Regulatory Influences That Will Likely Affect Success of Plug-in Hybrid and Battery Electric Vehicles

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Vehicle fuel use regulation/policy measures differ. Which should measure plug-in success?

- **Corporate average fuel economy (CAFE) ratings do not represent real world fuel use. However, the range ratings of EVs and PHEVs are based on CAFE tests.**
- **"Window sticker" information on vehicle fuel use predicts more gasoline and electricity use than CAFE ratings.**
  - The GREET model (basis of GHG saving estimates) is based on real world fuel use
  - Methods of crediting electricity use by PHEVs are under development
- **"Cash for Clunkers" measured ARRA program effectiveness on the basis of comparison of fuel economy of vehicles traded in vs. those purchased.**
- **Possibility: Cash for Clunkers & Window sticker approach: Were plug-ins bought instead of HEVs, or instead of conventional vehicles?**
  - If vs. HEVs, then a PHEV operating as a hybrid causes little change
  - If vs. similar conventional vehicle, electric (EV & PHEV) **&** hybrid (PHEV) operation save
  - If plug-ins often replace larger size vehicles, significant savings could be counted

Utility regulations, fuels and efficiency of generators will influence generation mix, GHGs, owner perception

- **Natural gas, wind and coal will be the primary competing fuels**
  - Oil will be saved by using PHEVs and BEVs
  - Preferable natural gas technology is combined cycle power, not gas turbine peakers
  - Old coal fired power plants will sometimes be a source of plug-in electric charge
  - The wind does not blow all the time, or on request
- **Plug-in vehicles are the latest "poster child" for the smart grid**
  - How many plug-in electric vehicle purchasers be upset with smart grid costs?
  - Will smart, high income early adopters insist on no-hassle smart grid technology?
- **Renewable performance standards (RPS) promote wind generation**
  - 35 RPS states by Sierra Club count
  - Philosophical/technological arguments will affect the counting of wind
  - Can it be demonstrated that smart controls have been installed to maximize use of wind?
- **GHG caps/targets in some states (CA certainly – the U.S.? – perhaps)**
  - Must you prove that coal will not be used to garner public support, obtain U.S. $?
  - Must you be able to claim a significant share of wind will be used?
  - Does your state want to impose the costs of measurement that CA will require?

Actually, (de)regulation (partial) creates differing regional pressures for control of plug-in charging

- **1990s theory push – charge time-specific marginal cost, not regulated average cost.**
- **Result: Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) are created by Federal Energy Regulatory Commission (FERC).** Transmission and distribution functions of utilities are separated from generation. Many states are still not covered by ISOs or RTOs, but FERC wants a U.S. system.
- **RTOs generally operate at a multi-state level**. Examples:
  - New England ISO (CT, ME, MA, NH, RI, and VT) (actually an RTO despite ISO name)
  - PJM Interconnection (DE, MD, NJ, PA, VA, WVA, parts of IN, IL, NC, MI, OH)
- **Problem – consumers do not see the marginal prices (@ short time steps)**, only the utility requesting or providing generation. The incentive structure is imperfect.
- **Plug-in storage can aid RTOs** in providing desired reliability and low cost electricity
- **Aggregations of plug-in's** could join the mix of legal entities that could buy and sell electricity through the markets managed by ISO and RTOs. Set up costs are implied.
- **Public Utility Commissions (PUCs) – state organizations that regulate utilities'** rate structures. Utilities so far cannot pass through varying time prices to consumers, but new rate systems are being promoted. States have the power to <u>require</u> renewables to be used – have done so. Note: there are many more utilities than states.
- **CA's PUC has just decided <u>not</u> to place charging services within utility regulation.**

Vehicle and utility regulators have different goals. Conflicts between goals must be managed.

