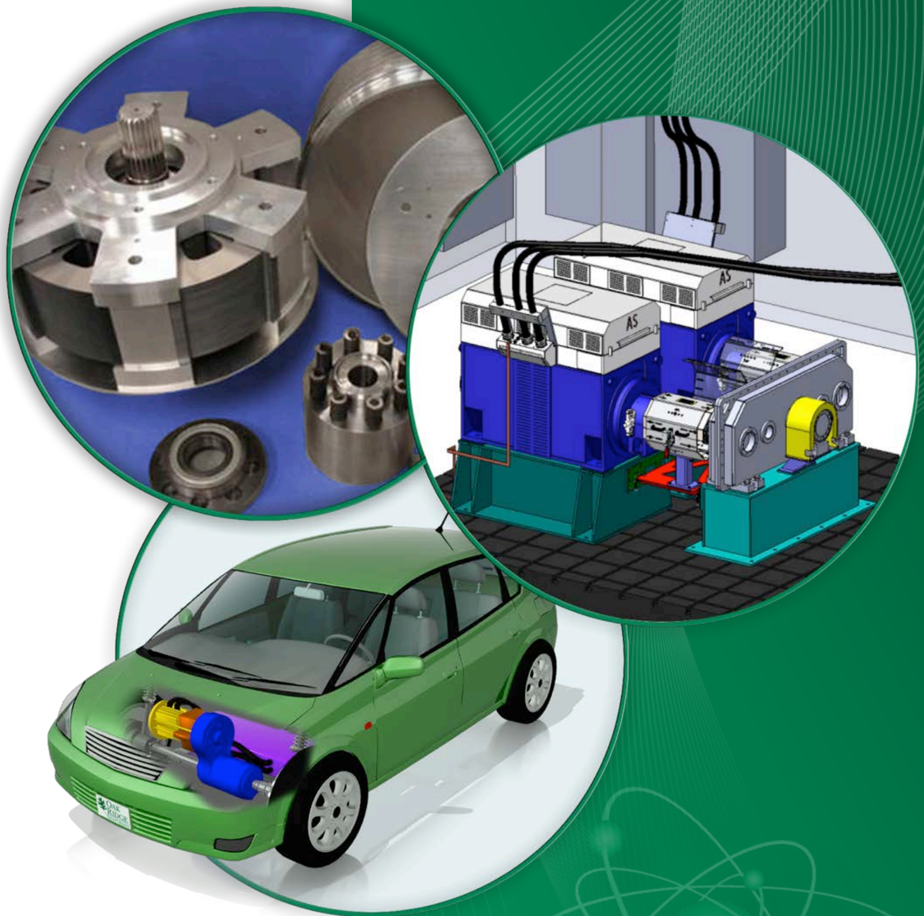
Dynamic Wireless Power Transfer (DWPT) Feasibility Study

P.T. Jones

Oak Ridge National Laboratory



2013 U.S. DOE Hydrogen and Fuel Cells Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting

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Project ID: VSS104

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Overview

Timeline

- Start – Nov FY13 (FY12 funds)
- Finish – Sep FY13
- 40% complete

Barriers

Electric Vehicle adoption impacted by:

- Cost, weight and range impacts of ESS
- Static Wireless Power Transfer (WPT) is in developing stages with multiple incompatible hardware systems
- J2954 progression noting conflicting goals from different industries
- Grid support and impact

Budget

- Total project funding
  - DOE share – 100%
- Funding to ORNL for FY12: $225
- Funding for FY13: $0K

Partners

- Idaho National Laboratory
- Argonne National Laboratory
- National Renewables Energy Laboratory
- DOT

Project Objective

- **Overall Objective**
  - To identify major opportunities, impacts and barriers to the adoption of wireless power transfer (WPT) for vehicles in-motion. Commonly referred to as dynamic wireless power transfer. (DWPT)
  - Identify critical characteristics required for DWPT & shape future research and create necessary partnerships for this paradigm in transportation technology to occur outside of railed vehicles.
  - Identify implementations/Deployments of DWPT with highest probability of success and best return on investment which allow maturity of the technology and determine different use case feasibility.

- **FY13 Objective**
  - All objectives to be completed in FY13 timeframe.

