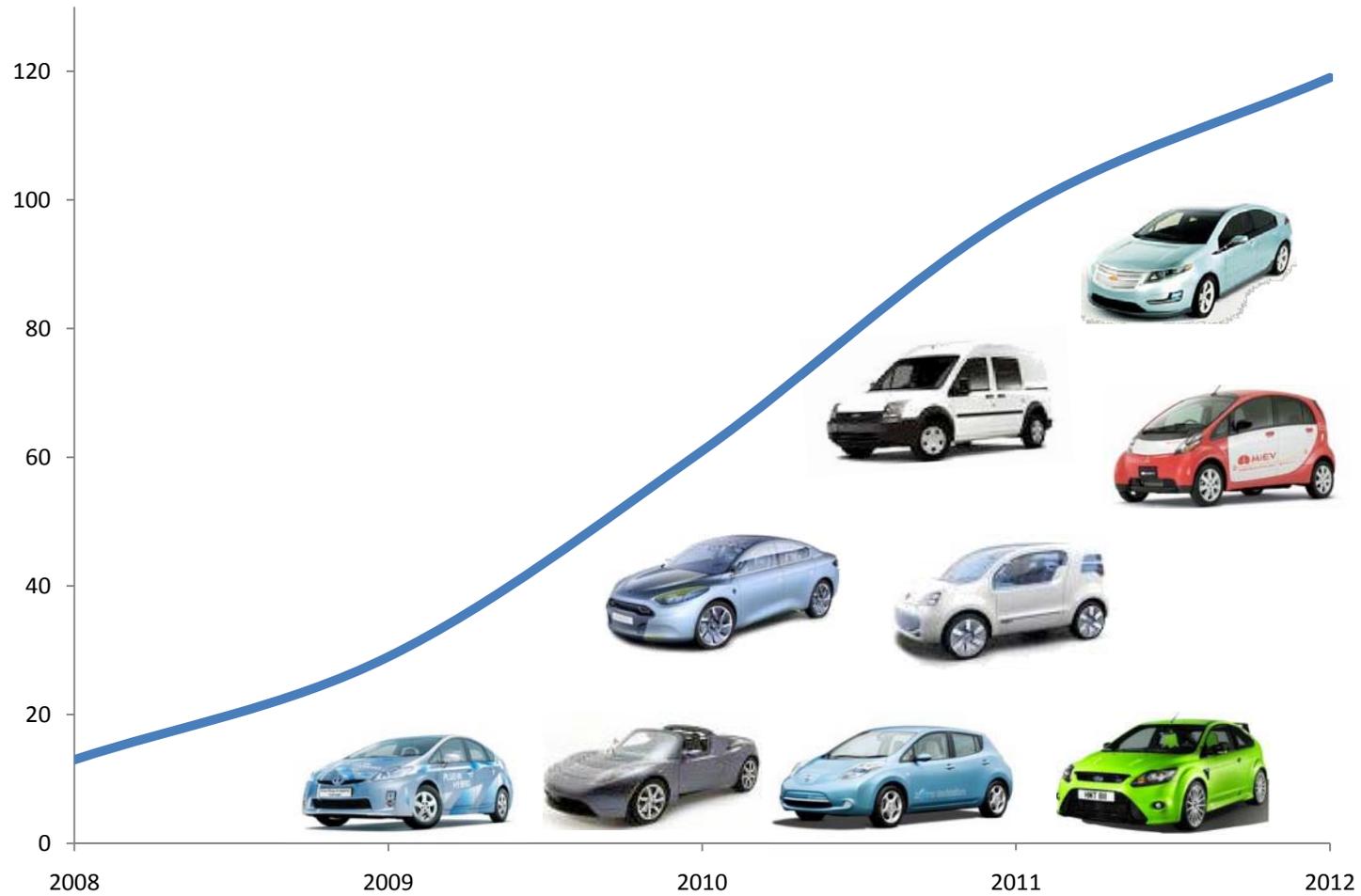


Electric Vehicle Characteristics:

- Instant and smooth acceleration
- Quiet (inside and out)
- Minimal maintenance
- Efficient energy usage
- Zero tail-pipe emissions



Electric Vehicle Models



Electric Vehicles: Battery Electric (BEV) vs. Plug-in Hybrid (PHEV)



Example: Nissan LEAF

- All Electric Range: 60 - 200 Miles, depending on battery size
- Level 1 (120 v), Level 2 (240 v) and optional Fast-Charging (480v)
- Target markets:
 - Urban Commuters
 - Second Car in Every Home
 - Eventually: all-purpose



Example: Chevy Volt

- Battery Electric plus ICE range extender
- 10-40 mi all-electric, 200-300 mi gas
- Level 1 (120v) and Level 2 (240v) Charging
- Target Market: all automotive applications

Nissan LEAF Range and Vehicle Efficiency

Speed and Driving Conditions	Outside Temp (F)	Accessories	Estimated Range (mi)	Vehicle Efficiency (mi/kWh)*
Cruising 38 mph	68°	None	138	5.75
Fairly steady 24 mph City traffic	77°	None	105	4.38
Steady 55 mph Highway	95°	A/C on	70	2.91
Crawling 15 mph Stop-and-go	14°	Heater on	62	2.60
Average 6 mph Heavy stop-and-go	86°	A/C on	47	1.96

Nissan LEAF has a 24 kWh battery

Source: "Nissan Agrees - EV Mileage Will Vary; Leaf Tests Show 91-Mile Variation." Green Car Advisor – edmunds.com. June 15, 2010.

