energy delivered

Current demand

Update information

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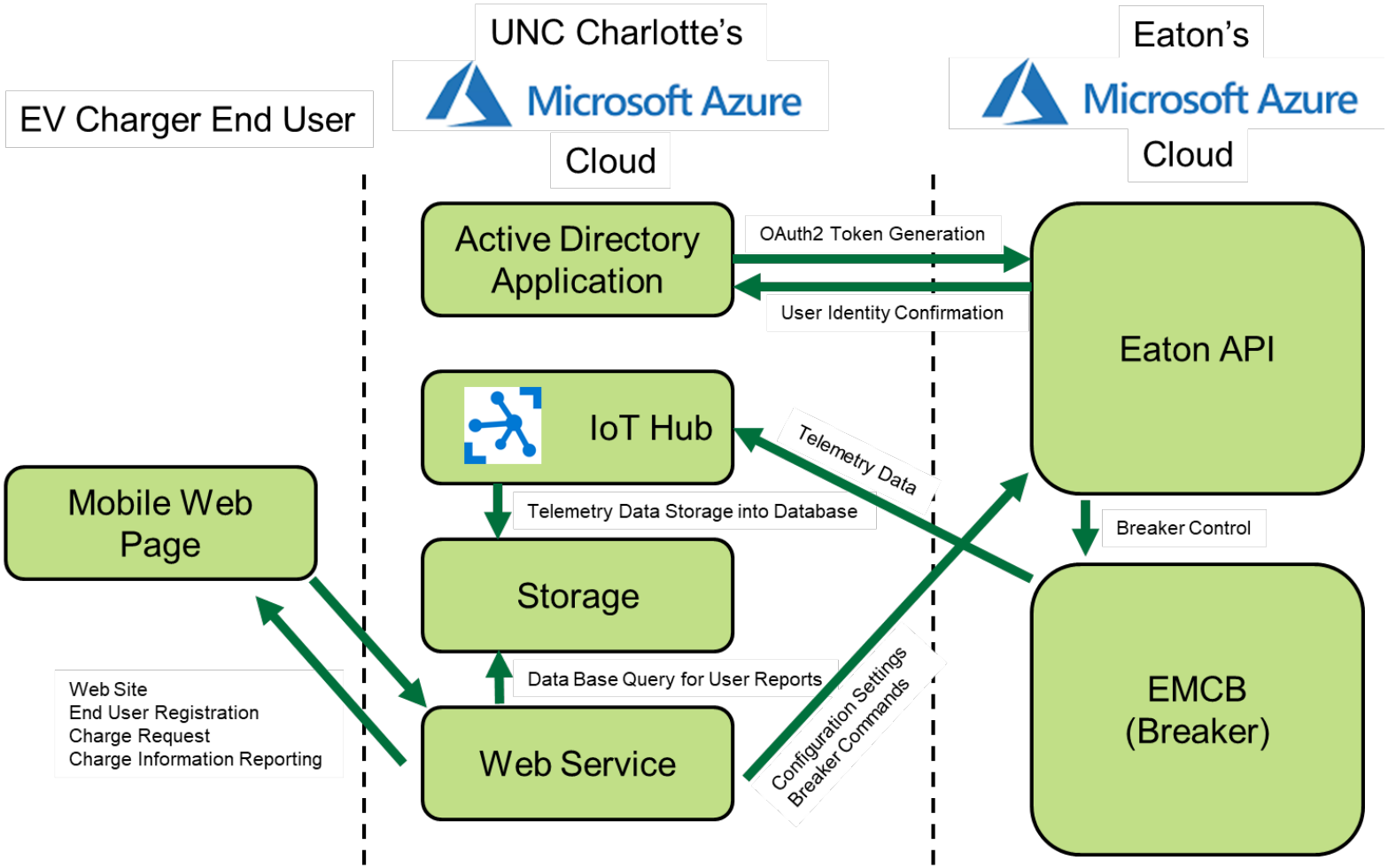
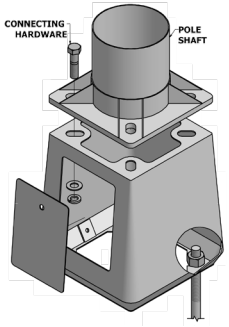
Project Accomplishments: Communications Infrastructure



Solution leverages cloud technology, which poses new challenges for implementation

