

# Panel 2: Energy Storage Applications and Economics

## EVs/PHEVs and Energy Storage

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A Utility's Energy Storage and Fleet's Service Provider

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# ELECTRIC VEHICLE RESIDENTIAL DEMAND

- Until now, base growth of 1% per year for USA Grid
- At 25% of US vehicle fleet is “only” 2% of total MW (and billions of \$ in generation and distribution costs)
- On a distribution feeder, a car’s 6 KW connection under a home’s peak usage of 3 KW is +200% & is very significant

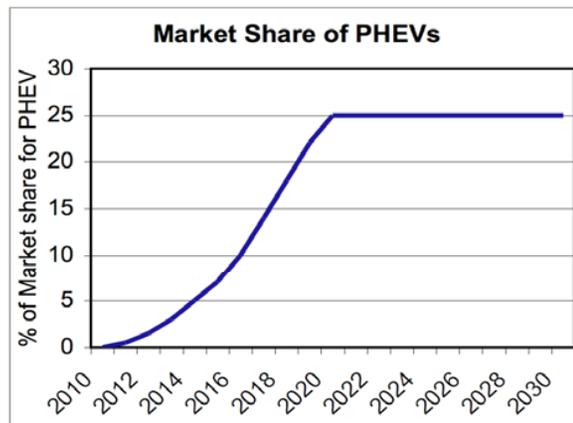


Figure 2. Projected market share of PHEVs.

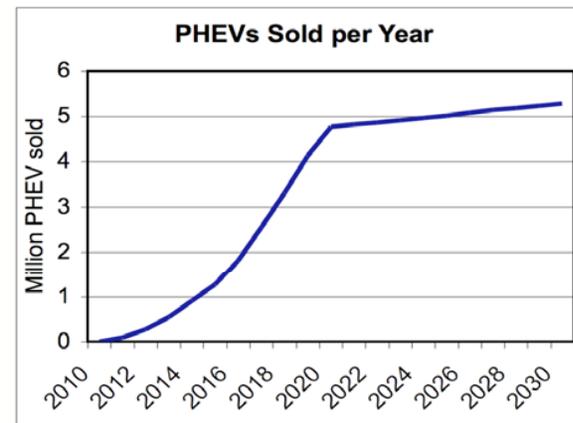


Figure 3. Projected number of PHEVs sold per year.

Oak Ridge National Lab

Potential Impacts of Plug-In Hybrid Electric Vehicles on Regional Power Generation (1/2008)

[www.ornl.gov/info/ornlreview/v41\\_1\\_08/regional\\_phev\\_analysis.pdf](http://www.ornl.gov/info/ornlreview/v41_1_08/regional_phev_analysis.pdf)

# Grid Impacts from PHEVs & EVs

- Without SmartCharging:

  - 130 new power plants needed with 25% PHEV/EV penetration (source: ORNL), but still 40% less emissions when “filled” with coal based generation

- With SmartCharging:

  - Theoretically ZERO new power plants needed (source: ORNL) until 73% of total fleet with generation “valley fill”

- With SmartCharging:

  - Reduce to 85% fewer car emissions by reducing total number of power plants (source: NREL, and being studied by Xcel Energy)

# HOWEVER!

## Commercial Fleets will Deploy First

### USA 2008 Data

Number of Motor Vehicles Registered

Millions of Annual Miles per Vehicle Class

% Miles in the United States

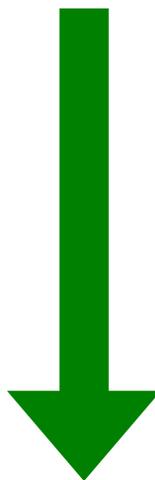
PASSENGER CARS	MOTOR-CYCLES	BUSES	OTHER 2-AXLE 4-TIRE VEHICLES	SINGLE-UNIT 2-AXLE 6-TIRE OR MORE TRUCKS	COMBINATION TRUCKS
137,079,843	7,752,926	843,308	101,234,849	6,790,882	2,215,856
1,615,850	14,484	7,114	1,108,603	83,951	143,507
54.3%	0.5%	0.2%	37.3%	2.8%	4.8%

