

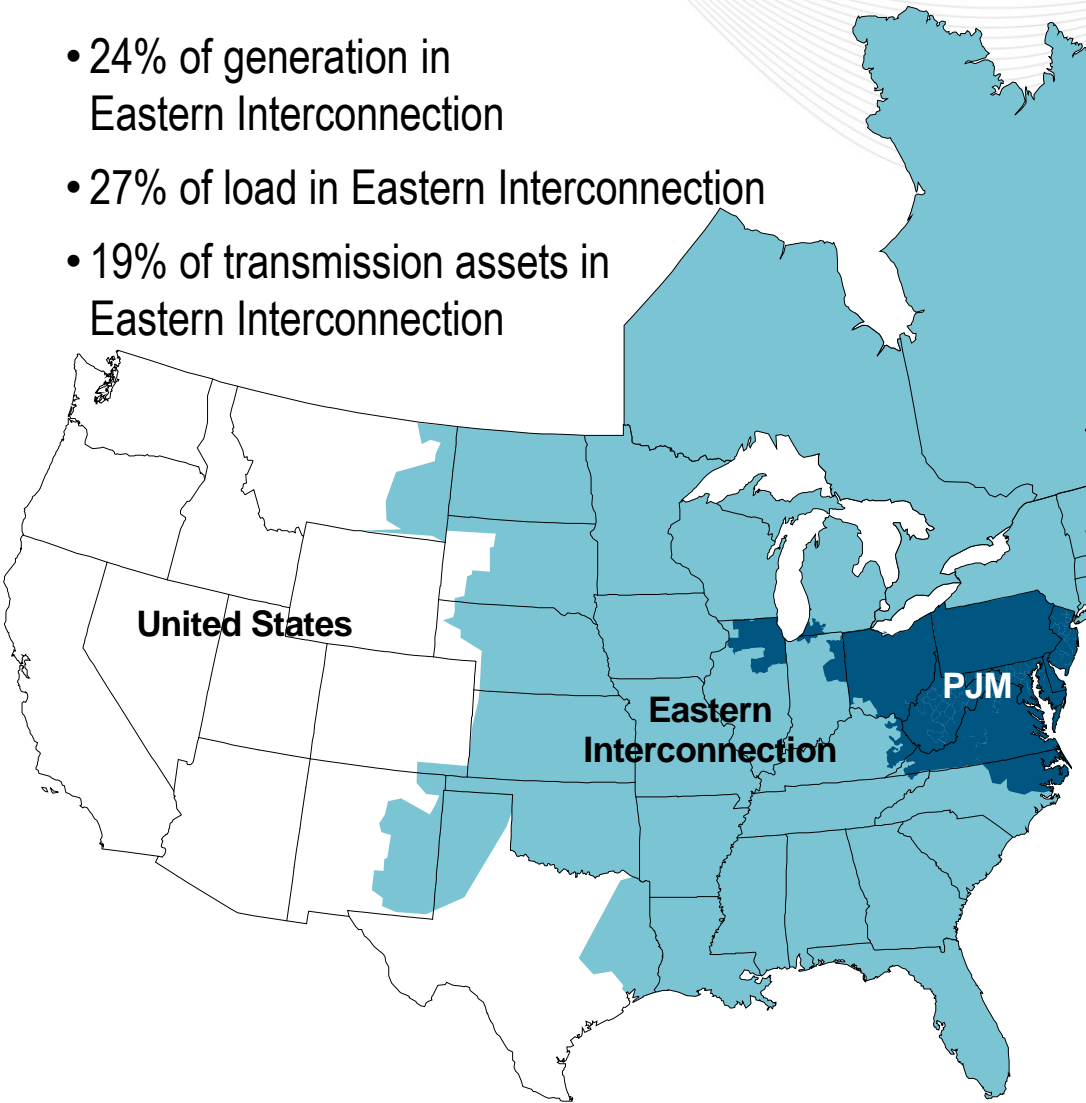
V2G and G2V: It's about grid scale storage!

Scott Baker
PJM Interconnection

Business of Plugging In
October 11, 2011
Dearborn, Michigan

PJM as Part of the Eastern Interconnection

- 24% of generation in Eastern Interconnection
- 27% of load in Eastern Interconnection
- 19% of transmission assets in Eastern Interconnection

