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Revolutionizing the way you think about energy.™
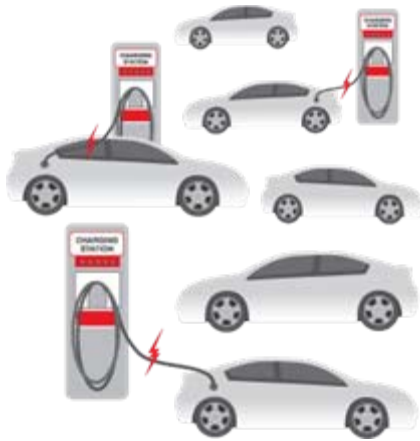
Intelligently Connecting

Plug-In Vehicles & the Grid

August 2009

Electric Transportation Arriving Soon

Over **70%** of auto makers* are introducing plug-in vehicles
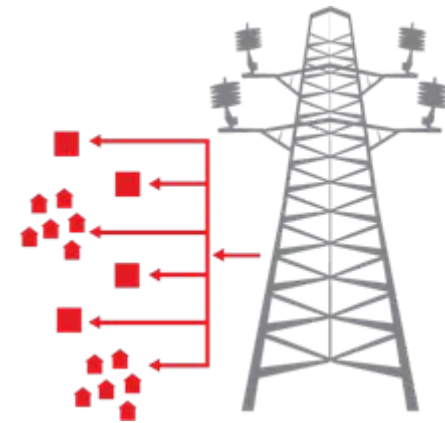
*by market share

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Establishing a Smart Grid Infrastructure for EVs

Smart Charging:

- Manages the one-way flow of energy

- Allows drivers to set parameters

- Balances grid & driver needs via sophisticated software

- Enables adaptive management:
  - Delay/slow during peak demand
  - Increase with availability of renewable energy

Plug-In Vehicles

- Connecting to the grid in 2010

- Many rollouts call for 240V/L2 wall mounted garage chargers

- Adoption likely clustered in neighborhoods

Grid Distribution System

- Charging management technology is required[*]

- Capacity exists for wide EV adoption[*]

- A few EVs, clustered & charging at peak, could impact reliability

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Smart Charging Management Opportunities

Load Shifting
Time based management shifts charging behavior into non-peak periods

Demand valleys can be filled by scheduling charging around a central time

Renewable Integration
Based on a live wind or solar signal, charging can be synchronized with the availability of renewable energy

System Regulation
Following an AGC signal, the charging load can be dynamically increase or reduced according to grid needs.

Spinning Reserves
The flow of energy can be rapidly slowed or stopped, creating capacity in response to an unexpected power disruption
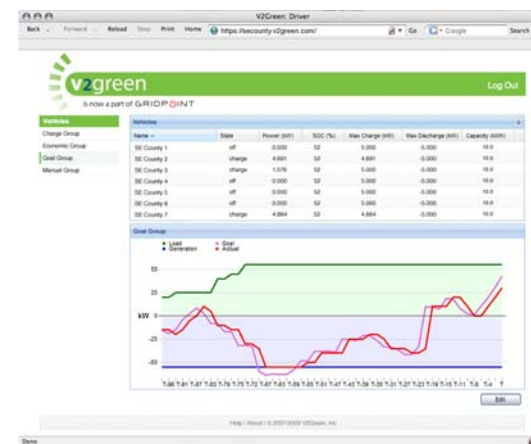
Economic Dispatch
Following a real-time price signal allows energy economics to determine charging behavior
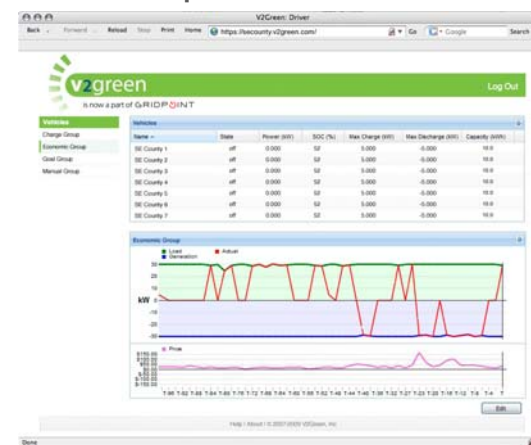
Load Shaping
Following an signal or schedule, charging load can be dynamically shaped according to grid needs

Load Shaping

Economic Dispatch

Smart charging requires connectivity

Smart charging can be highly bandwidth efficient. However:

▶ Many EVs will be sold in areas where the local utility does not operate an AMI data network

▶ Provisioning a location with traditional internet access to support a single EV damages the economics of smart charging

▶ For broad deployment, end users cannot be expected to perform advanced network configuration tasks

There is no one right connectivity solution.

▶ Existing premises internet is workable if the system provides a truly zero-configuration experience

▶ Utility AMI networks are workable in areas where they have been deployed

▶ Creative solutions must be found for locations where neither AMI nor premises internet is appropriate

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