Project Accomplishments: Understanding Infrastructure



Transformer Base

Anchor-Base Support

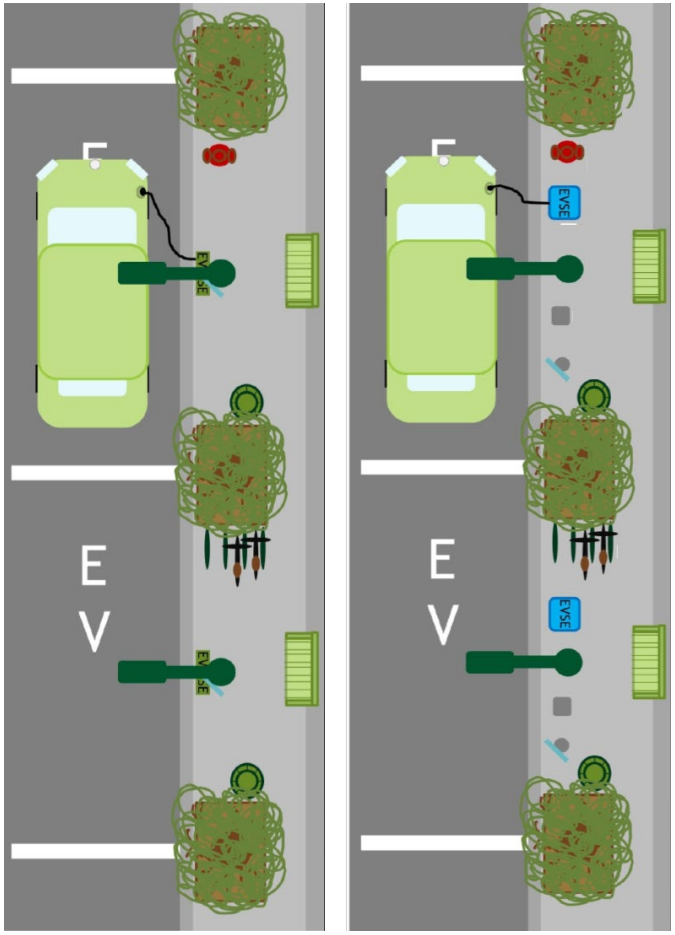
Direct-Buried Support

Overhead Poles

- Extreme diversity in terms of available technical infrastructure.
- Key technical questions:
  - How are existing lighting circuits controlled?
  - What is the voltage of the source feeding the pole?
  - Is there space existing in the underground conduit?
  - Is there spare capacity to support Level 2 EVSE charging, and how much?
  - Can power be provided to unit without replacing the pole?
- Four basic types of poles exist:
  - Wooden poles with overhead circuits are the utility's preferred solution
- Developed comprehensive review paper on charging needs in dense urban environments
- Developing a rubric for site evaluation

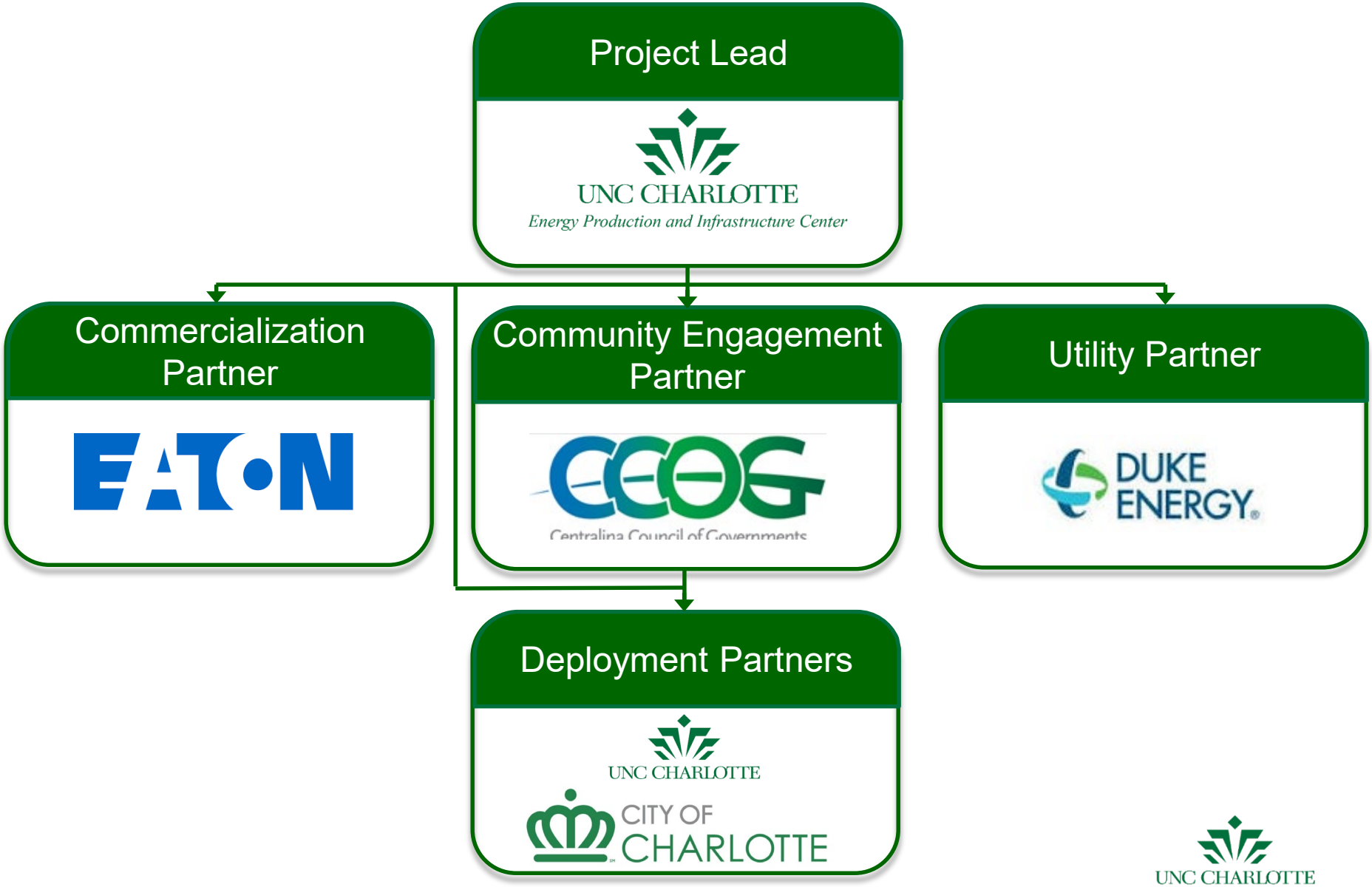
Project Accomplishments: Understanding Infrastructure