### Average Daily Range Needed (Twice Average)



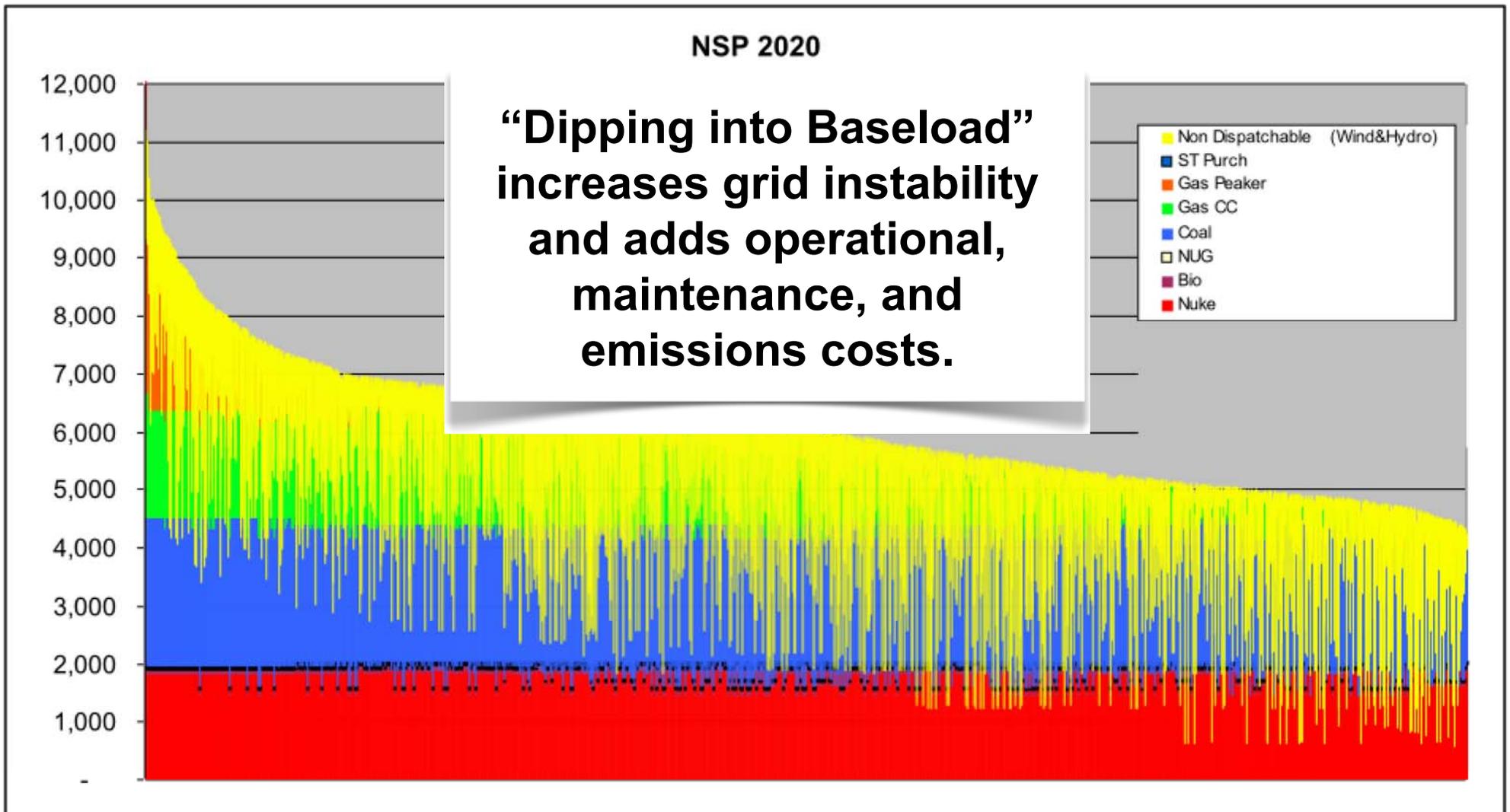
# Scale of The US Electrical Energy Grid

If Full, 50% of the US Fleet would hold **6,238 GWh** of Electrical Energy Storage



US Electrical Grid Produced **4,119,000 GWh** of Energy in 2009 or 470 GW each hour. The Fleet could average **13 hours per day** of stored energy.

