EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Utility Industry Value Proposition for PHEVs

EVS-23 PHEV Workshop
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“Times they are a changin’…”

- Generation technologies in a carbon constrained world
  - Carbon capture & storage

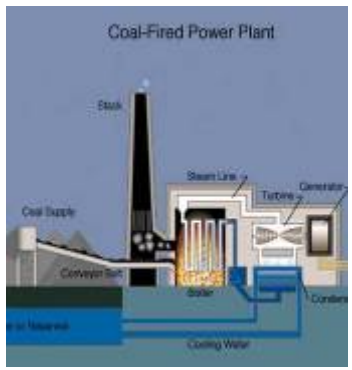
More than 70% of Coal is Carbon

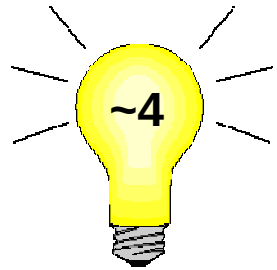
- Unprecedented convergence of computing and communication technologies
  - Advanced Metering Infrastructure is just the beginning of the **Smart Grid**

Smart Thermostat and Meter

Energy Efficiency – End to End

Generation	Transmission & Distribution	End Use Utilization
~ 65% loss	~ 7% loss	~ 88% loss (incandescent light example)

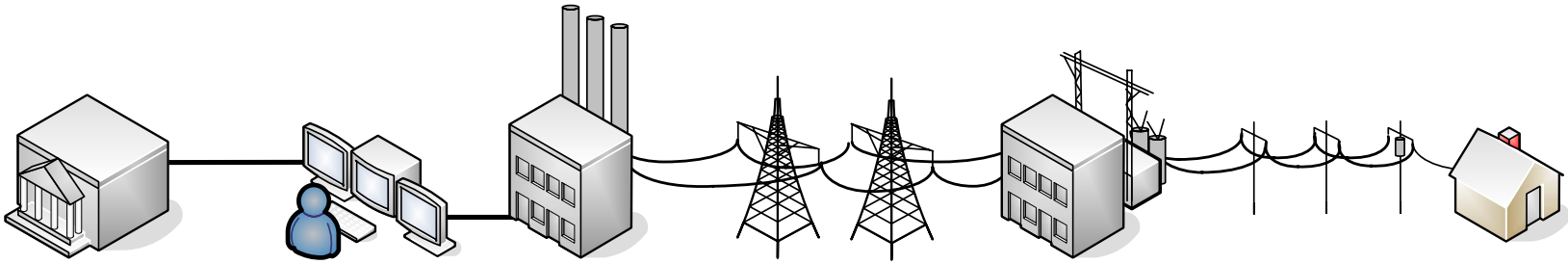
coal **100** → 

→ electricity **~ 35** →  → electricity **~ 32** → 

Generation, Delivery and Utilization –
Opportunities to Improve Efficiency Across the Electricity Chain

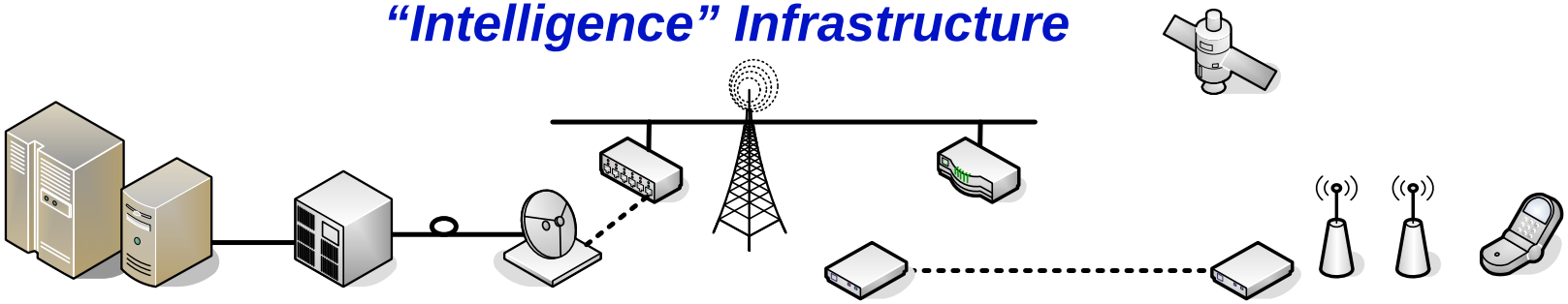
EPRI Engaging the Industry to Develop an End-to-End Energy Efficiency Framework

Achieving the Power Delivery System of the Future:
Integrating Two Infrastructures

