

Regional PHEV Demonstration A Grid Perspective

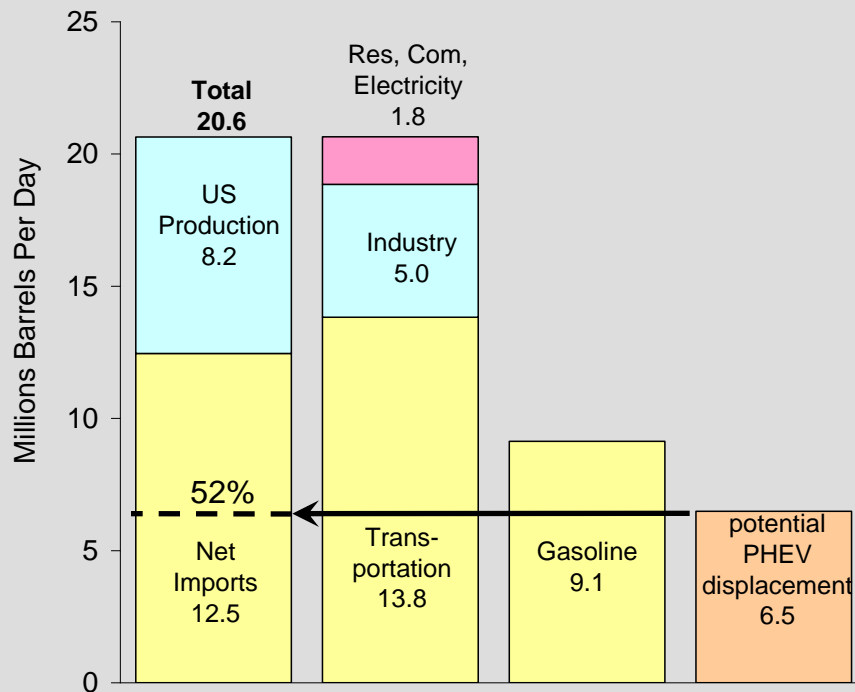
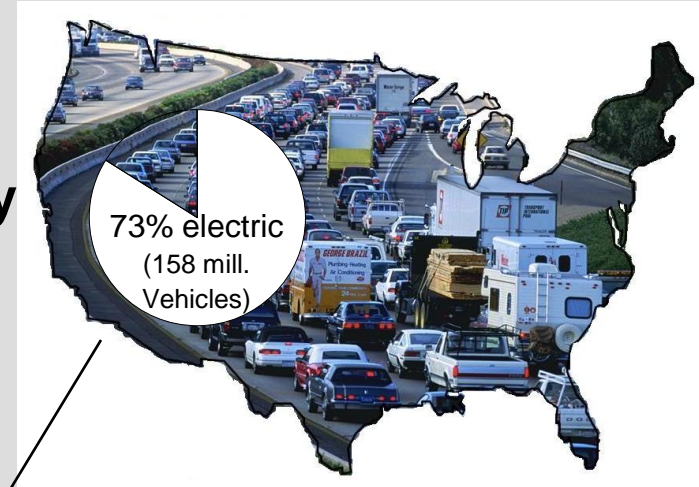
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Jump Start To A Secure,
Clean Energy Future
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U.S. Grid Capability

The idle capacity of the U.S. grid could supply 73% of the energy needs of today's cars, SUVs, pickup trucks, and vans... without adding generation or T&D capacity



- ▶ Potential to displace 6.7 MMbpd (equiv. to 52% of net imports)
- ▶ More sales + same infrastructure = downward pressure on rates
- ▶ Reduces CO₂ emissions by 27%
- ▶ Emissions move from tailpipes to smokestacks (and base load plants) ... cheaper to clean up
- ▶ Introduces vast electricity storage potential for the grid

Source: EIA, Annual Energy Review 2005

Smart Grid Can Deliver the Electricity for Millions of PHEVs

ELECTRIFYING THE TRANSPORTATION SECTOR WITH Plug-in Hybrid Electric Vehicles



"It's in our vital interest to diversify America's energy supply – the way forward is through technology.... We need to press on with battery research for plug-in and hybrid vehicles...." – *George Bush*

"Unused off-peak U.S. grid capacity could supply 70% of the energy for today's light vehicles and reduce foreign oil imports by 50%, without adding generation or transmission." – *Pacific Northwest National Laboratory*

