



PHEV Infrastructure: Smart Charging, Vehicle to Home and future Vehicle to Grid

AFVi Webinar
February 26, 2008

Efrain Ornelas
Environmental Technical Supervisor
Electric Drive Technologies
Clean Air Transportation Department
Pacific Gas and Electric Co.

Electricity as a Fuel



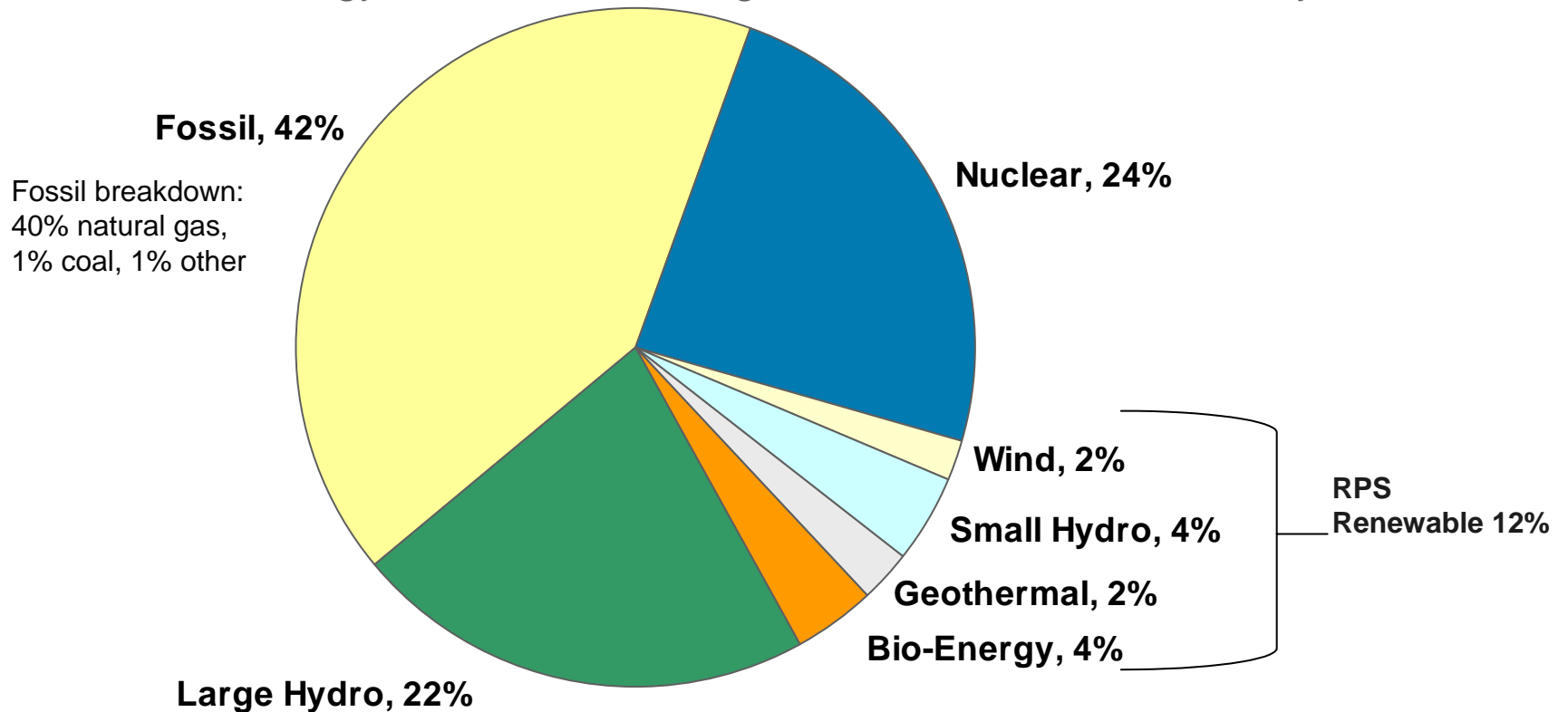
- ◆ Fuel diversity reduces impact from volatility and promotes stability
- ◆ Significant portion of existing generation fuel mix is currently CO₂ free
 - Approximately 56% of PG&E's energy portfolio is CO₂ free
- ◆ Recent and ongoing legislation promotes cleaner generation mix over time
 - RPS legislation enacted in 21 states
- ◆ Low fuel cost and minimal additional infrastructure required
- ◆ Time of Use rates for EV/PHEV charging can create economic incentives
 - Preferential rates for off-peak consumption
- ◆ Large night-time “off peak” usage can reduce overall system average rates
 - Improves utilization rates for existing generation portfolio
- ◆ Projected future renewables tend to be an off-peak energy resource