Fuel Source: Electric Power Grid

Grid-Enabled Vehicle System Architecture

Electrification Architecture

(48%) COAL GENERATION
Coal is the dominant fuel source in U.S. power generation, and domestic resources are abundant. Concern regarding emissions has led to investments in technology to capture and sequester CO₂ emissions.



(22%) NATURAL GAS GENERATION
Advances in technology have unlocked substantial natural gas resources in the United States. Burning natural gas emits less CO₂ than coal or oil.



(20%) NUCLEAR GENERATION
Nuclear power is an emissions-free source of baseload power. Some uranium is imported, but from stable suppliers like Canada and Australia.



TRANSMISSION AND DISTRIBUTION
Electricity from America's diverse set of generation sources is delivered to consumers via a widespread network that already exists today.



(9%) RENEWABLE GENERATION
Renewable sources of electricity like wind, solar, geothermal, and hydropower are growing sources of emissions-free domestic energy.

Power Storage
Because wind and solar power are intermittent, they require augmentation. Today, natural gas turbines often perform this function, but stationary lithium-ion batteries may ultimately prove more cost-effective.



The U.S. transportation system and the electric power sector are completely separate today. The emergence of grid-enabled vehicles offers the possibility to synergize these two systems for the first time. In doing so, the transportation system would access the fuel diversity and price stability of the electric power sector, thus substantially improving U.S. energy security.



WORKPLACE
During the day, while GEVs sit idle at the driver's workplace, a network of lithium-ion batteries could function as a valuable source of peak power supply for the electric grid.

RESIDENTIAL HOME
The primary charging location for most non-commercial grid-enabled vehicles will be at homes. By encouraging off-peak charging, policymakers can ensure that GEVs take advantage of substantial spare capacity in the power sector.

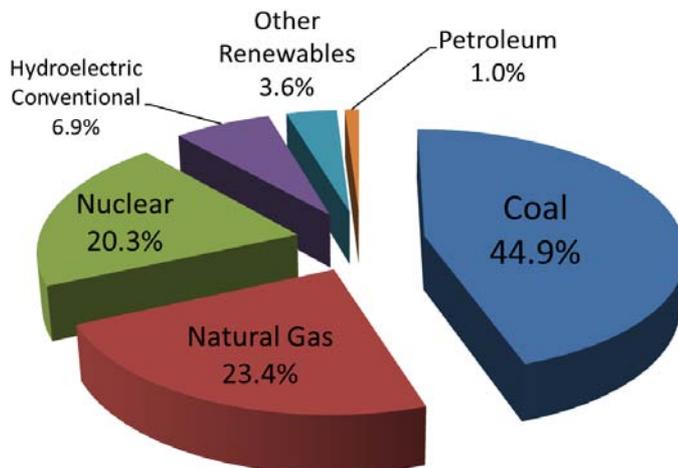
RETAIL LOCATIONS
Access to electric vehicle supply equipment at retail locations could allow drivers to charge while shopping. It would also increase early consumer confidence in GEVs and provide retailers with a marketing opportunity.

Fuel Source: Electric Power Grid

Advantages:

- Diverse and domestic
 - Prices are stable
 - Substantial spare capacity
- Network infrastructure already in place
 - Electric miles cheaper than gas
 - Electric miles are cleaner than gas
 - 65 percent of present U.S. light-duty vehicles could be powered by existing off-peak generating capacity

2009 U.S. Electricity Generation by Source



Fuel Source: Electric Power Grid

Managed Charging Reduces Costs and Risks to Utilities

Projected grid Impacts of 2 million electric vehicles

Israel Electric Co. (2008)	Additional Generation	Additional Transmission	Additional Distribution	Total Cost
Unmanaged Charging	2,345 MW	1 switching station 10 substations 18 transformers	2,158 km cables	\$4,586M
Off-Peak Incentives	1,770 MW	1 switching station 7 substations 13 transformers	1,581 km cables	\$3,414M
Managed Charging	<i>None</i>	<i>None</i>	287 km cables	\$471M

Charging Infrastructure

- Level 2 charging (SAE 1772) will be the majority of charging both at home and in public and will be used by all OEMs for both electric and plug-in vehicles.
- DC Fast-charge (Level 3) is more expensive, but delivers higher performance.

Level	Input Voltage	Typical Charging Time	Breaker Size (A)	Electrical Loads (kW)	Typical Locations
I	120 V	8 – 12 hours	15-20	2	Standard 120 volt plug; NEV/Motorcycle charging, Emergency charging
II	240 V	2 – 4 hours	40 amp Typical	3-6	Residential garages, parking lots, public garages, transit centers
DC Quick Charge	480 V 3 phase	20 – 40 minutes	various	30-60	Rapid charging facility near high traffic volume arterials

Charging Infrastructure



- Level 2 chargers (SAE 1772)



- DC Fast-charge (Level 3)