

# **Impact of Electric Vehicles on the Power Grid**

**Electric Vehicle Infrastructure Council  
June 4, 2010**



At Eastern Connecticut  
State University

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# Understanding Vehicle-To-Grid Technology

- Envision a day, in the near future, where millions of people are driving around in plug-in electric vehicles; we find that each of these cars has a battery. Since a battery needs to charge, each of these cars have to be plugged into the power grid in order to operate. Therefore would it not be ethical to create a system in which cars plugged into the grid can charge their batteries when needed and conversely store excess electricity for when demand on the grid is high? If we take it one step further we could possibly generate a large percentage of the electricity needed to charge the car using renewable energy sources. Consequently you are now reducing emissions at the power generation facility and eliminating them at the tailpipe. This kind of comprehensive, rechargeable battery network is called vehicle-to-grid technology (V2G).

## **The Wide Angle: 10 Electric Car Grid Projects**

Tracy Staedter, Discovery Tech and Tracy V. Wilson, HowStuffWorks.com

Link: [Cars And Grids: A Two Way Street?](#)

<http://www.youtube.com/watch?v=cJgRznnjYm0&feature=related>

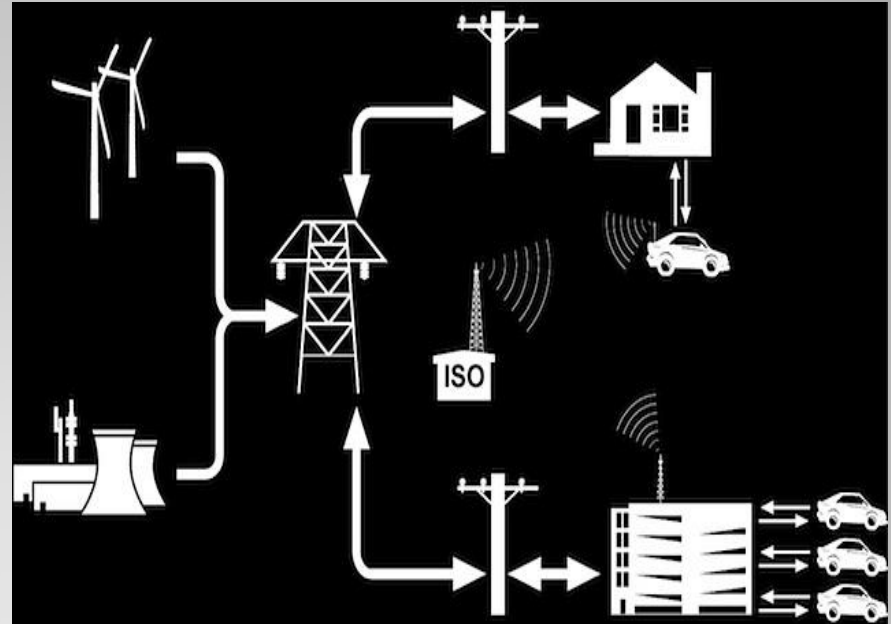


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# How Does V2G Technology Work?

- Electricity flows from generators through the grid to electricity users.
- Electricity flows back to the grid from the batteries in EV
- The control signal from the grid operator (ISO) could be a broadcast radio signal, a cell phone network, or power line carrier.
- The grid operator sends requests for power to a large number of vehicles.
- The signal may go directly to each individual vehicle, to a fleet operator, or through a third-party aggregator to dispatch power from individual vehicles.



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## V2G Study

- Evaluated V2G for Base Load, Peak Power and Spinning Reserves.
- Evaluated potential from EV, PHEV, and Fuel Cell Vehicles
- Conclusion:
  - V2G could be cost effective during high cost peak periods but may effect vehicle reliability
  - Financially cost effective for use as demand response strategy and as spinning reserves
  - PHEV & FC work without compromising reliability
  - V2G can Improved Customer's reliability

Link: [Electric Car Feeds Grid](http://www.youtube.com/watch?v=5639ceWg0us)  
<http://www.youtube.com/watch?v=5639ceWg0us>



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Discovery



# Estimated Load Growth Impact on Grid at Major Cities from On-Peak Charging

## Los Angeles

- The Los Angeles Area is expected to encounter the largest growth in PHEVs over the next couple of years.
- Projection: 119,069 EVs by 2019
- If every PHEV was plugged in simultaneously this could add an electric load of up to 658 MW
- If PHEV charging was staggered over 8 hour period ➔ +147 MW; over 12 hour period ➔ +98 MW

## New York City

- New York City is another megacity predicted to see a major increase in PHEVs.
- Projection: 54,000 EVs by 2019
- If every PHEV was plugged in simultaneously this could add an electric load of up to 299 MW
- If PHEV charging was staggered over an 8 hour period ➔ +33 MW; over 12 hour period ➔ +22 MW

[Ref: ISO/RTO Council \(IRC\) March 2010  
Assessment of Plug-in Electric Vehicle Integration with ISO/RTO Systems](#)



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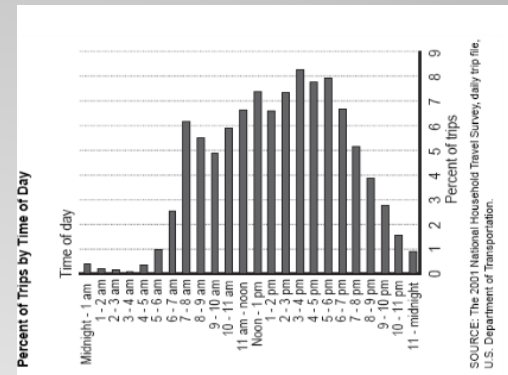
# Compatibility of Drive Time versus Charge Time