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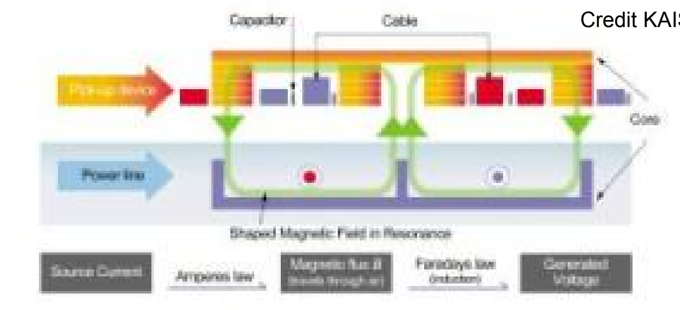
Milestones

Date	Milestones and Go/No-Go Decisions	Status
Nov-2012	Milestone: Kick-off meeting and individual lab focus areas defined	**Complete**
July 2013	Milestone: Summary presentation to DOE	
Sept-2013	Go/No-Go decision: Final report to DOE	

Strategy

Lessons learned from previous grid connected and wireless activities drove the need for this type of study:

- Thorough understanding of current research of technologies and characteristics used for quantitative comparisons



Credit KAIST

- Develop scenarios for deployment, identify Scenarios of Interest (SOI)

- Determine technology readiness, impact, applicability per SOI

- Verify basic power levels required and other key characteristics of SOI

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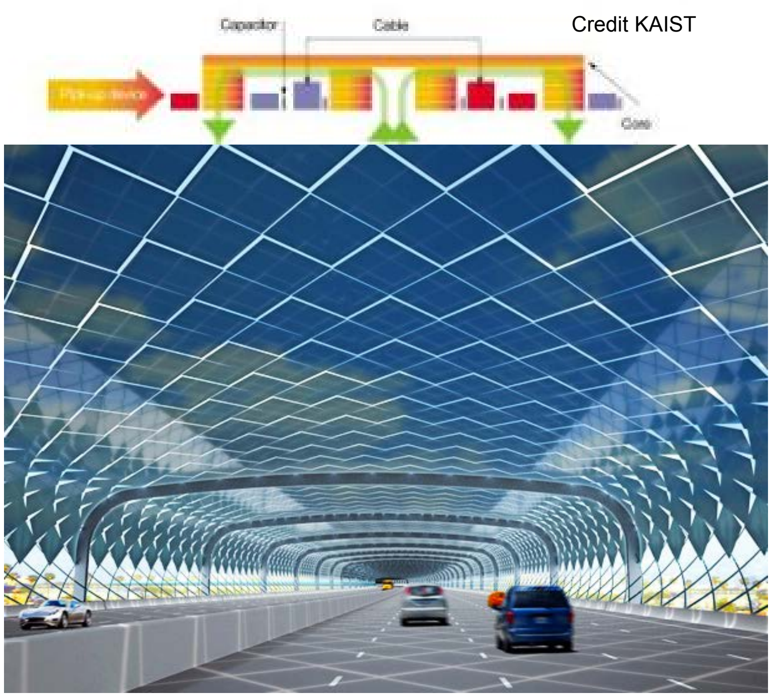

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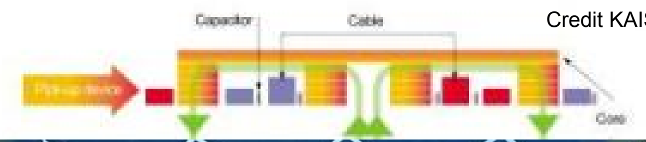

http://www.ultraglobalprt.com/

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Current Technology Assessment

- **Static WPT Commercial Products Limited Availability**
  - System OEMs nearing production
  - Cost and deployment impacts still studied
  - Communications guidelines/topics

http://www.electricvehiclesresearch.com/

- **Dynamic WPT**
  - Transportation topic since 1970's
  - Mid 2000's short route fleet conversions to BEV
  - KAIST first demonstrated its On Line Electric Vehicle system OLEV in 2009