- **Vehicles (Federal CAFE) – save oil**
  - Charge PHEVs as often as possible; use EVs as much as possible
  - Sell as many plug-in vehicles and as much electricity as possible (keep costs reasonable)
    - Squeeze as many miles from batteries as possible
    - Keep electricity costs affordable
- **Regional Transmission Organizations– adopt a "smart" grid**
  - Don't charge on-peak, charge off peak (overnight)
  - Don't create new system peaks by bunching charge initiation or ending at specific hours
  - Don't give electricity away – charge high rates on-peak
- **Public Utility Commissions (states) – equitable, efficient, reliable electric supply**
  - Increasing block rates for equity (and distribution cost) reasons?
  - Time-of-day (TOD) rates to reduce need for underutilized new generating capacity
  - EV specific rates with second meters to incentivize EVs?
  - Control systems to link charging and wind generation to meet RPS?
  - Don't create new neighborhood peaks via multiple high kW chargers w/o control
- **State and city safety regulators – assure quality installation of new charge points**

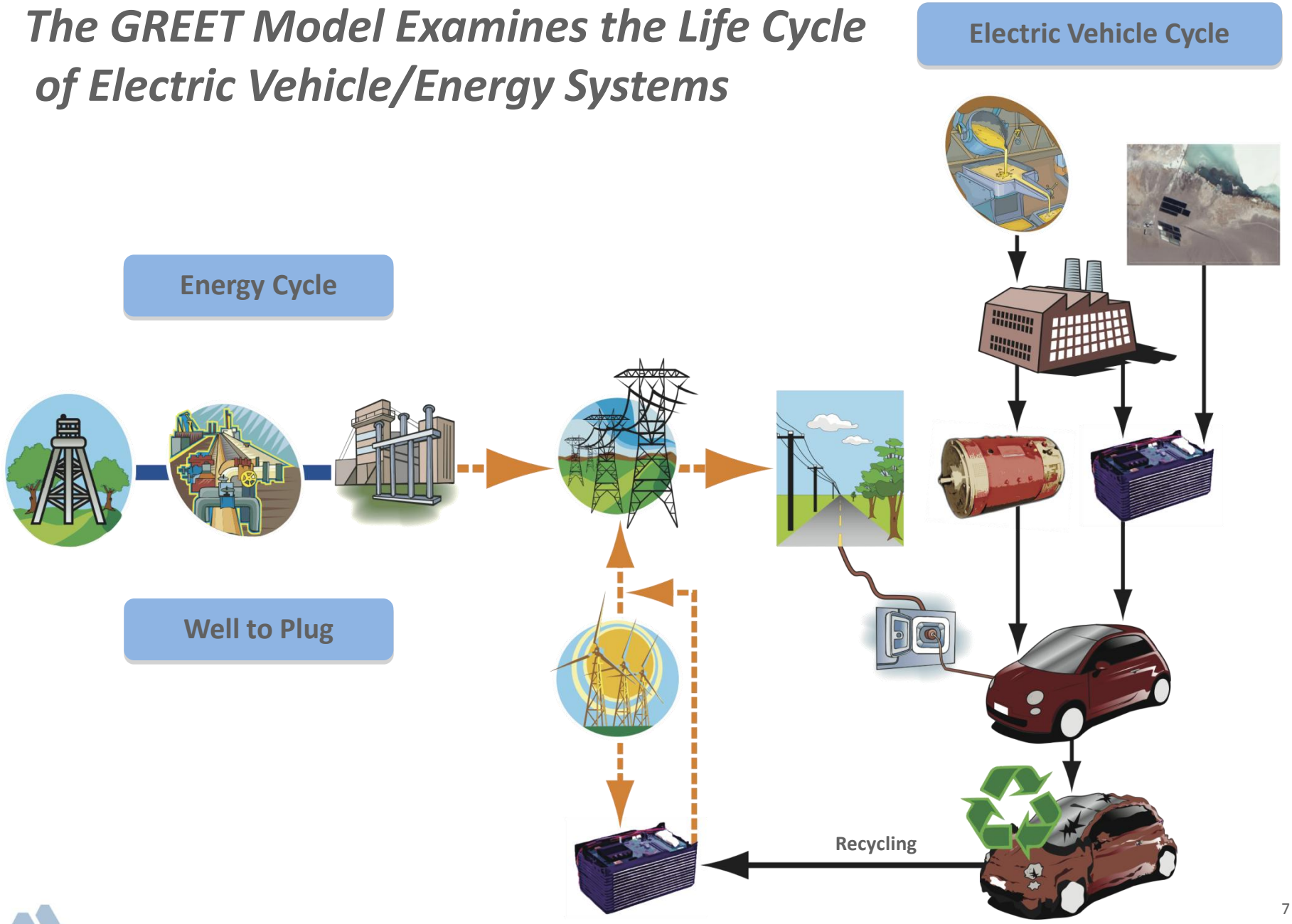
Where ozone reduction for only part of the U.S. was the goal of the 1990s CA ZEV mandate, oil and GHG reductions across all of the U.S. are now top priority.

