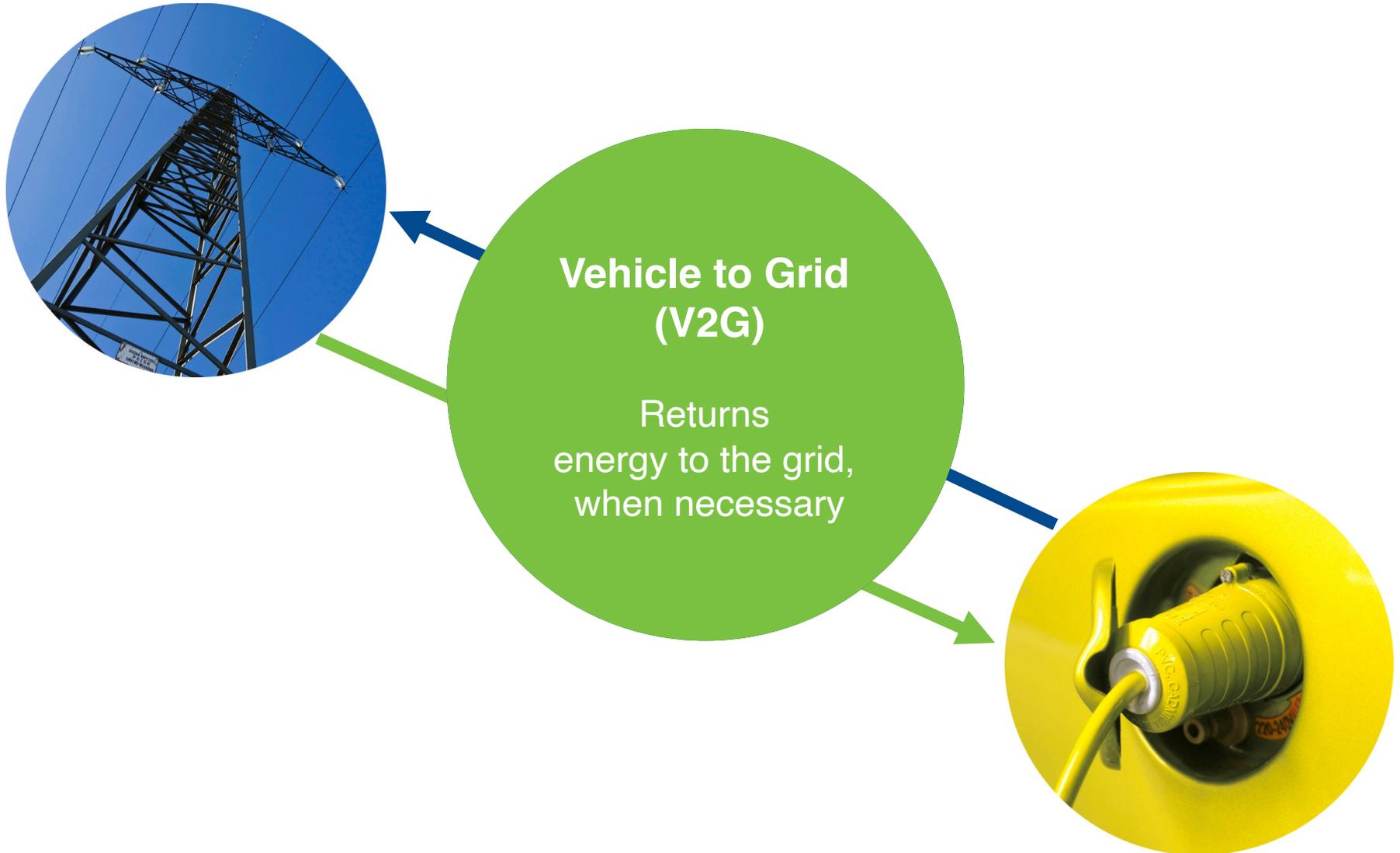**Beyond Oil**

September 4, 2008

Building 'smart grid' technology
to control the flow of electricity
between the grid and plug-in vehicles

Delivering Real-Time Charging Management to Utilities

Vehicle to Grid (V2G)

Returns energy to the grid, when necessary

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Why is Charging Management Important?

- Allows the existing grid to support wide-scale plug-in adoption
  - Avoids damaging grid stress and delays expensive infrastructure investment

- Enables use of renewable energy as vehicle "fuel"
  - Allows charging to be synchronized with the availability of wind or solar power, further reducing greenhouse gas emissions that cause global warming

- Increases integration of clean power in energy generation
  - Plug-in vehicles can serve as inexpensive storage for renewable energy that can be used in generating electricity

- Creates opportunities to reduce the cost of electric transportation
  - Utilities, eager for participation in charging management programs, will offer drivers discounted electricity rates for plug-in vehicles

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Ongoing 2008 Charging Management Trials

Utility/Laboratory	Vehicles	Trial	Objective
Xcel Energy, NREL	6 Ford Escapes	Smart Charging V2G	Deploy first V2G capable fleet Explore storage, ancillary services production
Austin Energy, ERCOT	2 Toyota Priuses	Smart Charging	Focused on wind power integration
Idaho National Laboratory (INL)	57 plug in hybrids (various models)	Data Logging	Real-time data capture, deployed in WA, CA, OR & HI
Seattle City Light, INL	13 Toyota Priuses	Smart Charging	Evaluate impact of urban plug-in fleet on the grid
EPRI, PG&E	2 AC Propulsion eBoxes	Smart Charging V2G	Identify communication protocol requirements
U.C. Davis, INL	13 Toyota Priuses	Driver Performance Feedback	Determine impact of performance data on driver behavior

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Considerations for a National Demonstration

What Can Be Learned?

- **Plug-in vehicle performance**
  Mileage, emissions, fuel cost

- **Impact on the grid**
  Points of stress

- **Requirements for utilizing renewable energy**

- **Utility needs**
  Charging management, roaming, billing

- **Driving /charging behavior of vehicle owners**

- **Best locations for charging infrastructure**

- **Requirements for driver participation**

What Is Required?

- **Clear Goals & Objectives**

- **Vehicles & Drivers**

- **Utility Participation**

- **Charging Management Solution**

- **Charging Infrastructure**

- **Detailed Data Logging**

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