- Numerous questions exist on policy/community needs:
  - Desired cable management approach
  - Encroachment into right-of-way
  - Permitting process
  - ADA accessibility
  - Signage
- Longer term questions related to Smart City goals
  - Curbside interface and access
  - Business models for EVSE integration and ownership
- Team is engaging with City of Charlotte and Clean Cities Coalition to document



Clean Cities

Collaboration and Coordination



Collaboration and Communication: Roles and Responsibilities

- Project lead (UNC Charlotte)
  - Overall coordination and project management
  - Leading prototype development for hardware and software
  - Coordinating with CCOG, UNCC, and City on deployment
  - Funding: Receiving federal share and providing cost share
- Community outreach (CCOG)
  - Coordinating with the City of Charlotte for deployment issues and marketing
  - Funding: Receiving federal share and providing cost share
- Commercialization partner (Eaton)
  - Supporting UNC Charlotte with commercialization effort & station design
  - Funding: Providing cost share
- Utility partner (Duke Energy)
  - Supporting UNC Charlotte with:
    - Testing services
    - Deployment assistance
    - Understanding street lighting infrastructure
    - System evaluation
  - Funding: Providing cost share
- Deployment partners (UNC Charlotte & City of Charlotte)
  - Pilot site hosts
  - No direct funding
- Communications:
  - Quarterly calls with UNC Charlotte, CCOG, Eaton, and Duke Energy
  - Bi-weekly calls with UNC Charlotte and CCOG
  - Separate bi-weekly calls with UNC Charlotte/Duke and UNC Charlotte/Eaton

Overall Market Impact

- Project directly addresses the need to investigate cost-effective charging station deployment in dense urban and multi-family areas
- Accomplishments to date:
  - Developed and field-deployed alpha prototype units on UNC Charlotte campus
  - Developed alpha version of smart-phone interface
  - Developed report on available literature and studies on needs and costs for urban charging infrastructure
- Upcoming/In Progress:
  - Completing beta prototype development and testing at Duke Energy Mt. Holly Laboratory
  - Reviewing numerous potential locations for installation and documenting technical integration process
  - Thoroughly documenting policy / permitting issues
  - Deployment at up to 3 pilot locations throughout the City of Charlotte with test data for up to one year
- Sustainability:
  - UNC Charlotte and Eaton working on commercialization agreement for EVSEs
  - Eaton directly supporting UNC Charlotte team with industrial design expertise
  - UNC Charlotte to provide Eaton with manufacturing-ready design
  - Commercial deployment in 2021 for parking lots

Summary

Goals

- Develop, deploy, and test a low-cost EVSE solution for retrofit deployment into existing street lighting infrastructure
- Understand market potential and implementation issues associated with streetlight integration
- Establish a path to commercialization