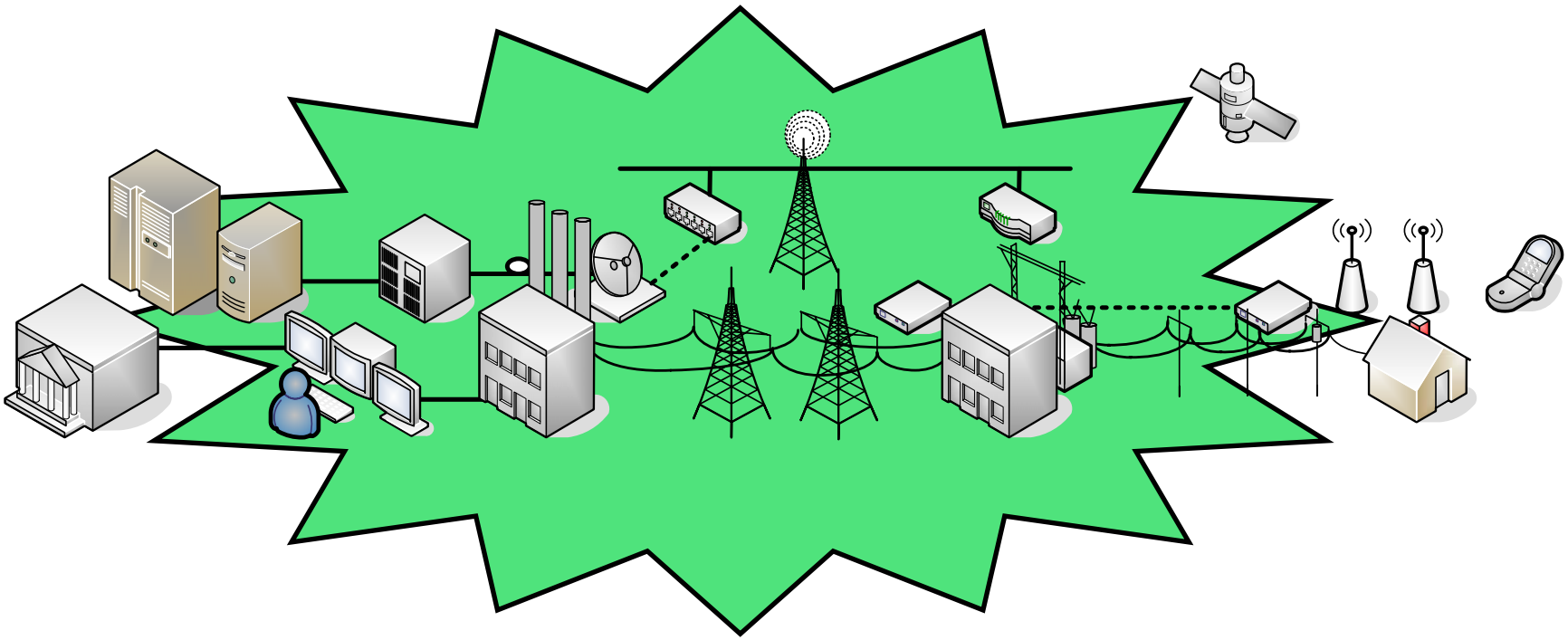


Electrical Infrastructure

"Intelligence" Infrastructure



The Smart Grid
One Integrated Process



Value of Improving Load Factor

Generation

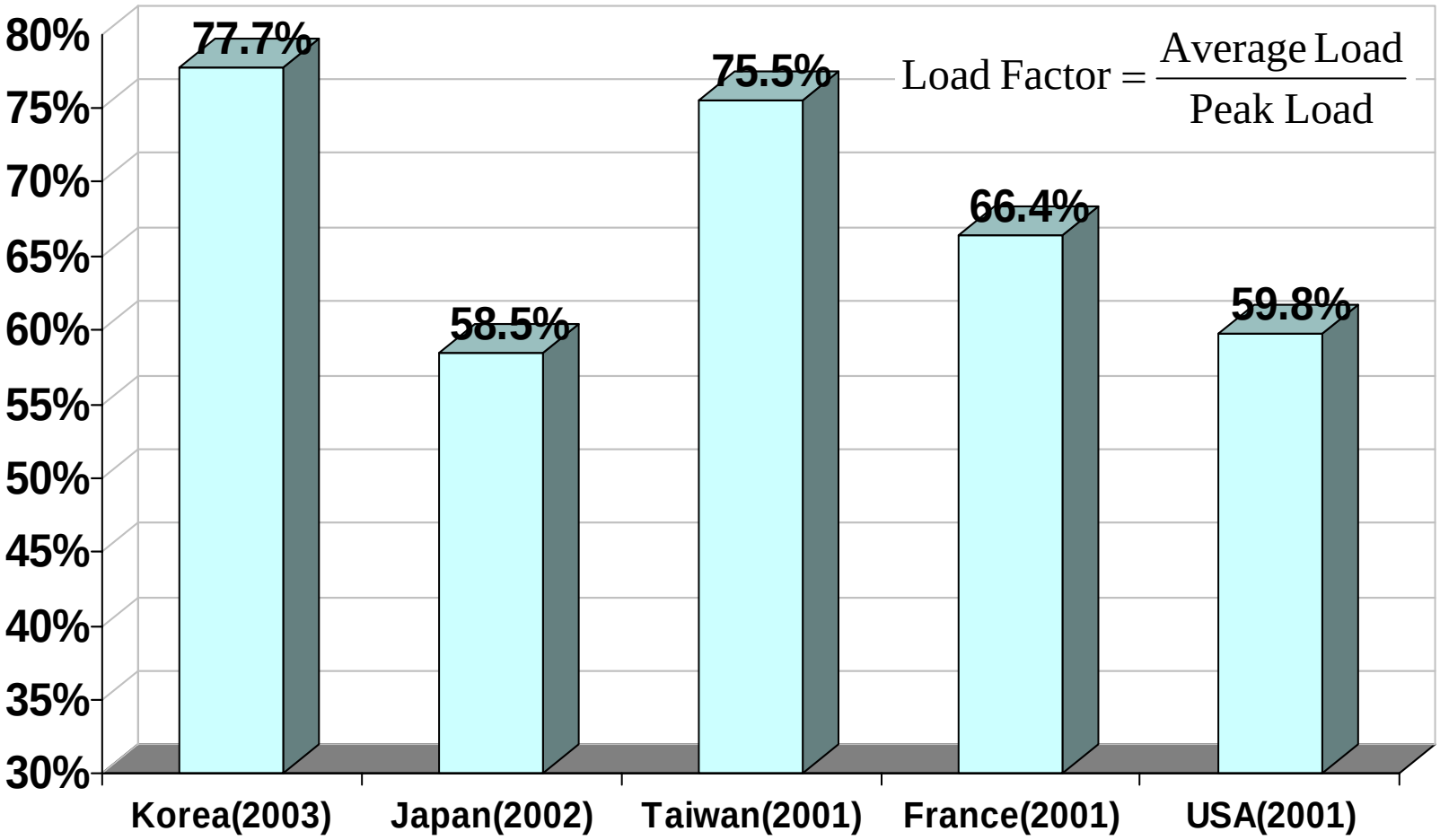
- Reduction in the need of peaking generation capacity
- Conservative estimate ~$50/kw-year of avoided capacity

Transmission & Distribution

- Reduction in power system load losses
- Transmission and distribution capacity release
- Deferments of new or upgraded T&D infrastructure
- Relief of transmission system congestion

Value of Improving Load Factor for T&D System is Difficult to Quantify
Ballpark Savings Estimate ~ 10% of Avoided Generation Capacity