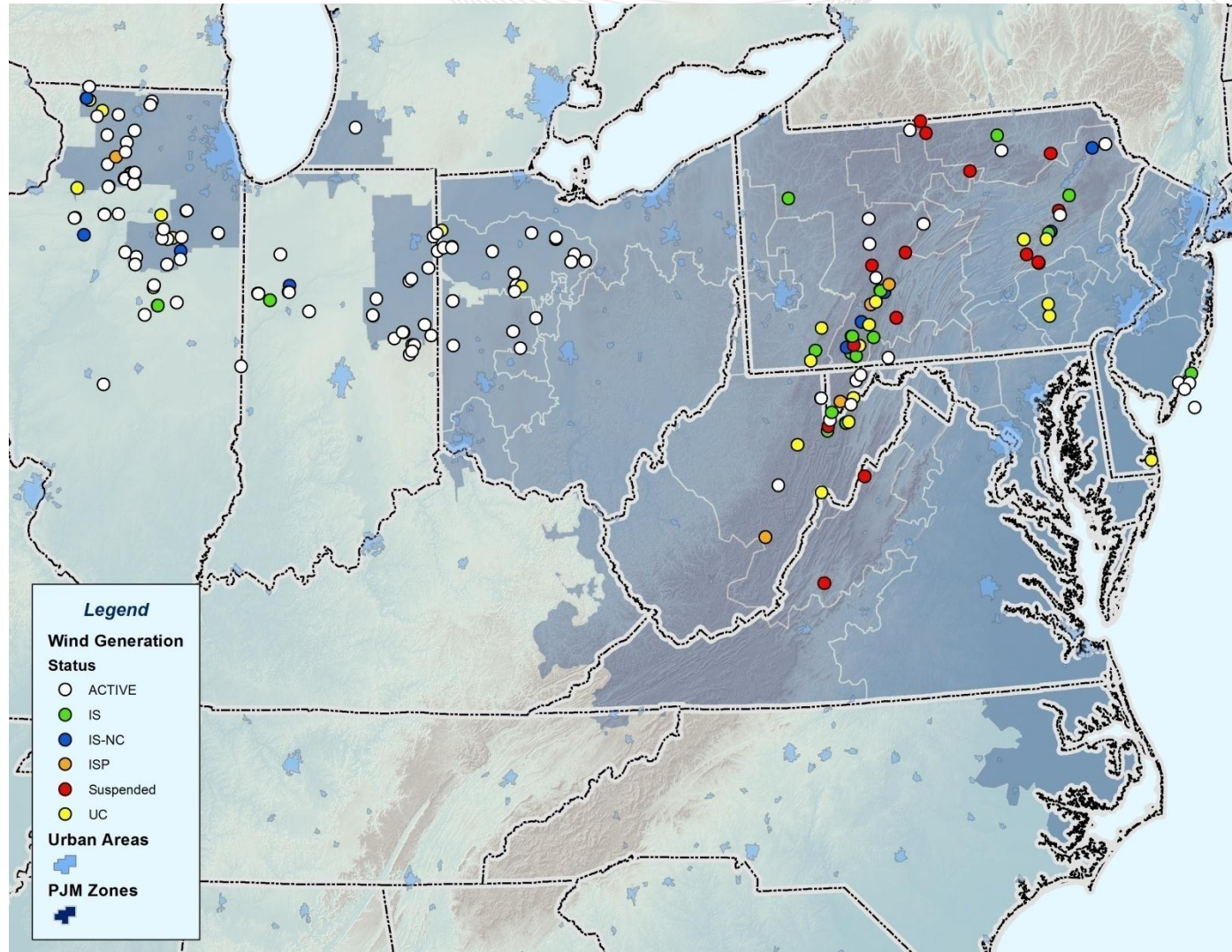


KEY STATISTICS

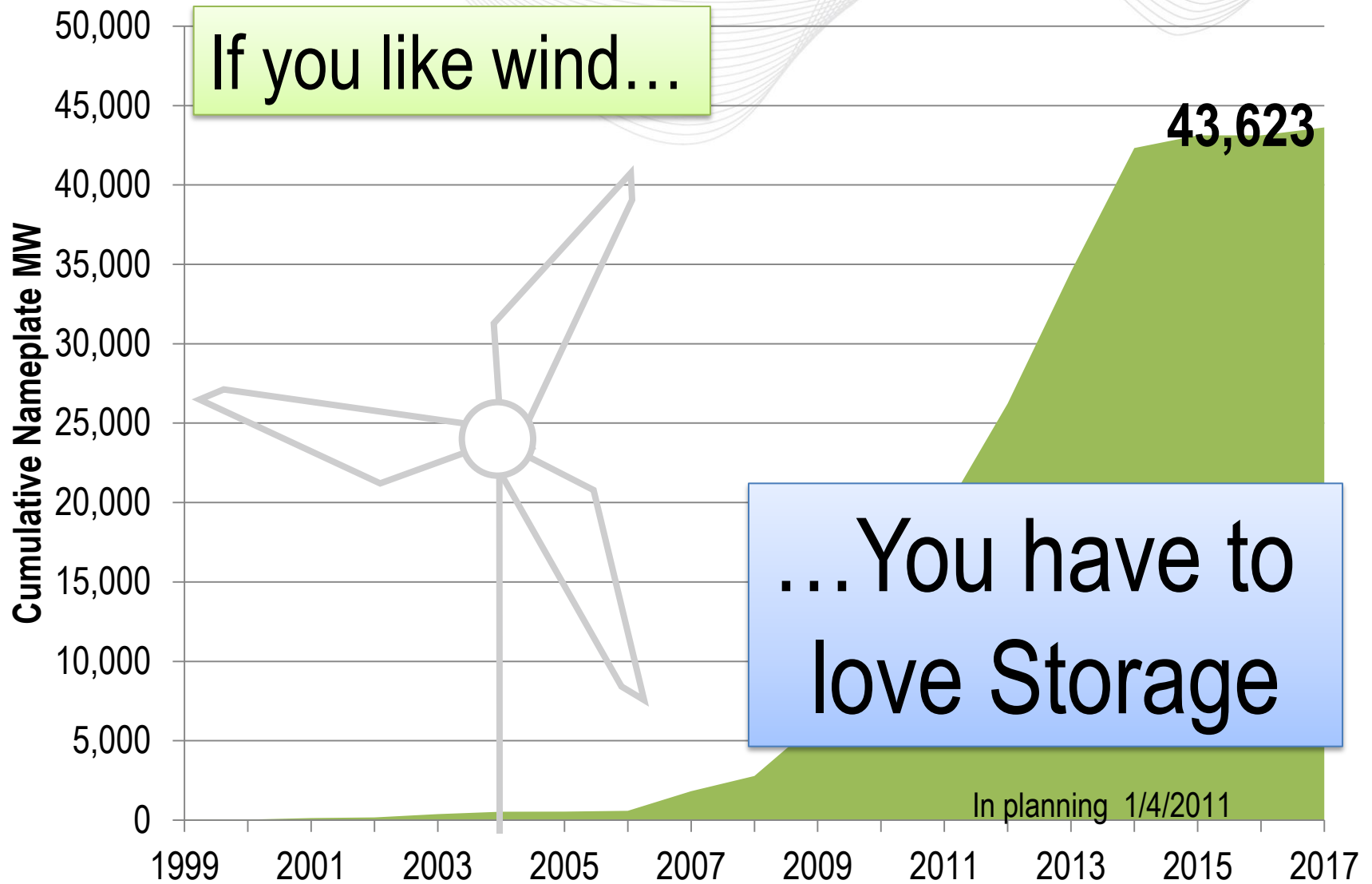
PJM member companies	710+
millions of people served	58
peak load in megawatts	158,450
MW of generating capacity	180,400
miles of transmission lines	61,200
GWh of annual energy generation	794,335
generation sources	1,365
square miles of territory	211,000
area served	13 states + DC
Internal/external tie lines	142