Approach

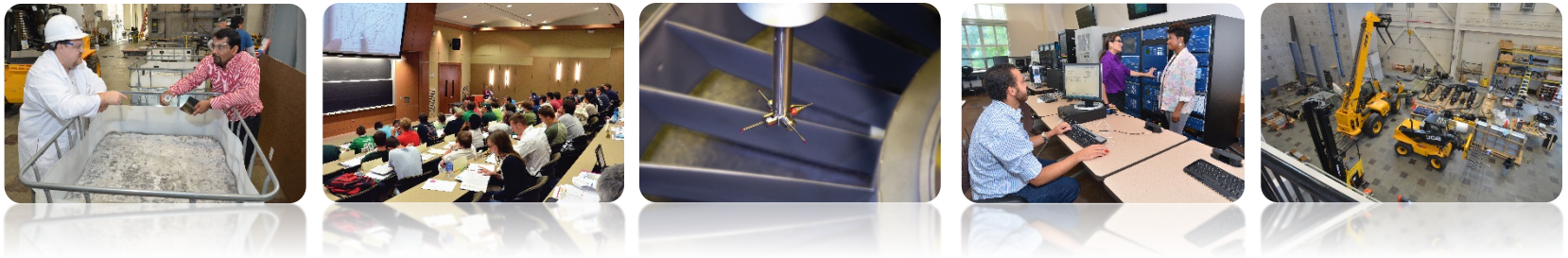
- Select strong set of commercialization, utility, and community partners
- Develop solution around an emerging IoT technology
- Develop and test in phased approach (university lab, utility lab, field)
- Work with utility & community partners to understand implementation challenges

Collaborations

- Partners: UNC Charlotte (lead), Centralina Council of Governments, Eaton, Duke Energy
- Working with UNC Charlotte and City of Charlotte for pilot deployments

Accomplishments

- Developed alpha prototype and launched field deployment
- Designed beta prototype and beginning on-grid testing at Duke Energy laboratory
- Working to deploy up to 3 stations in City of Charlotte
- Documenting integration process



Thank You!
Questions?

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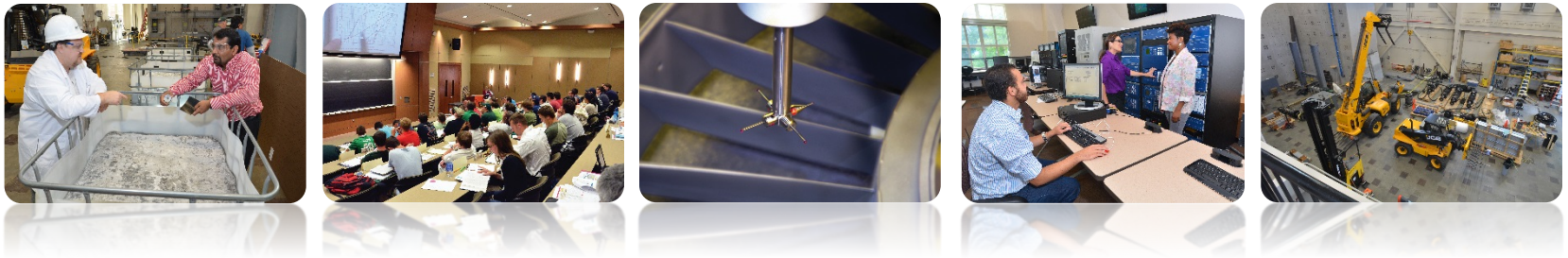

Reviewer-Only Slides

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Publications and Presentations

- M. Rahman, B. Papari, J.C. Thill, and R. W. Cox, “Current Status of Electric Vehicle Adoption: A State-of-the-Art Review,” *Transportation Research Part D: Transport and Environment* (under review)
- Prototype displayed at Distributech 2020 in San Antonio, Texas.

Critical Assumptions and Issues

- Project schedule:
  - Deployment is on schedule. Unless unforeseen issues arise, team should meet all milestones
    - Covid-19 could pose supply-chain challenges in obtaing UL-approved breakers from Eaton
  - Spending lagged behind because of time taken to negotiate agreements with Duke Energy and Centralina Council of Governments. Spending ticking upwards in 2020 as deployment and commercialization efforts intensify.
- Original project assumed that significant de-risking might be required for structural testing on pole and wireless communications, such issues have not been significant
- Team did not expect Eaton to take as large a role. Duke Energy was the original intended deployment channel. Duke Energy remains heavily involved in the project. Duke envisions themselves as a potential customer for an EVSE solution rather than as a provider of an EVSE solution.
- Covid-19 has not presented major slowdowns. Project was granted a “research exception” by UNC Charlotte Vice Chancellor for Research and Economic Development.
  - Team members can come to campus as needed for laboratory work.