PG&E's Diversified Resource Portfolio



2006 Electric Energy Deliveries by Technology

PG&E's Energy Portfolio¹ is among the "cleanest" in the Industry

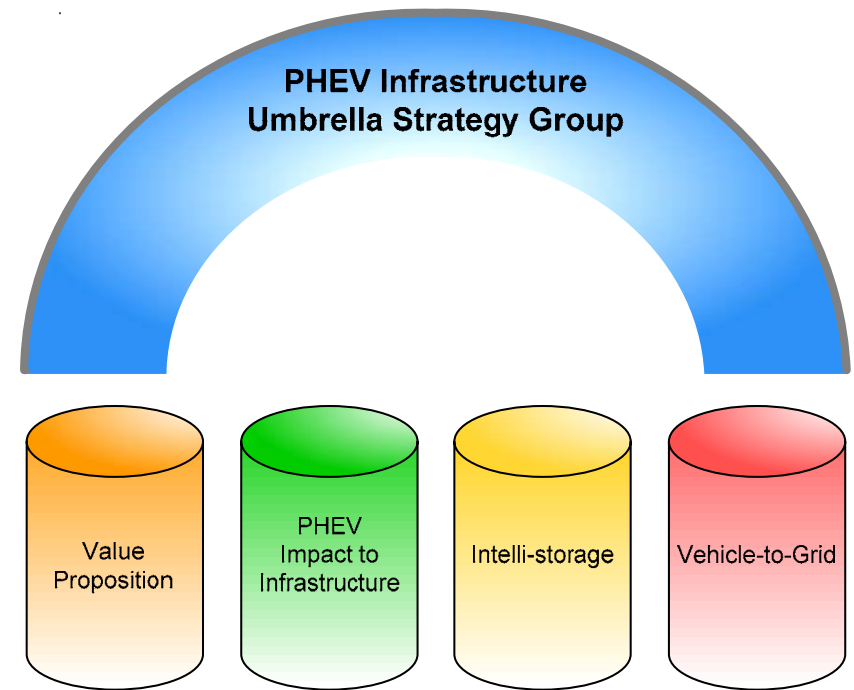


¹ Energy portfolio is comprised of all of PG&E's owned generation plus PG&E's power purchases and is based on actual energy delivered

EPRI - Advanced Infrastructure for PHEVs



- ◆ Enable participation by utilities and others with wide variety of interests
- ◆ Utility value proposition analysis for PHEVs
- ◆ Distribution system impacts analysis
- ◆ Intelli-storage applications of high-volume advanced batteries
- ◆ Vehicle-to-grid requirements, issues & concerns, testing and demonstration
 - Communications Protocols and Standards is Key



Definition of Smart Charging, V2H and V2G



Vehicle-to-Grid (V2G) refers to a spectrum of technologies that involve plug-in vehicles, either plug-in hybrid electric vehicles (PHEV) or dedicated electric vehicles (EV), together referred to as plug-in vehicles, interacting with the electrical grid beyond simple charging of the vehicle batteries.

In the following slides and in rough order of increasing complexity, uncertainty, required research, and necessary additional infrastructure I'll try and describe the various options I'll define as Smart Charging, V2H and V2G.