# Storage as “Shock Absorber” to Mitigate Baseload “Bottoming”?



**NSPM System: Effect of Absorbing 3,800 MW of Wind Energy**

# 2007 XCEL ENERGY / NREL



## PHEV STUDY

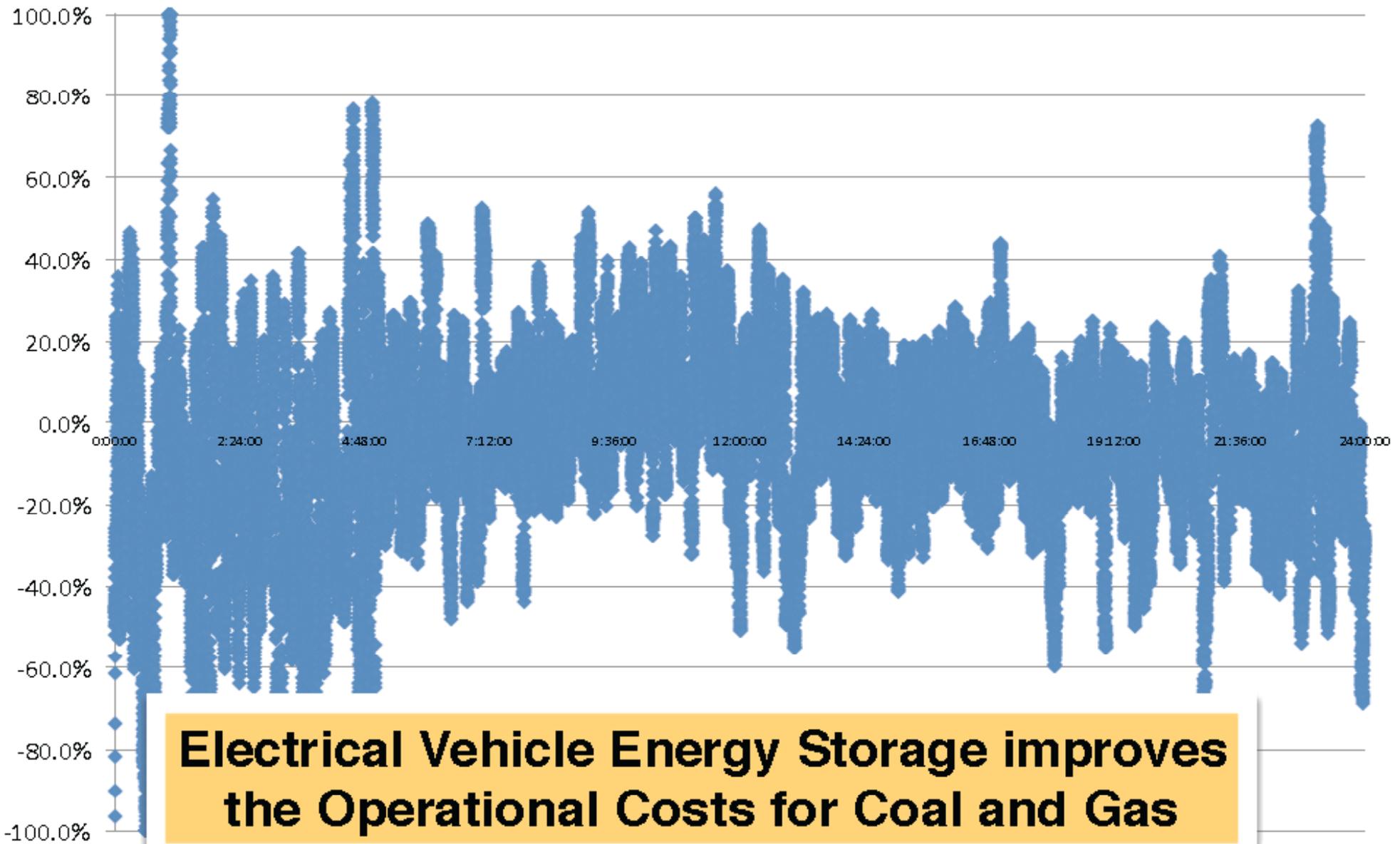


Scenarios	Production Cost	Capacity Cost	Avoided Gasoline	Emissions	Distribution Impacts
Do Nothing	Good	Worse*	Good	Better	Worse*
Delay to 10pm	Better	Best	Good	Good	Best
Optimized to Off-peak	Best	Best	Good	Worse	Best
Opportunity Charging	Worse	Worse*	Best	Best	Worse*

We discovered that for any utility:

- Time of charging matters...
- Coincident peak loading matters...
- Tailpipe versus upstream emissions matter...