- **Ozone** – eliminate tailpipe emissions within many polluted urban airsheds on the hottest days of the year. The ZEV acronym was developed because of a tailpipe emissions reduction goal by regulators responsible for the vehicle's contribution to the *summer* airshed total. This ignored powerplant emissions.

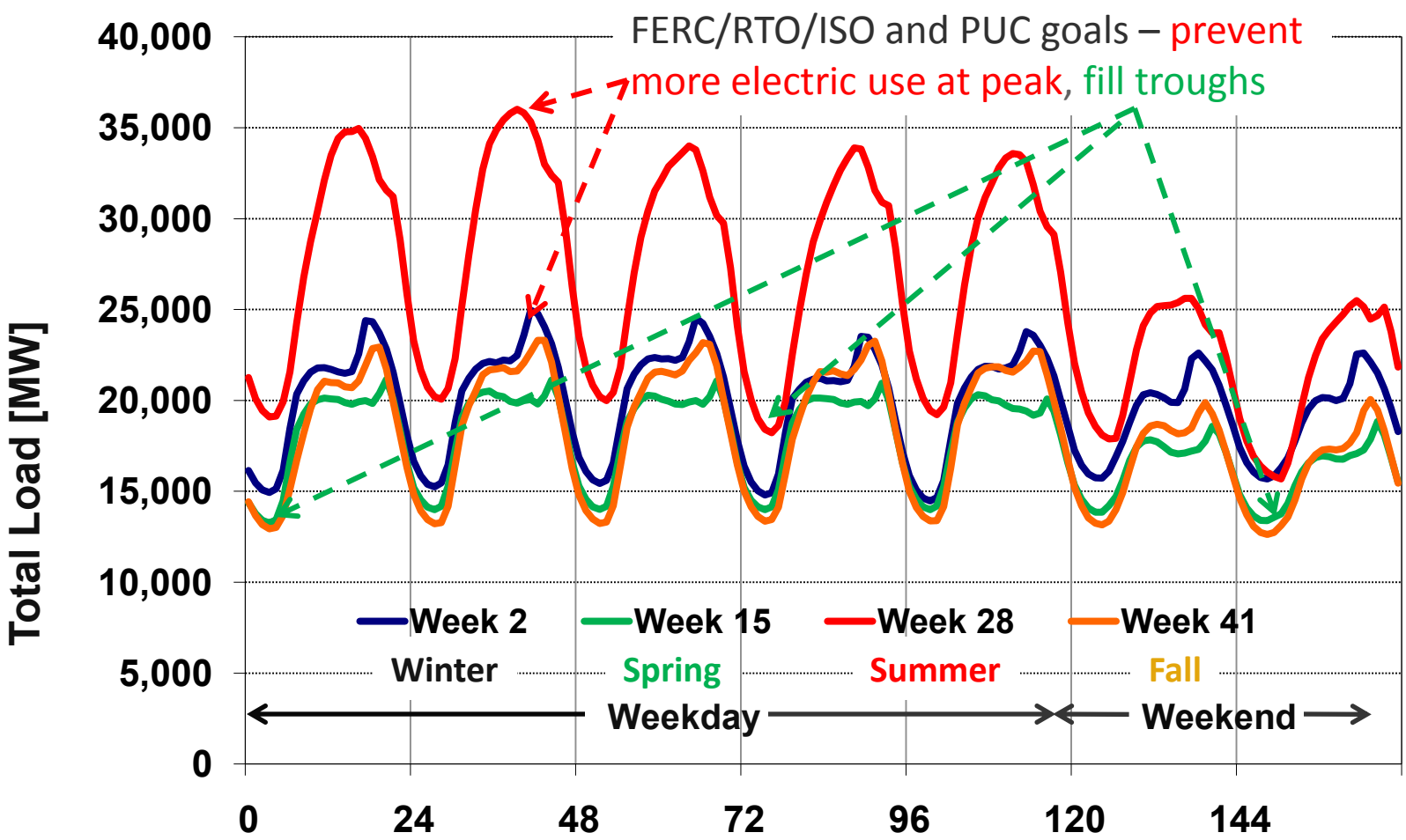
- **Oil use reduction** – fully electrify miles (EVs, E-REVs) and implement more efficient electric drive to reduce fuel use per mile (PHEVs, HEVs). A *year round* national effort accounting for four season performance fluctuations. Vehicle level analysis suffices.