In terms of timing, Smart Charging may be available in a few years as utilities take advantage of synergies with the deployment of Smart Meters, Backup Power and Home Energy Management (V2H), and Distributed Resources may be available 5-10 years from now, and Ancillary Services and Peak Shaving (V2G) will likely not be available for 15-20 years.

Smart Charging



- ◆ Smart Charging involves the utility controlling when plug-in vehicles charge to minimize the necessity of additional generation and grid capacity to fuel these vehicles. The electrical grid is built to handle times of peak usage, typically summer afternoons and evenings when residential air conditioner use is high.
- ◆ Though we refer to Smart Charging as within the realm of V2G, it will not actually involve the discharge of power from vehicle batteries. The communication technology required to allow Smart Charging will largely be in place when our SmartMeter rollout is complete. The ability for the utility to communicate with vehicle chargers is necessary for several of the applications listed below.

Backup Power/Vehicle to Home



- ◆ Though PG&E is constantly seeking to improve reliability, there are occasionally conditions beyond our control, such as extreme weather events, that disrupt power to our customers. Through the integration of specialized equipment on the customer's plug-in vehicle buy the maker and proper safety controls at the service panel to prevent energy from flowing back to the grid when the utility power is down, the customer can power a few critical items until utility power is restored.

Home Energy Management and Distributed Resources



- ◆ During critical peak periods when the grid is strained with residential air conditioning loads, the price of energy can be very high. With specialized equipment and proper safety controls, customers may choose to use their vehicle batteries to offset some of their energy use. Customers may do this on their own, based on price alerts from the utility, or it may occur automatically through utility signals utilizing the Smart Meter system.