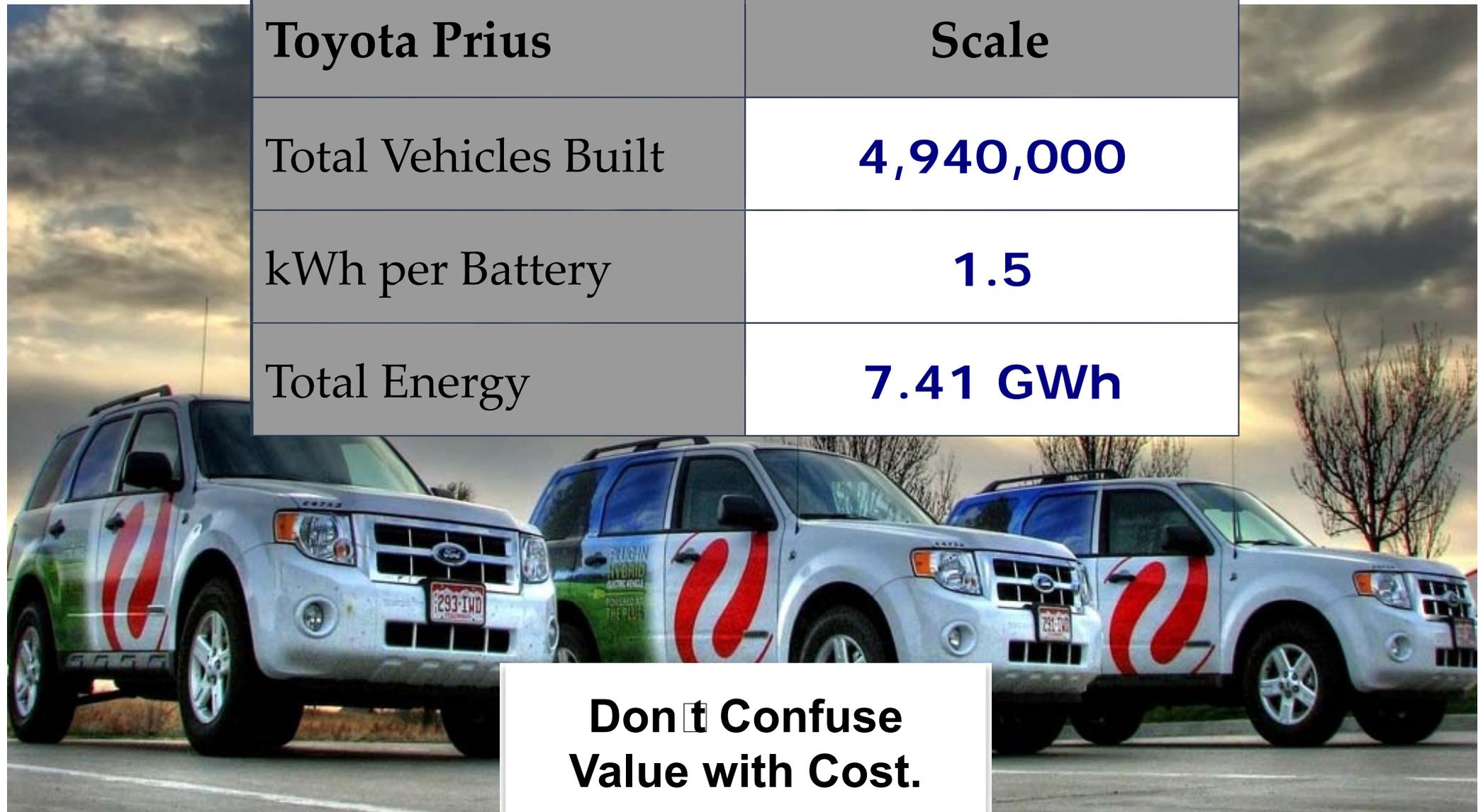
## 2 Second Generation Control Signal for One Day in August (as a % of Power Needed)



**Electrical Vehicle Energy Storage improves  
the Operational Costs for Coal and Gas**

# Batteries are Already Everywhere

Toyota Prius	Scale
Total Vehicles Built	<b>4,940,000</b>
kWh per Battery	<b>1.5</b>
Total Energy	<b>7.41 GWh</b>



**Don't Confuse  
Value with Cost.**

# Commercial Fleet Plans

- Top 100 Fleets are 80% of All Commercial Vehicles
  - Commercial Vehicles are 60% of all Vehicles
  - Electric Vehicles are viable considering Total Cost of Ownership for 30% of the Present Commercial Fleet
  - Commercial Fleets will spend capital to reduce operating costs
  - Commercial Fleets can justify the cost of LARGE grid interconnects
1. Commercial Fleets will not follow to deployment of low GVWR vehicles like the Prius as they are a very different customer segment
  2. Commercial Fleets will retrofit post-warranty vehicles if they can cost justify the expense to their operations
  3. Impact to the Utilities will be managed pro-actively and under professional but time-sensitive fleet management

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