- **GHG reduction** – same as oil use reduction except "Life Cycle" analysis is required. Generation technology and fuel type must be tracked. Energy used in the added vehicle mass from battery packs must be accounted for. *Year round* widely scoped *system level* analysis is required, even extending beyond U.S. borders.

The GREET Model Examines the Life Cycle of Electric Vehicle/Energy Systems

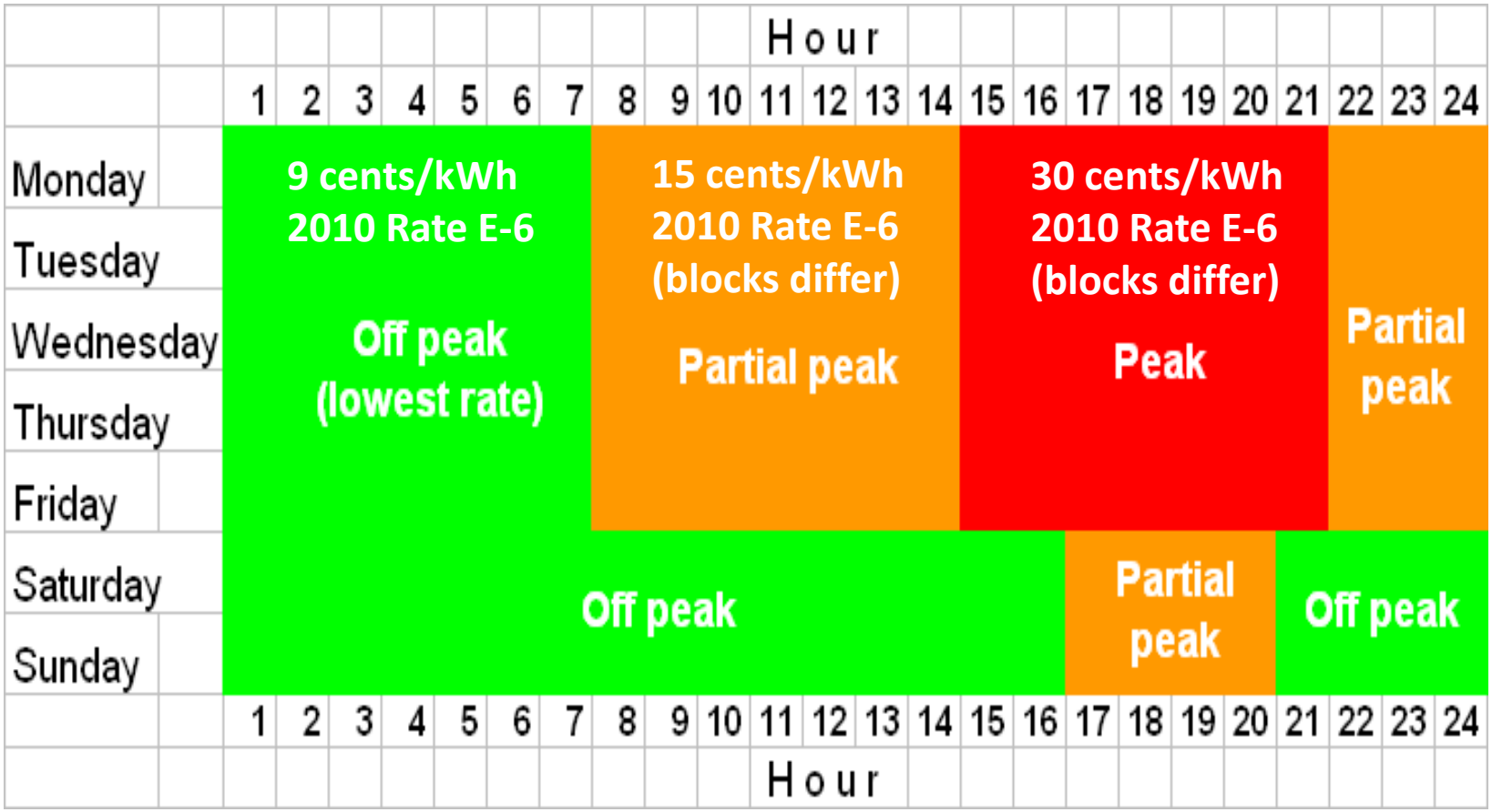


The value of electric drive to utilities and the grid is to make use of capacity wasted in overnight troughs



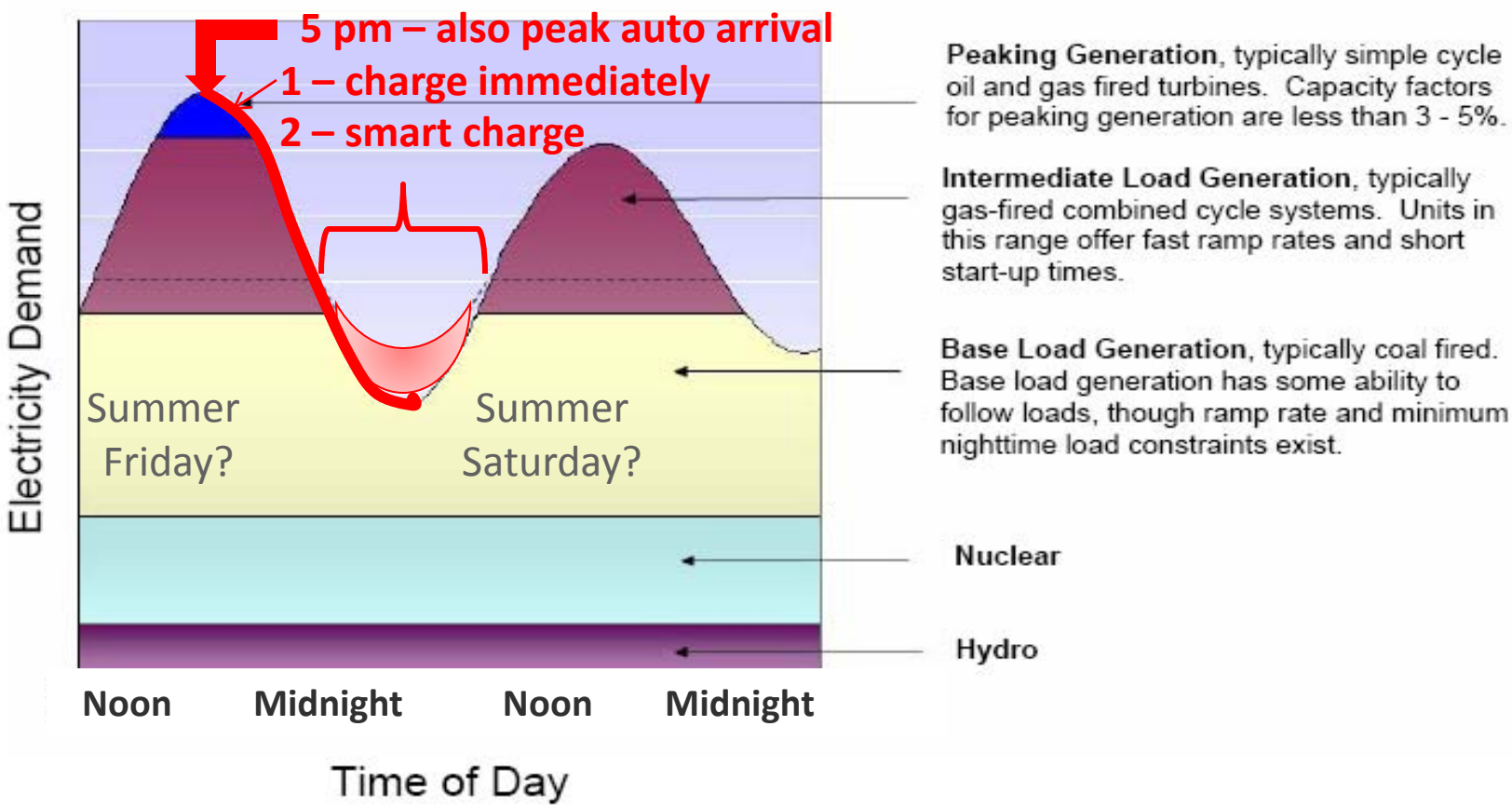
NY-ISO Seasonal Load Profiles - Hour in Week