Ancillary Services



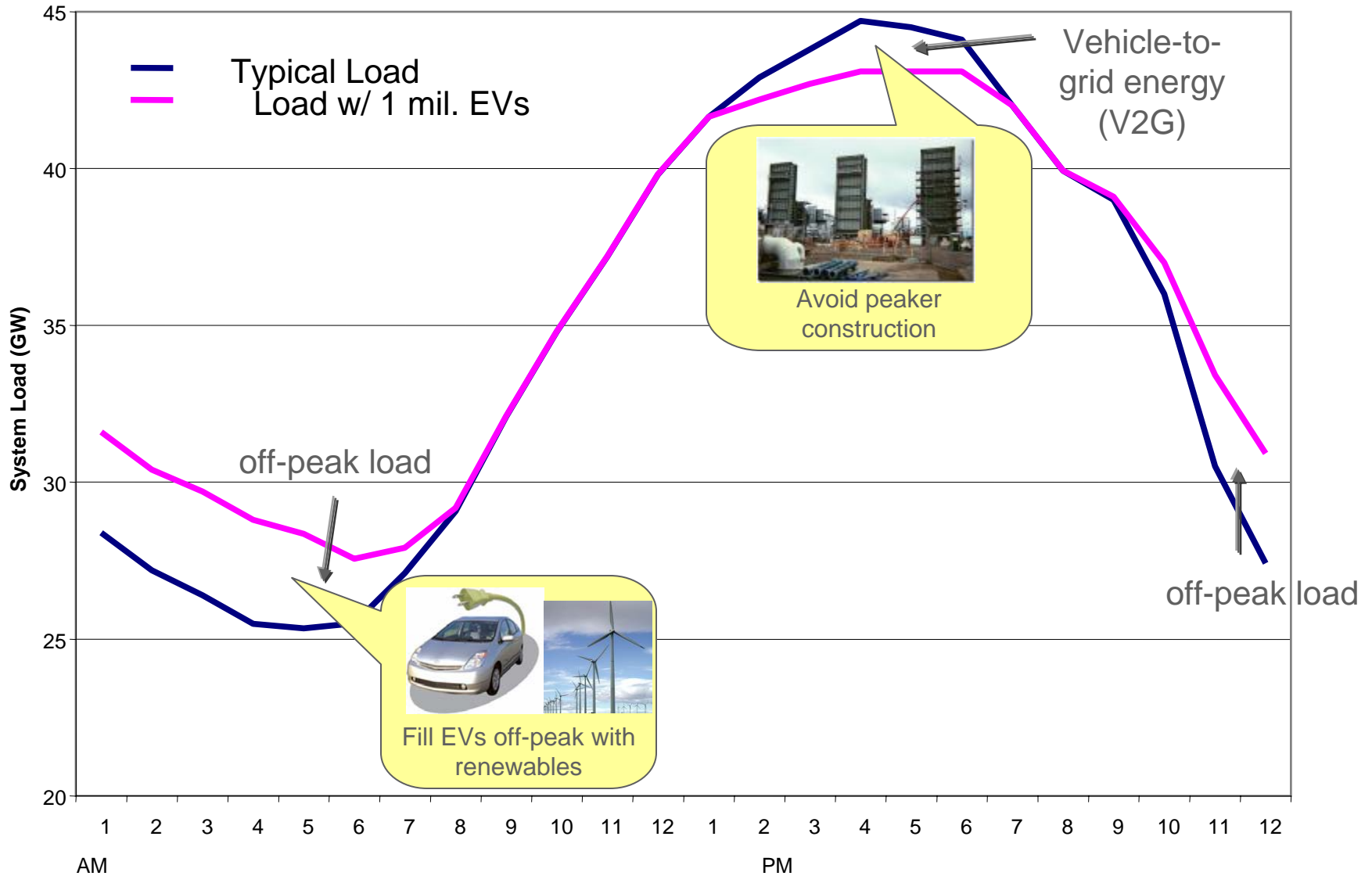
- ◆ In order for our grid to function properly, the amount of generation must be constantly adjusted on a fine scale to keep it matched with the amount of demand. Currently, energy generators such as hydroelectric dams are turned up or down by California's Independent System Operator to regulate the grid, but this may be more cost effective through the remote charging and discharging of vehicle batteries. Due to the level of communication required among the utility, vehicle and customer, along with the need for detailed economic analyses, using plug-in vehicles for ancillary services is likely to be many years away, but much research is occurring now to evaluate this option.