**20% of U.S. GDP
produced in PJM**

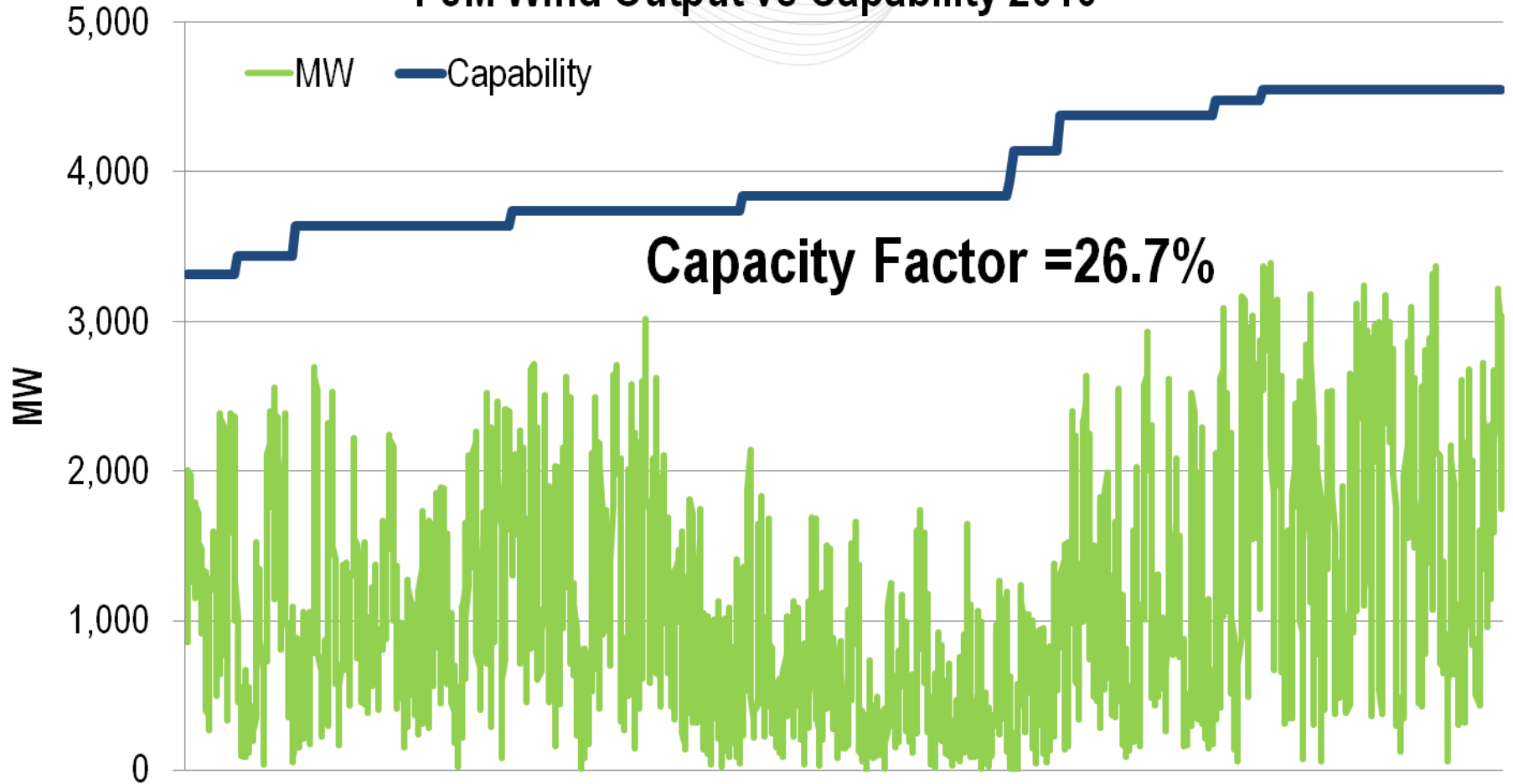
As of 7/21/2011



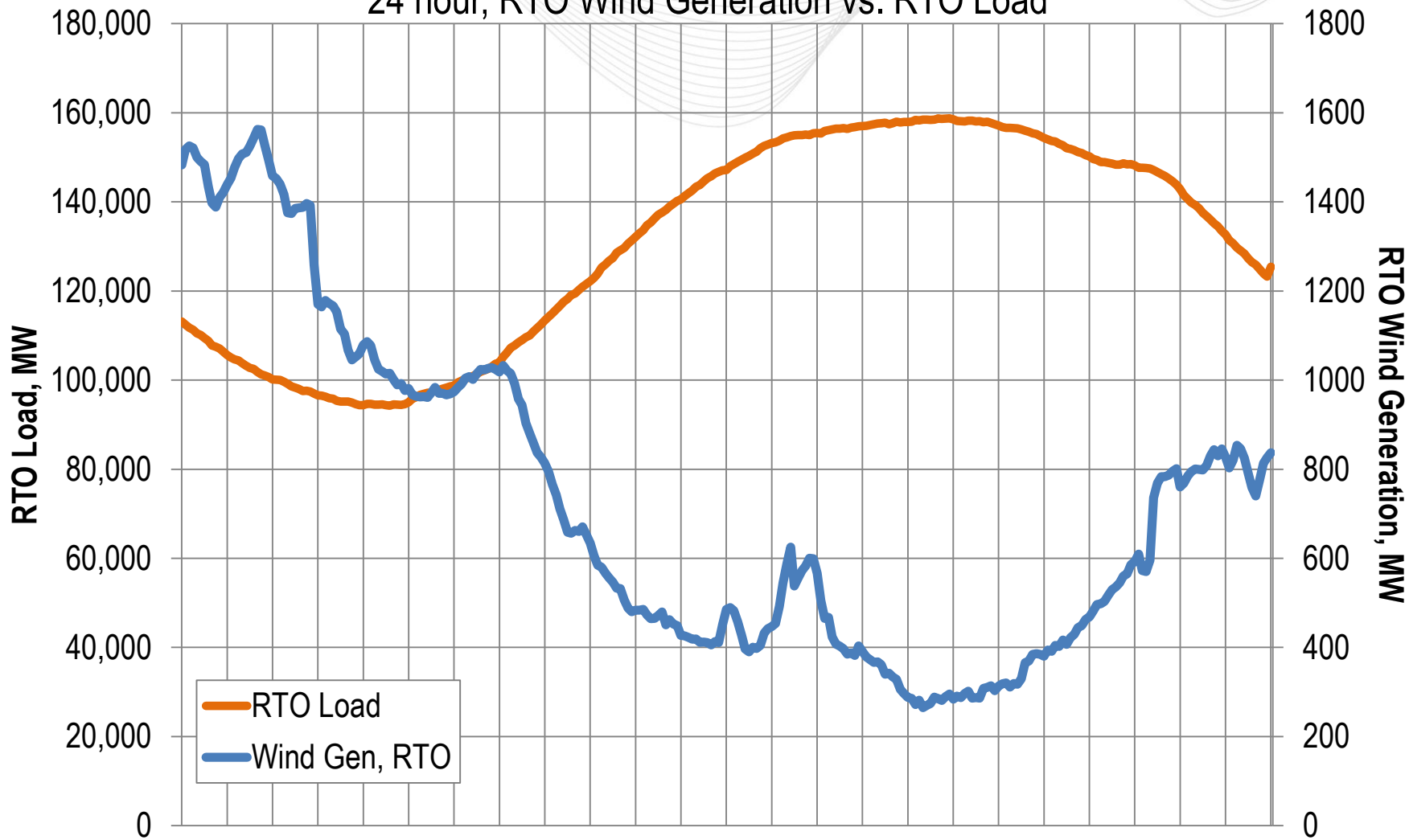
As of December 2010



PJM Wind Output vs Capability 2010



24 hour, RTO Wind Generation vs. RTO Load



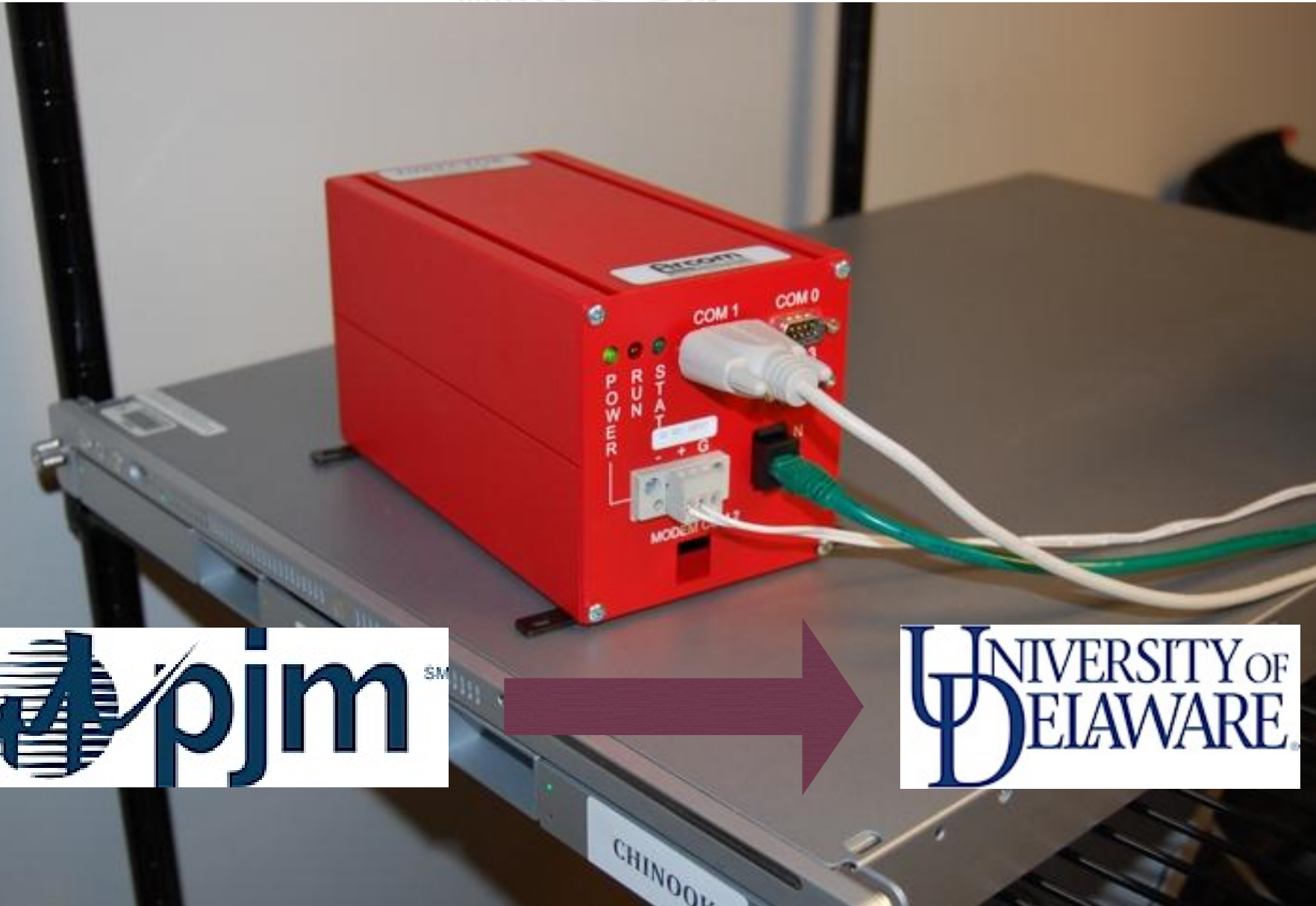


- **Mid-Atlantic Grid Interactive Car Consortium (MAGICC)**
- **Over three years experience**
- **7 cars capable, 5 currently aggregated**
- **Using Power Line Carrier to push AGC signal to the vehicle via the SAE J1772 pilot wire.**





Link from ISO to UD server:
encrypted Distributed Network Protocol (DNP)



- No moving parts, fits under dash
- Receives signal from coalition server
- Reports capacity and current state back to coalition server
- Checks in with a calendar system to plan for next trip.

