

# Wireless Power Transfer Technology at ORNL

**Madhu Chinthavali**

**Team Lead, Power Electronics**

**SPARK**

**June 21 2016**

ORNL is managed by UT-Battelle  
for the US Department of Energy



# Our Vision

*Provide flexible, efficient, safer, and convenient power distribution with cutting edge wireless energy technology solutions.*

# Spectrum of Our Wireless Energy Solutions



Automotive



Off highway  
vehicles



Buildings



Marine  
Applications



## Inductive Coupling

Market Opportunities  
and Potential:

Wireless Charging for  
Automotive Applications



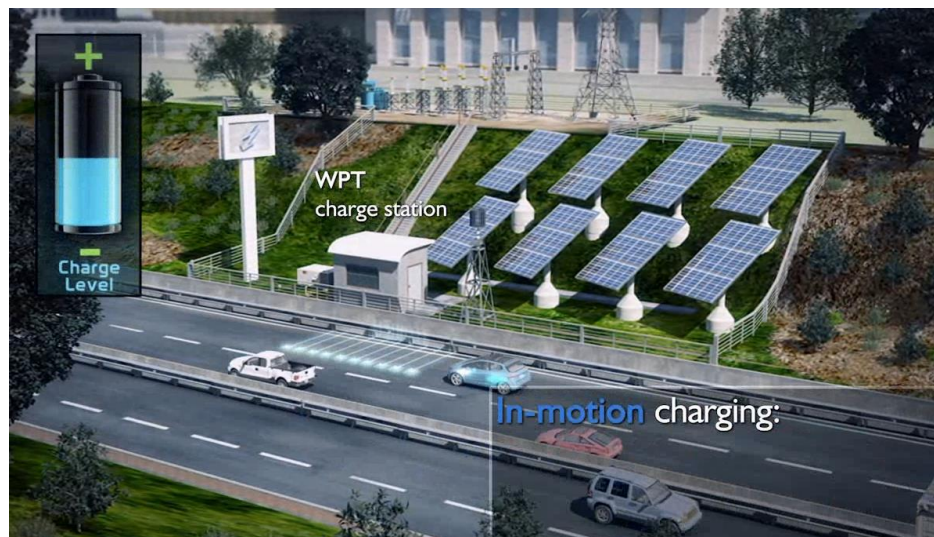
# Automotive Wireless Charging



Stationary Charging



Opportunity/Quasi-Dynamic Charging



In-motion/Dynamic Charging

# Vehicles Integrated and Tested at ORNL

Chevy Volt



Toyota Prius Plug-in



Scion IQ EV



Toyota RAV4 EV



- **Power transfer level ( $>6.6\text{kW}$ ),**
- **Efficiency  $\sim 90\%$**
- **Misalignment tolerant (up to  $\pm 40\text{mm}$ ),**
- **System integration for 7 vehicles**
- **Airgap:  $162\text{mm}$**
- ***Met the IEEE and ICNIRP safety standards***



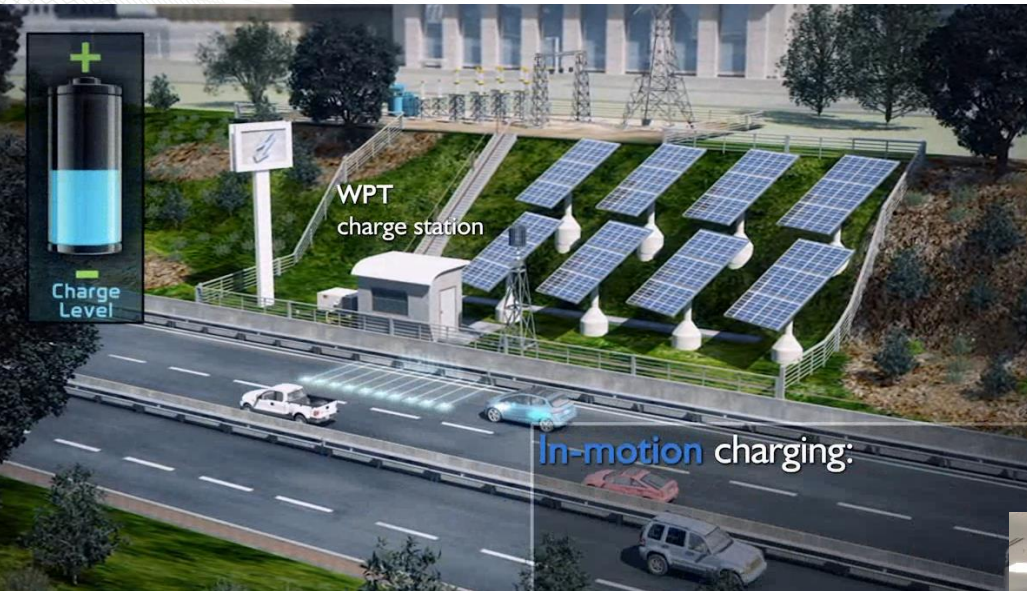
# Opportunistic/ Quasi-Dynamic Wireless Charging