Basic Scenario Identification

- **Considerations for DWPT deployment**
  - Environmental/Vehicle load impacts to roadway and WPT tech
  - Road modification traffic interruption, maintenance changes
  - Roadway usage, speeds, time of day

http://www.sigalert.com/

- **Example Scenario- LDV Stem Route**
  - HOV lane stem route metropolitan highway
  - Road usage high percentage VMT
  - Speeds varied → higher speed/higher power
  - Replacing high power consumption portion of trip with charging opportunity, maximizes range and reduces ESS size and weight
  - System failure impact, traffic, range and routing

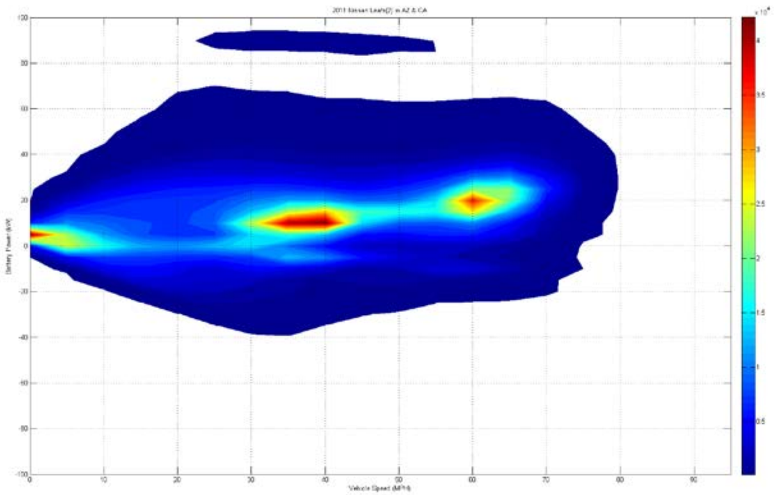
Scenarios of Interest

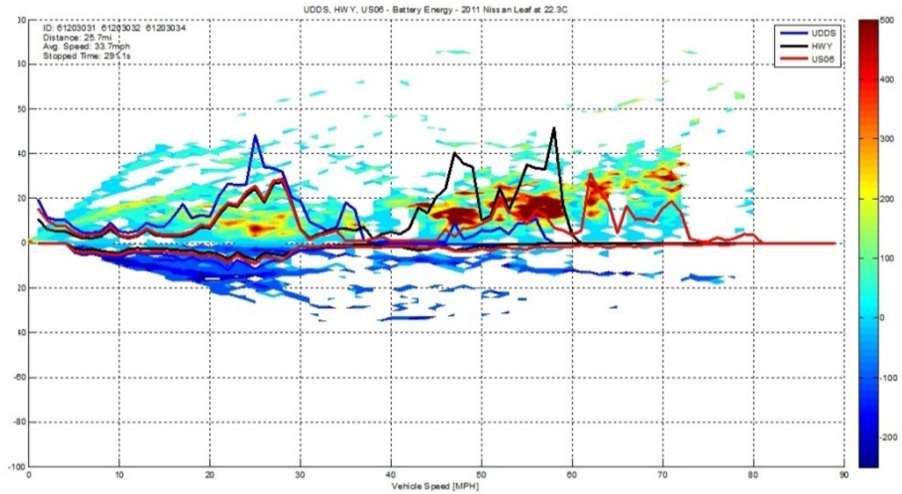
- **Metric Development**
  - Quantitative analysis requires comparable parameters for varied technologies
  - Freight analysis simplified?:
    - person/km/cost
    - cost/km/kW
- **Evaluation**
  - Complete cost analysis and petroleum reduction vs investment for SOIs using technology efficiency projections and traffic flow impact studies
  - Predict maintenance and cost impact for leading SOI
  - Formulate study parameters for DOT focus area
  - Identify barriers and risks for SOIs with best ROI within transportation sector

DOE Field and Dyno Data Use

Utilized data from INL's AVTA and ANLs APRF testing:

- On-going advanced vehicle evaluation and testing activities
- Vehicle list updated with latest production based advanced technologies
- Determine in-use power over variety of speed and use criteria