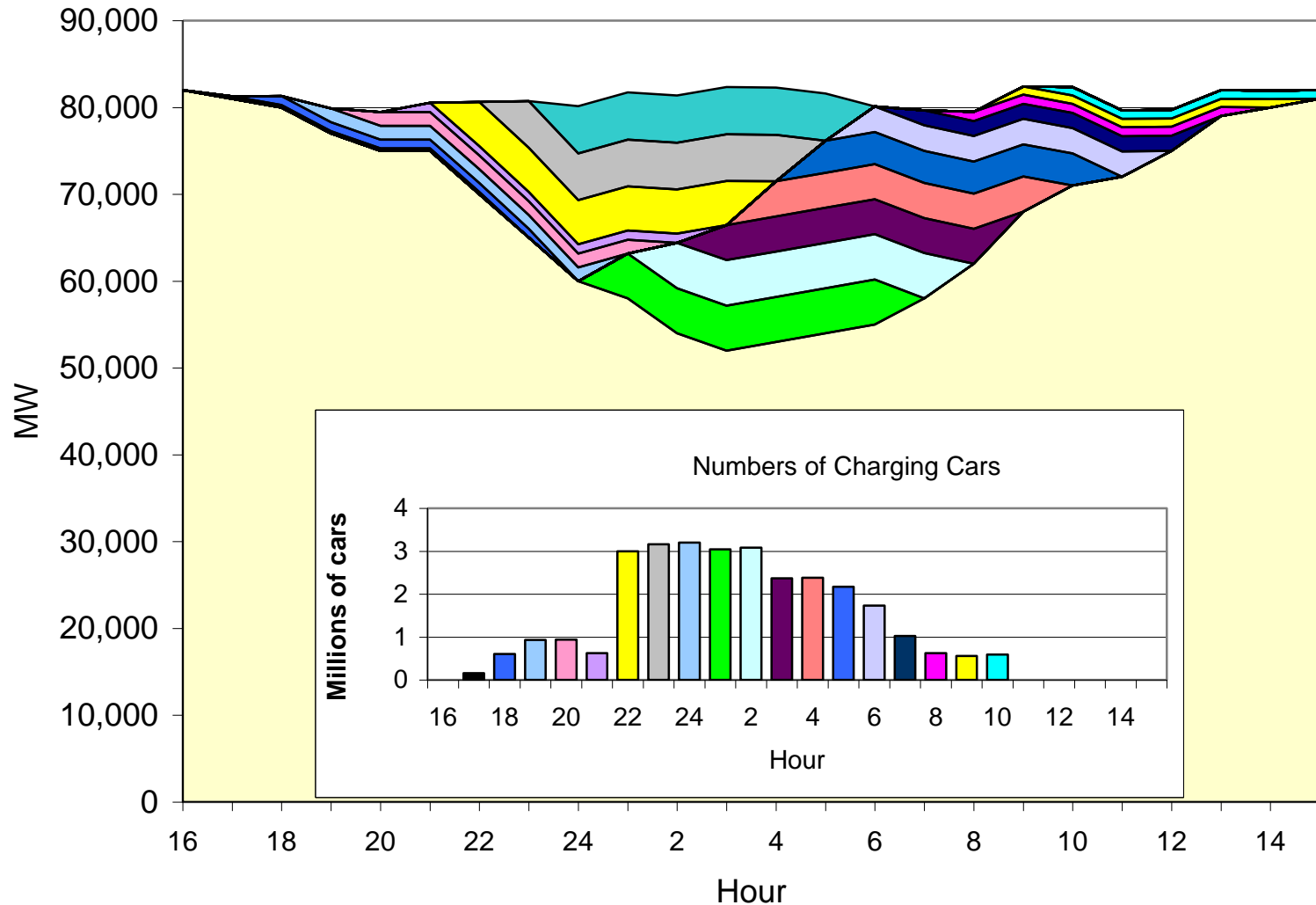
"Nationwide adoption of plug-in hybrids will increase the use of domestically produced electricity and can ultimately reduce greenhouse gas emissions by up to 800 million tons per year." – *EPRI*

"Rarely in history has an emerging technology offered such an attractive opportunity ... as both a new load and resource, to enhance overall performance of the electric power infrastructure." – *National Renewable Energy Laboratory*

"Working with automakers and local utilities, we need to understand how large numbers of PHEVs will be used, and their effect on the grid." – *University of Michigan*

Perfect Valley Filling ECAR Summer Load Profile

Charge each PHEV: 1.4 kW charge (**120V, 12A**) for **7 hours**=10 kWh



Smart Grid as an Enabler to High PHEV Adoption

- ▶ Value proposition of PHEVs works only when off-peak power can be used
 - Customers:
 - Off-peak, retail: 7 ¢ /kWh electricity - > \$0.77/gal_e
 - On-peak, retail: 33 ¢ /kWh electricity - > \$3.63/gal_e (SCE TOU-EV1)
 - Utility:
 - PHEV attractive as valley filler to achieve higher asset utilization
 - Enormous generation and T&D investments if peak power is used
- ▶ “Smart” charger will become a necessity for
 - Load management
 - Price-based: critical peak/time-of-use pricing/real-time pricing
 - Direct load control
 - Autonomous control to reduce stress during emergency condition
 - V2Home
 - V2Grid

Key Issues to Address in Regional PHEV Demonstration

- ▶ Analyze interactions with the grid
 - Validate charging profiles
 - Where, when, how much PHEVs are charged
 - T&D planner need to know PHEV load profiles to maintain reliability
 - Key outcome of DOE's Technical Review of PHEV Grid Impacts (May 14, 2007)
 - Fair and attractive rate design to incentivize load management
 - Technology demonstration for load management and V2Grid
- ▶ PHEV demonstration will reveal technical & organizational challenges
 - Who owns the “smart charging” space?
 - What are the infrastructure challenges w.r. to a moving load?
- ▶ Technology standards will provide certainties necessary for infrastructure investments
 - Remember the Infrastructure Standardization/Single Charger System for EVs (CARB, 2001)