- 11 kW bench prototype
- 20 kW static power -OEM vehicle
- Efficiency > 90 %



# In-motion/ Dynamic Charging



- Currently, we gain  $E_2=281.08$  **Watt-seconds** (joules)  $\rightarrow$  0.08 Watt-hours
- 75% of a highway should we covered with coils with 9.28kW peak power
- With 100kW power transfer, only 7.5% of the roadway should be WPT installed.



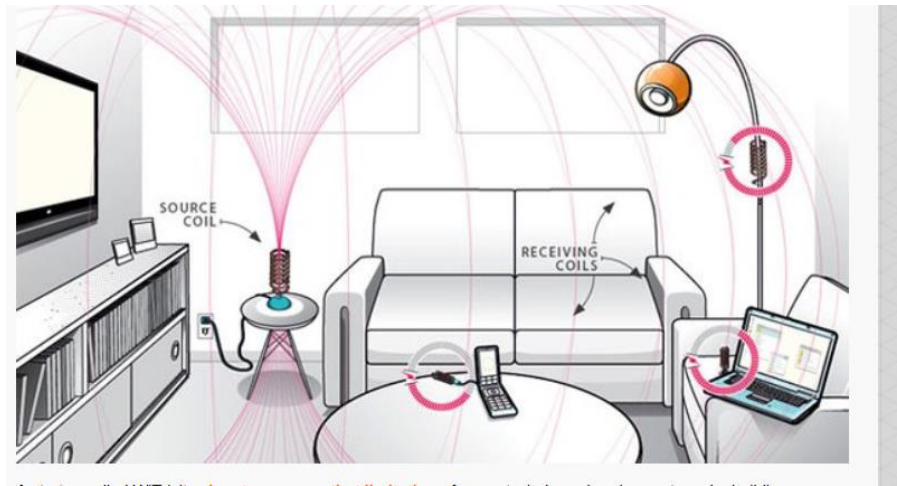
- Demonstrated up to 3 kW using a GEM vehicle
- Demonstrated up to 9 kW using Toyota RAV4



Market Opportunities and  
Potential:

Energy Management for Buildings

# ORNL vs. Competition



A screenshot of the RRC website. The header includes 'RRC wireless power' and navigation links: Home, Applications, RRC Technology, Products, Company, News, Contact. The main content area features an illustration of a power outlet connected to a coil, which transmits energy to another coil connected to a light bulb. Below the illustration, there are links for 'RRC Wireless Power', 'Go Green', 'Evaluation Kit', 'WPC Partner', 'WPC News', and 'White Papers'. A section titled 'Wireless power transmission' includes a sub-section 'How it works' with text explaining the principle of power transmission without electrical contact, using an alternating electromagnetic field.

A screenshot of the Duracell Powermat website. The header includes 'DURACELL powermat | TakeCharge. BeEmpowered.' and navigation links: Live Chat, Questions? Contact Us, Shopping Cart. The main content area features a headline: 'Double your iPhone 5's battery &amp; enjoy wireless charging'. Below the headline, there is a sub-headline: 'Introducing the PowerSet II Kit. A uniquely designed battery case that not only doubles your iPhone 5's battery, but also enables you to recharge wirelessly on the included PowerMat.' There are two buttons: 'Buy Now' and 'Special 20% Off Site Wide\* Enter code TakeCharge at checkout \*Terms and restrictions apply'. To the right, there is an image of the PowerSet II Kit, showing an iPhone 5 in a black battery case, which is placed on a black PowerMat charging pad. The iPhone 5 screen shows the time 2:47 and a green battery icon.



**More outlets in building per connection point enabled by portable outlets**

**ORNL solution is the CAT6 equivalent for power in a house**

# AMIE- Advance Manufacturing + Integrated Energy



- **Demonstrated bi-directional capability up to 10-kW on a bench top**
- **Demonstrated up to 1 kW with a house load and vehicle charging up to 6.6 kW**



***Thank you!***

**Contact: Madhu Chinthavali**  
**[chinthavalim@ornl.gov](mailto:chinthavalim@ornl.gov)**  
**865-946-1411**