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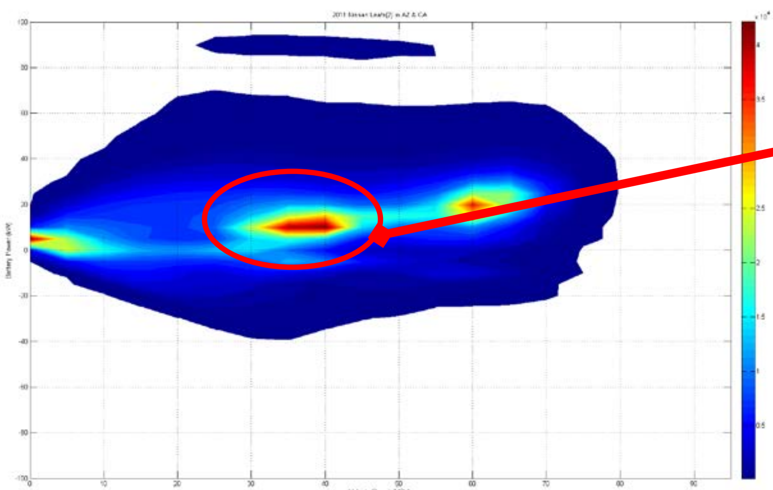
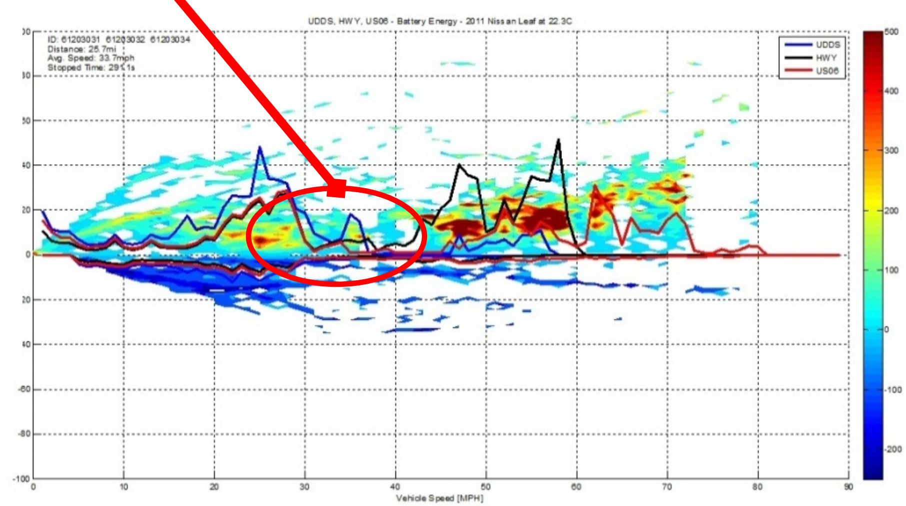


Field data fills in gap from test cycle data



Collaboration and Coordination

Organization	Type of Collaboration/Coordination
National Renewable Energy Laboratory	Advanced MD/HD Vehicle field data power requirements. Road use analysis and infrastructure cost
Argonne National Laboratory	Coordinated chassis dyno testing results with INL field test data for LDV power requirements. Also linked to J2954 standards for communications progress
Idaho National Laboratory	Coordinated field data testing results with ANL chassis dyno test data for LDV power requirements.
DOT	Estimations of road impact and embedded technology durability

Summary

- Relevance
  - Mass adoption of grid powered electric vehicles is being curtailed partly due to range anxiety, utility factor and cost of large Energy Storage Systems
  - Electrified roadways offer extended use of pure electric vehicles and large potential oil displacement, however the investment must be shown to have significant benefit
- Approach
  - Determine in-use power requirements for various vehicle applications
  - Define implementation strategies for dynamic wireless power transfer (DWPT), evaluate potential costs, barriers and benefits of various scenarios
  - Compare various technologies to determine which are capable of DWPT based on given assumptions
- Technical accomplishments and Progress
  - Literature search and DWPT application baseline determination
  - Developed scenarios of interest (SOIs) and evaluation criteria
- Collaborations:
  - INL, ANL, NREL and DOT
- Future Work: (rest of FY13)
  - Complete scenario evaluations and presentation to DOE and project report

Acknowledgements & Team Members

- Argonne National Laboratory
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Technical Back-Up Slides

Technologies for comparison

- **Organizations currently researching Dynamic Wireless Power Transfer**
  - Momentum Dynamics USU
  - Qual Comm/Halo IPT
  - ORNL
  - Bombardier
  - KAIST
  - Conductix
  - Seimens