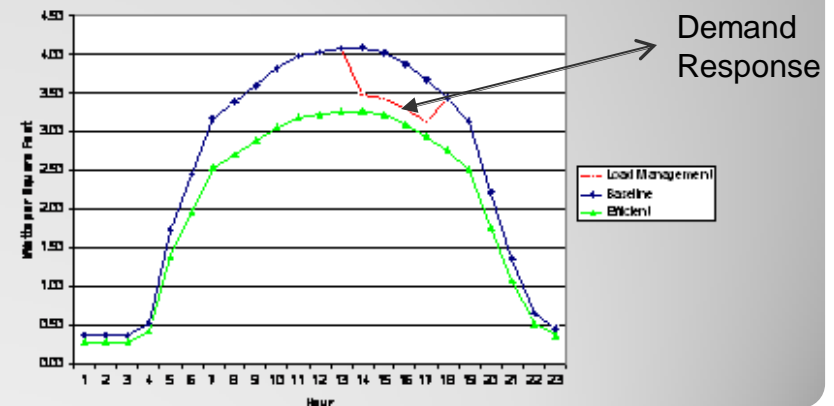
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- Research shows that a vast amount of driving occurs from the hours of 7 A.M. to 8 P.M. Coincidentally these hours also reflect on-peak hours of electricity consumption.
- It is believed that most charging is likely to occur between the hours of 11 P.M. and 7 A.M.
- Time-of-Use Rates that reflect the true market cost of power would encourage this behavior.
- Charging in the off-peak hours would improve the load factor of the grid and lower overall electric costs.

## Typical Driving Time

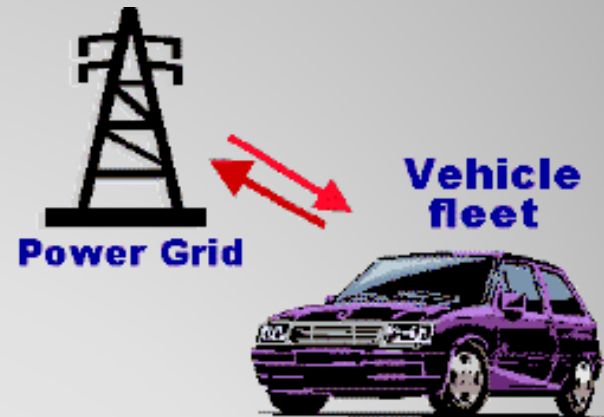


Combined Commercial Cooling and Lighting Loadshape  
Baseline and Load Management Compared to Energy Efficiency



# When will V2G be ready for Prime Time?

- Determine the Impact on Battery life
- Determine the potential for use as a Demand Response Strategy
- Development of communication network and protocols
- Develop appropriate rates and contracts



Link: [Vehicle to Grid Demonstration](http://www.youtube.com/watch?v=pQTwgzZnbjs&feature=related)  
<http://www.youtube.com/watch?v=pQTwgzZnbjs&feature=related>



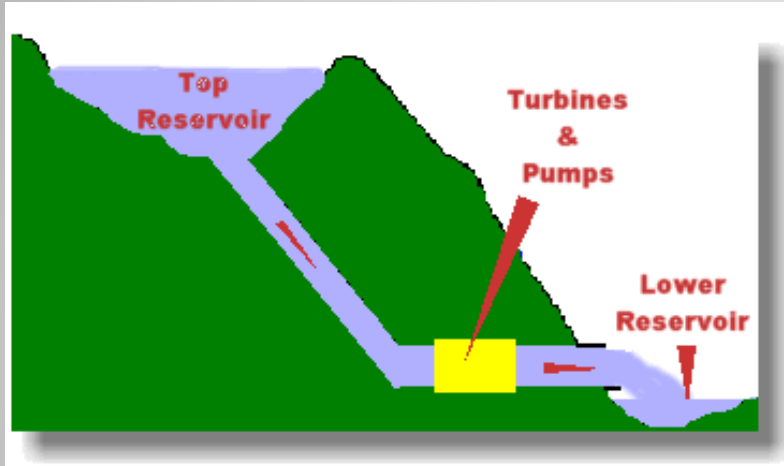
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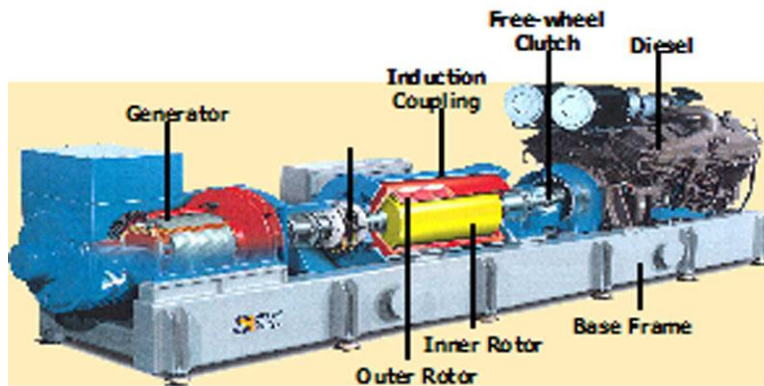
# Batteries as a Power Reliability Solution



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Grid Reliability  
"pump storage"



Flywheel Technology



Portable Batteries

Customer Reliability

# On-Site Battery Storage



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- Provides technology to utilize off-peak kwh in the on-peak
- Reduces on-peak demand charges
- Provides back-up for the consumer from grid interruptions
- Provides possible demand response option to the grid

**Stationary**



**In Vehicle**



Mr. Electricity's Solution

V2G Solution

**Discussion?**

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