Time of Day (TOD) "smart" pricing is desired to keep customers from charging on peak, requiring new capacity. Smart grid advocates tout cheap rates at night (don't mention high day rates)

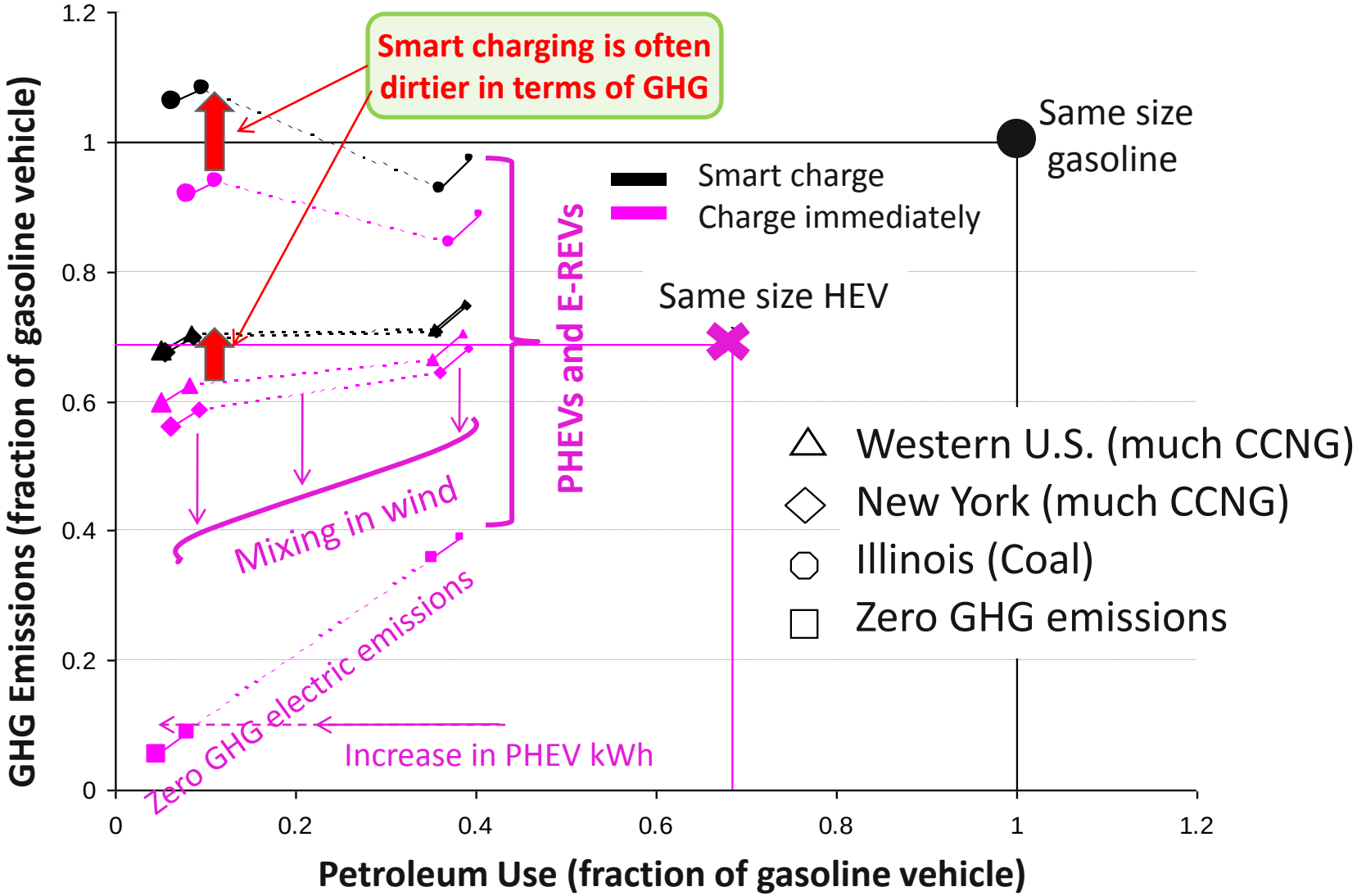


Pacific Gas and Electric 2007 summer rate blocks as a function of time and day

If the trough dips into coal generating capacity, then coal may be the source of power for "smart" "super off peak" charging. If not, combined cycle natural gas generation is likely.



Complicated, but simple. The more kWh/day, the more a plug-in reduces oil use. For GHGs — if too much coal, maybe up. NG only, down. Fold in wind, show how.



Don't let optimism inappropriately stretch potential positives to idealized probabilities

- **Smart charging and plug-ins are a <u>not</u> perfect combination**
- **Wind power and plug-ins are <u>not</u> an inexpensive, effortlessly implemented combination**
- **Power plants are not running unnecessarily at night – electricity for plug-ins is <u>not</u> excess electricity. Excess capacity, yes; excess generation, no!**
- **Although marginal costs of overnight electricity for plug ins are very low, introduction costs will exist and must be minimized.**
  - Neighborhood transformers can overload if plug-ins cluster at that transformer
  - Level 2 charging upgrades in garages vary in cost, can cost thousands per upgrade
  - Level 3 "fast" charging between cities – can be <u>very</u> expensive
  - <u>Some</u> new power plants may be needed if poor charging strategies are used

As with diet pills, sales of plug-in vehicles alone does not guarantee success. Your results may vary.

- Current generation mix (Argonne study says little/no added capacity for plug-ins)
- Charging strategies adopted
  - Charge immediately
  - Instruct the vehicle to complete charge just prior to departure
  - Charge voluntarily according to manufacturer and ISO recommendations
  - PHEV delay to charge in off peak, after installing a TOD meter
  - EV delay to charge in off peak, after installing a separate EV meter and level 2 charger
  - Turn over charge management to the ISO/RTO or its representative, after installing smart meters and control systems, with contracts