Peak Shaving

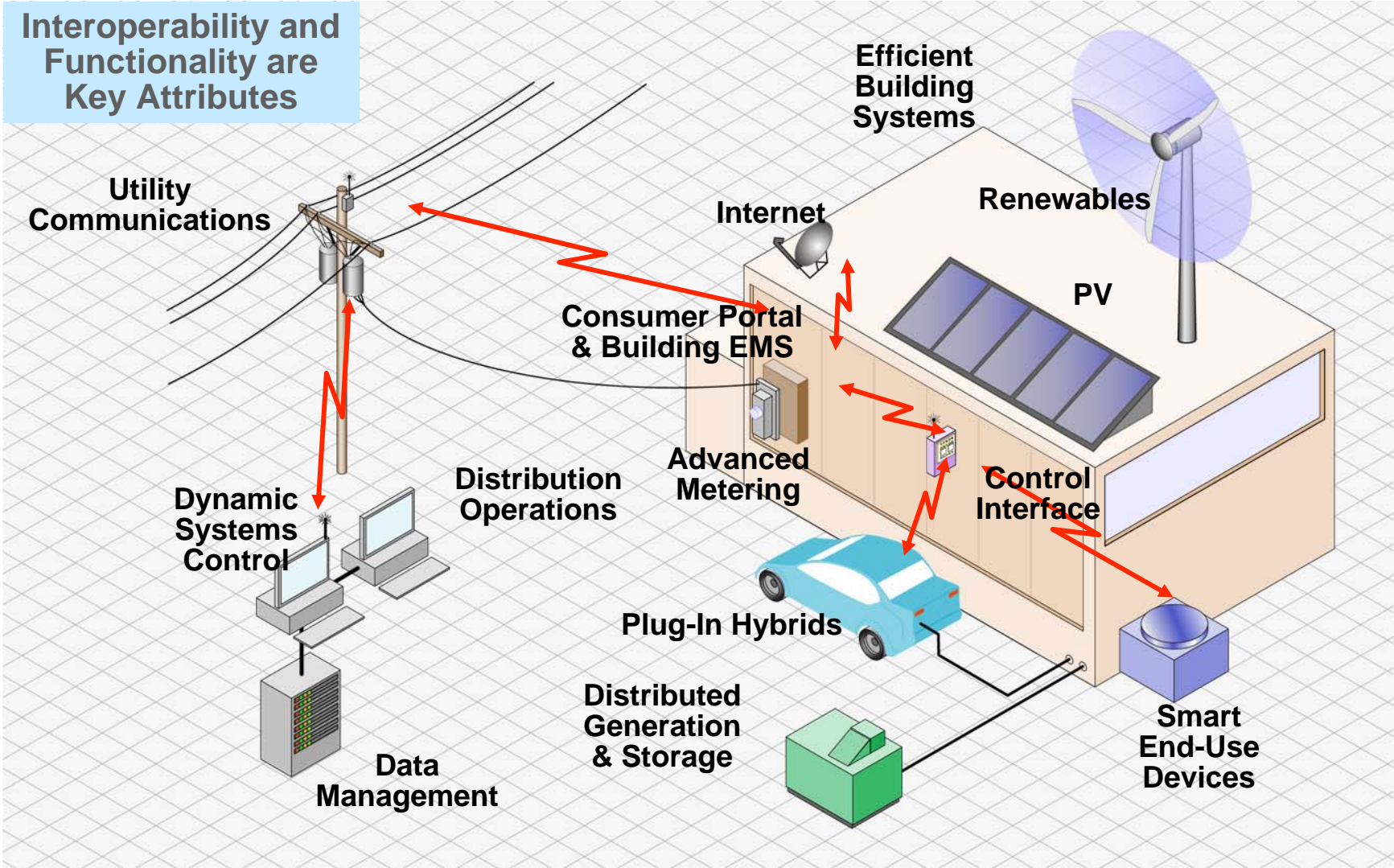


- ◆ Though grid infrastructure, communications and metering technology would require significant upgrades, plug-in vehicle owners may eventually be able to sell energy back to the utility during peak times. In summer afternoons when energy demand peaks, utilities must pay much more for energy from power plants than they do during the middle of the night when demand is lower. Utilities will be exploring possible programs that allows customers to sell energy back to them during the day when their vehicle is parked at their office or train station for a much higher price than they paid for it the previous night when charging their vehicles.

Timeshifting Electricity



Future Intelligent Infrastructure Enabling PHEVs, Energy Efficiency, Consumer Choice



Research Priorities



- ◆ Customer education,
- ◆ Working with auto and truck makers to field-test prototype PHEVs,
- ◆ SmartMeter link to provide a communication and control node for managing the energy necessary to charge vehicle batteries
- ◆ The development of charger and charging standards to ensure interoperability regardless of vehicle maker
 - SAE J1772 and SAEJ2293
- ◆ Building and NEC code revisions to facilitate the addition of PHEV chargers at home.

Closing



- ◆ PG&E strongly believes that plug-in vehicles offer benefits not only to customers who purchase them, due to fuel cost savings and increased fueling convenience, but to society as a whole due to reductions in greenhouse gas (GHG) and pollution from the internal combustion engine and increased energy independence. As such, our main priority is working with automakers, customers and regulators to ensure a positive experience for consumers that want vehicles they can fuel with electricity and investigating the other benefits this technology may offer to the utility and the grid.



PG&E Corporation is committed to being an environmental leader by providing safe, economical, and reliable products and services in a responsible and environmentally sensitive manner.



THANK YOU!