Automotive-grade Linux computer



Vehicle to Grid -- Coalition Server

University of Delaware

Coalition Status

ISO	Power Capacity Up (kW)	Power Capacity Down (kW)	Power Requested (kW)	Power Provided (kW)	Energy Charge (kWh)	Energy Empty (kWh)	Number of Cars
PJM	49.37	49.37	-14.80	-15.81	104.30	35.70	4
CAL-ISO	0.00	0.00	0.00	0.00	0.00	0.00	0
Simulated-ISO	0.00	0.00	0.00	0.00	0.00	0.00	0

Hide Charts

CAL-ISO

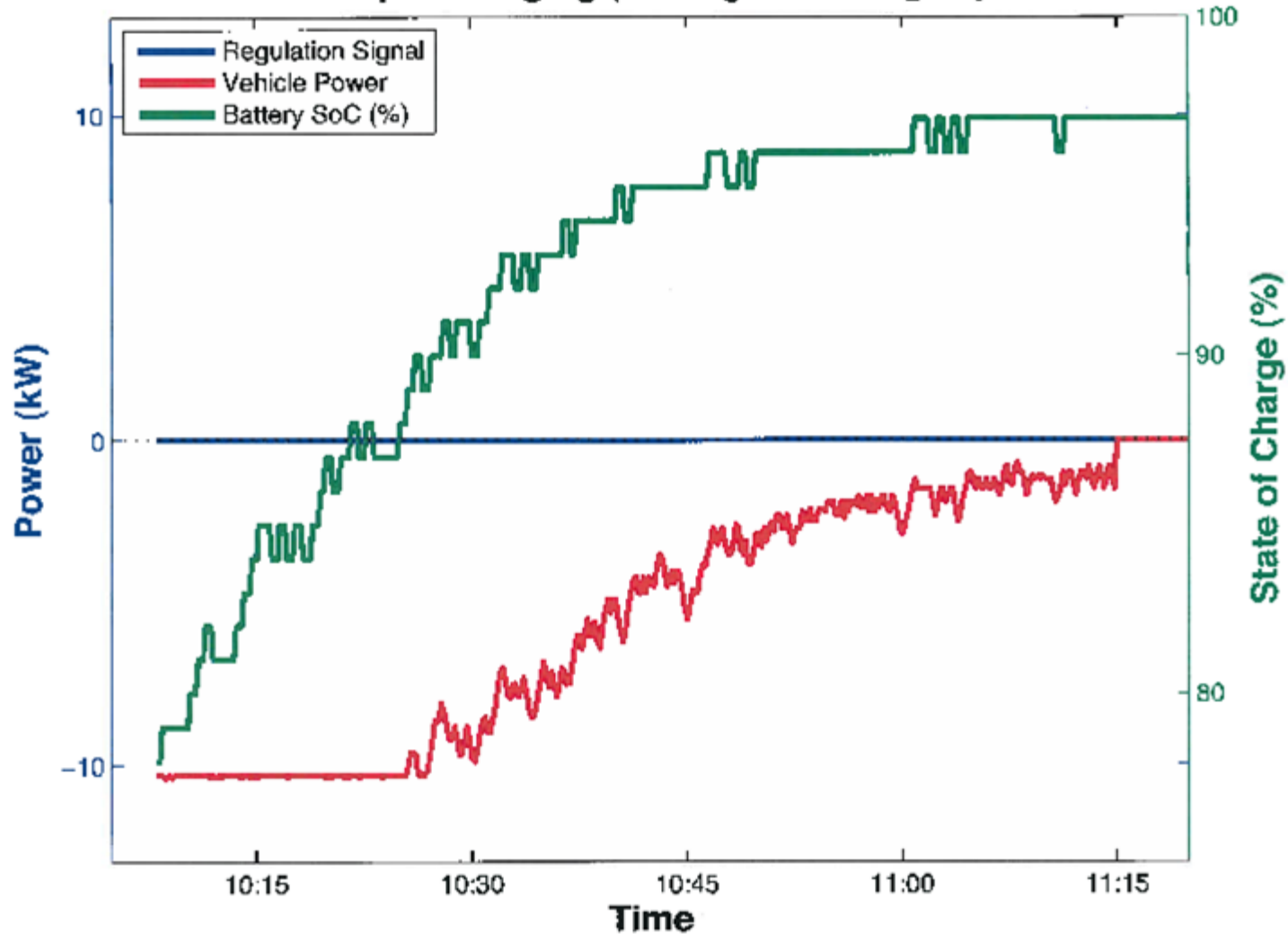
Simulated-ISO

PJM

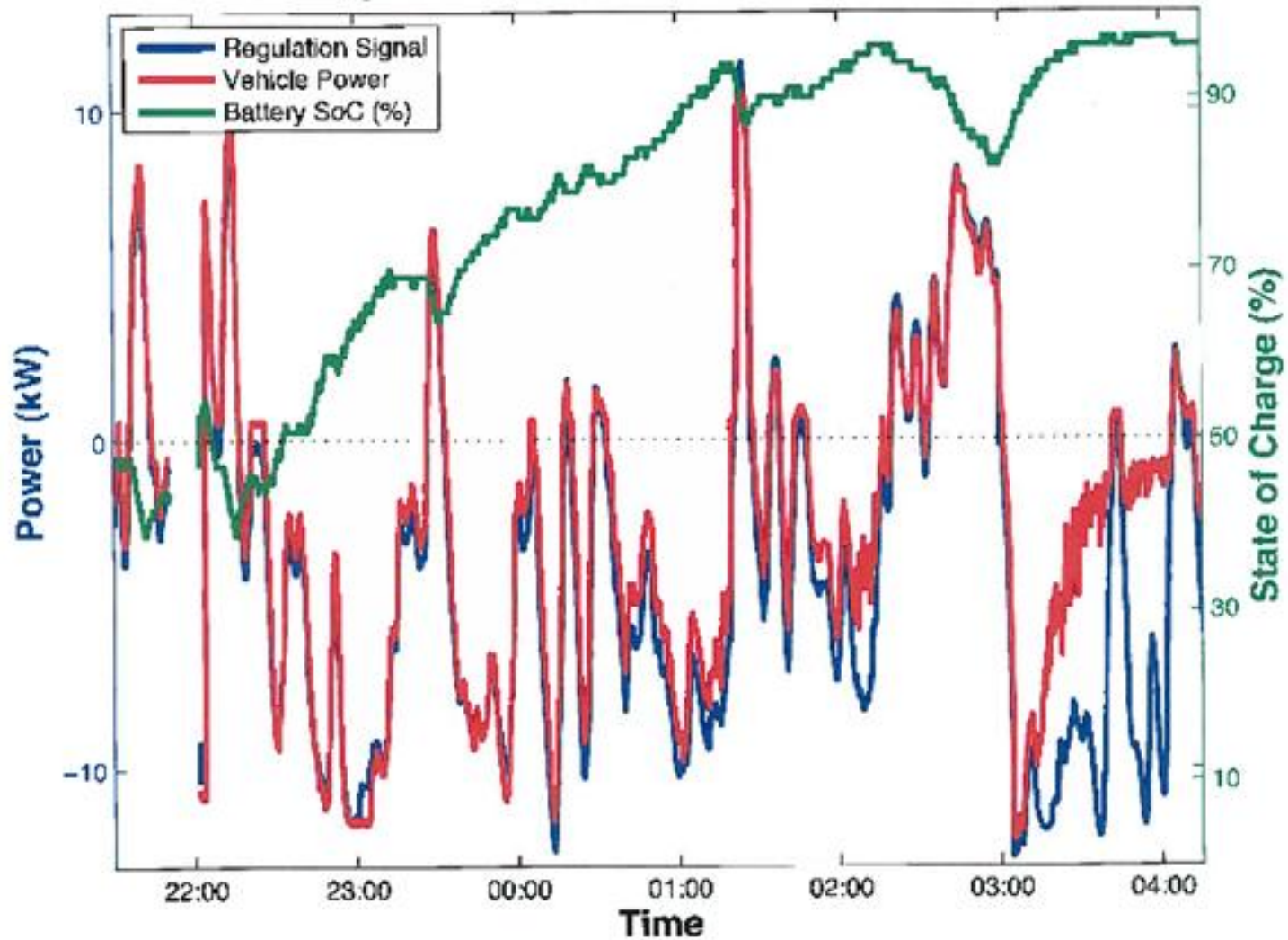
Individual Vehicle Status

Car Name	Power Capacity Up (kW)	Power Capacity Down (kW)	Power Requested (kW)	Power Provided (kW)	Energy Charge (kWh)	Energy Empty (kWh)	Miles	Volts (V)	Amps (A)	Monthly Credit (\$)
UD-296	0.00	0.00	0.00	0.00	29.05	5.95	91.30	211	22.5	33.17
UD-170	11.23	11.23	-3.36	-3.95	12.60	22.40	39.60	234	16.9	76.31
DEState5205	10.70	10.70	-3.21	-2.05	33.25	1.75	104.50	214	9.6	21.73
DEState0000	17.36	17.36	-5.21	-5.70	31.50	3.50	99.00	248	23	24.59
UD-210	10.08	10.08	-3.02	-4.09	26.95	8.05	84.70	210	19.5	23.38