- Existing and planned electric rates, support or indifference by PUC, ISO, RTO, utilities
- Coordination of charging to maximize use of wind capacity (through ISO or RTO?)
  - Turn over charge management to the ISO/RTO or its representative, after installing smart meters and control systems, with contracts
- Success of charging strategies in promoting (and/or deterring) daytime charging
- Age of building stock and rate of new construction (new is cheapest way to do charging infrastructure, young is next cheapest)
- Level of state and community support for easy, efficient charge circuit installation

If smart grid advocates don't want charging at the peak, do we want to promote daytime charging?

- Should restaurants and retail outlets offer free electricity to customers (due to state laws preventing resale of kWh)?
- Should households "top off" during dinner at home, in preparation for a show or shopping?
- Should workplaces shuffle multiple cars per day to limited charging stations, pushing charging late into the afternoon?
- How much will oil savings benefits rise with daytime charging?

Closing thoughts on oil savings via clean technology

- **To enable a "Cash for Clunkers & Window sticker" approach to estimating nominal gasoline (oil) savings, data is needed. Were plug-ins bought instead of HEVs, similar conventional vehicles, or large conventional? What information gathering strategies with dealers and fleet managers can be developed?**

- **To save more oil, increase kWh throughput of plug-in vehicles. Work with fleet managers and consumers to eliminate surprise costs, coordinating with the state PUC and your utilities on impacts of present and potential rate structures your plug-in owners will see.**

- **Manage conflicting relationships with smart grid advocates /opponents and with environmentalists. Be aware of upstream emissions from electric drive and battery pack manufacture. Promote charging that reduces life cycle emissions and does not strain the capacity of the grid. Track implementation of charging equipment/infrastructure, smart controls & contracts to use wind.**

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