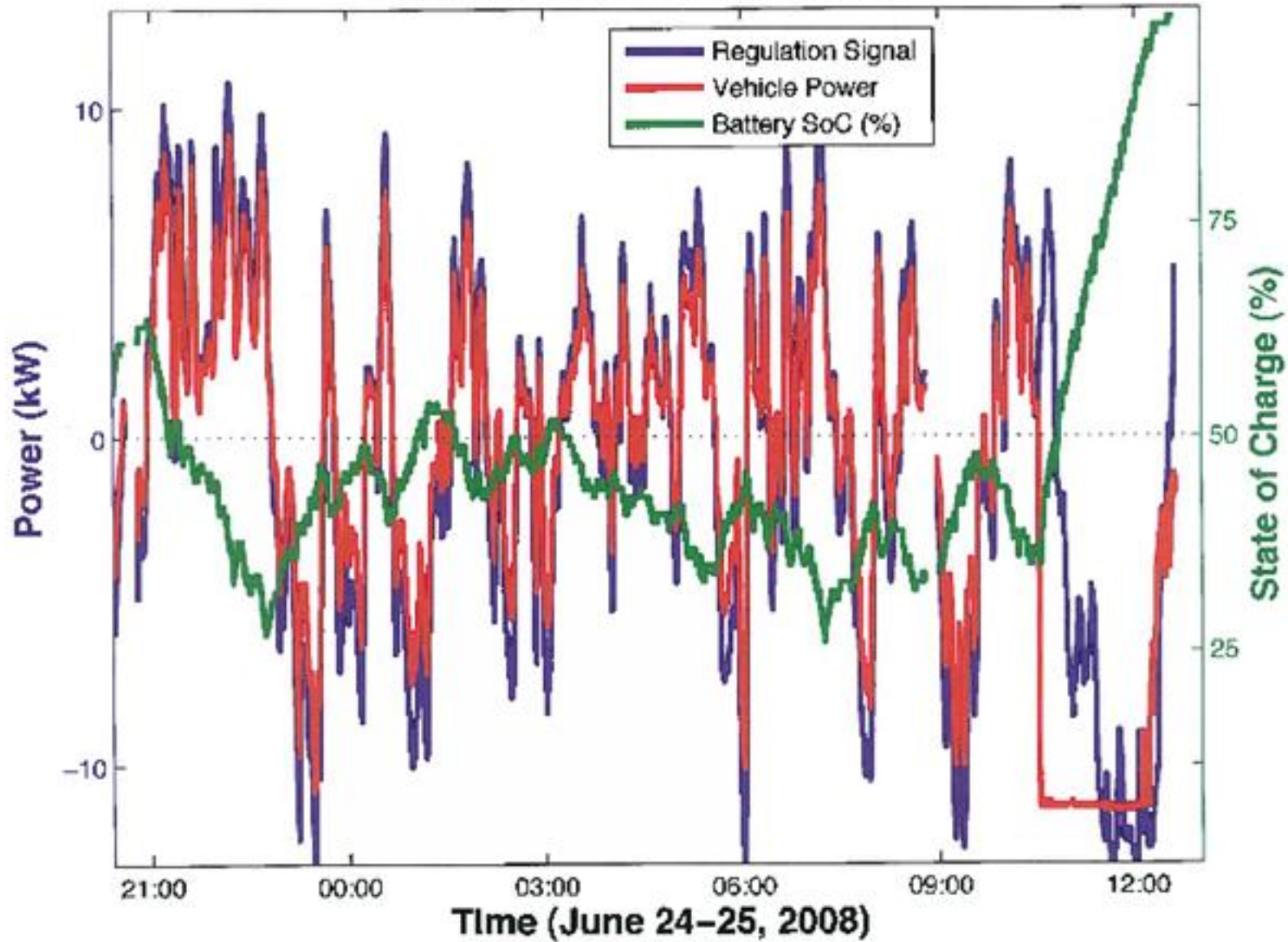
Simple Charging (no Regulation signal)



Regulation Supply (incidental charging)



Charge Sustaining Regulation



- **New “Dynamic Regulation” signal**
 - Based on total ACE but calculated to be energy neutral, highly correlated to system frequency
- **Pay-for-Performance**
 - Performance scores incorporated into market clearing process
 - Alignment of compensation with benefit to system control
- **Lower Regulation capacity requirement**
 - 1 MW > 500 kW > 100 kW (pending FERC approval)
- **Sub-metered telemetry for DR Regulation**
 - Requirements being considered in DR Subcommittee for device level M&V



Available for full-time Summer job.



Bottom Line: Your vehicle is a valuable asset to the electric system when it isn't driving