International Comparison of Load Factor

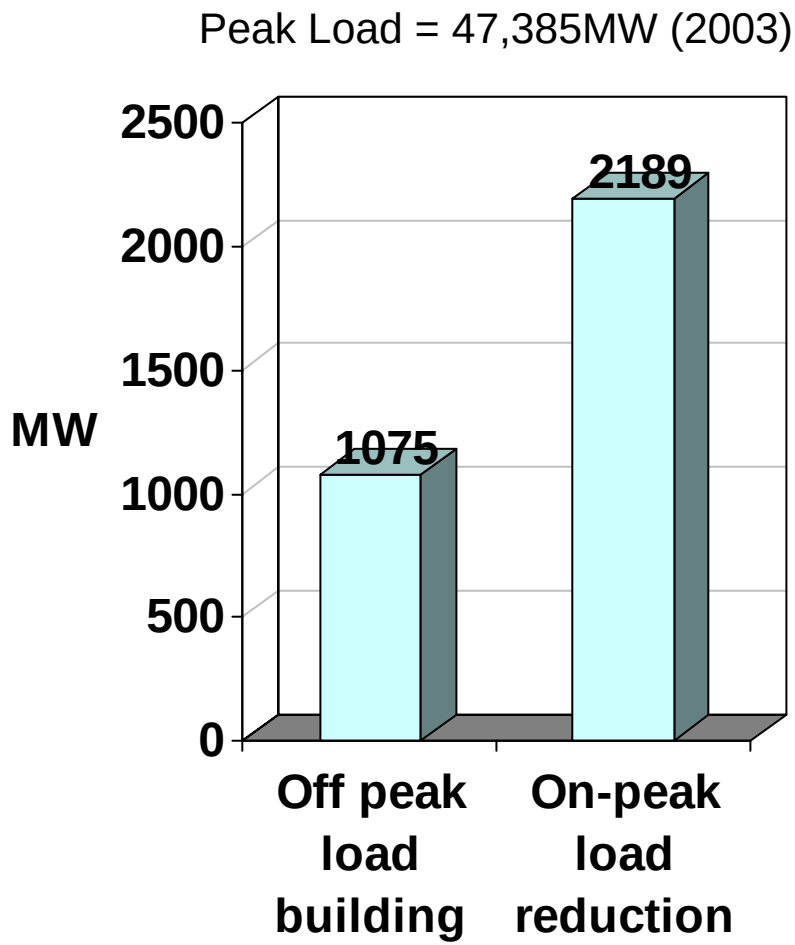


Significant Opportunity to Improve Load Factor in US Power System

Source: KEPCO Annual Report

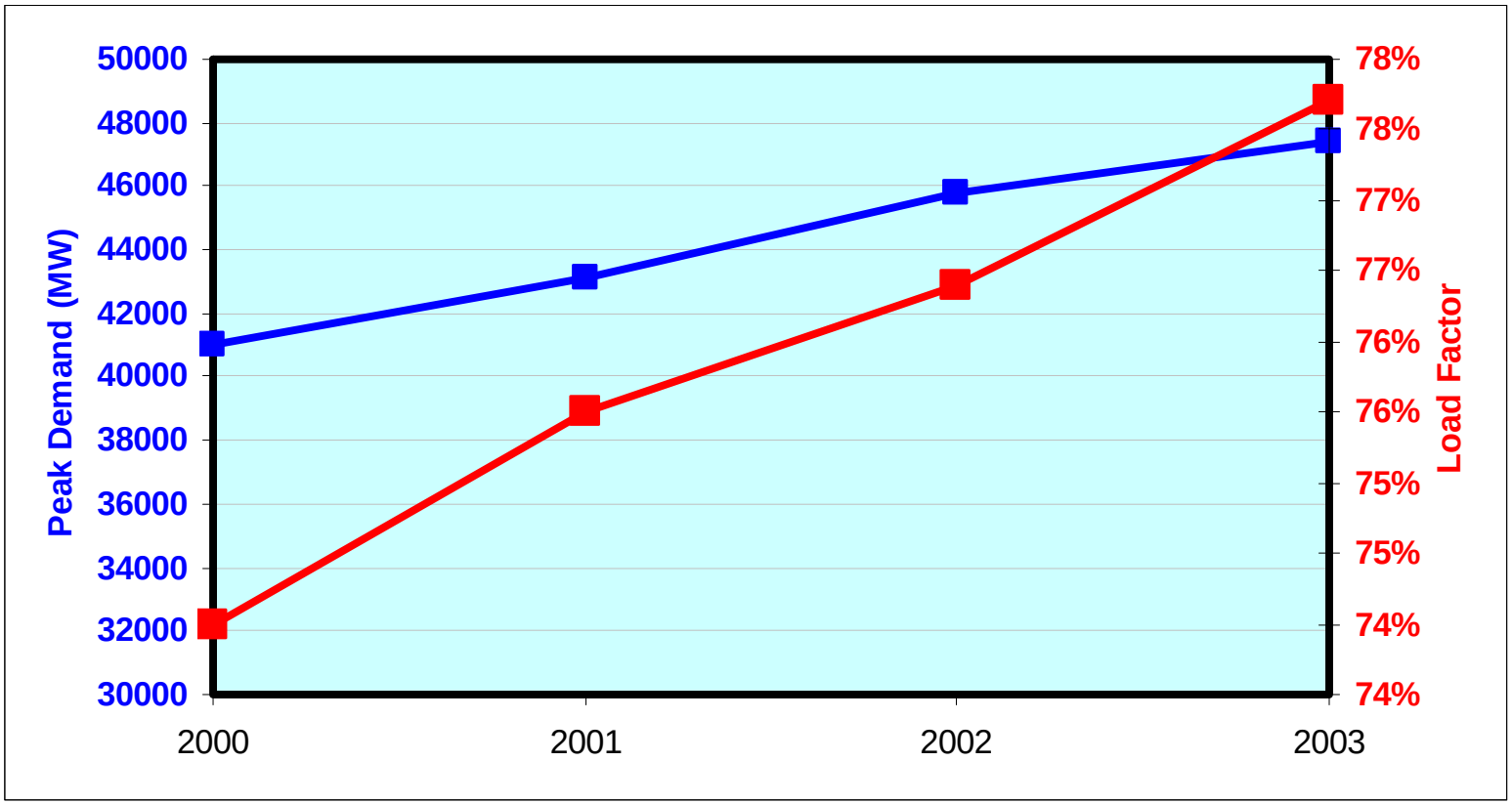
High Load Factor Electric Power System – KEPCO Example

- Off peak load building
  - Thermal Storage – Ice Storage
- On peak load reduction
  - Demand Response



Source: KEPCO Annual Report

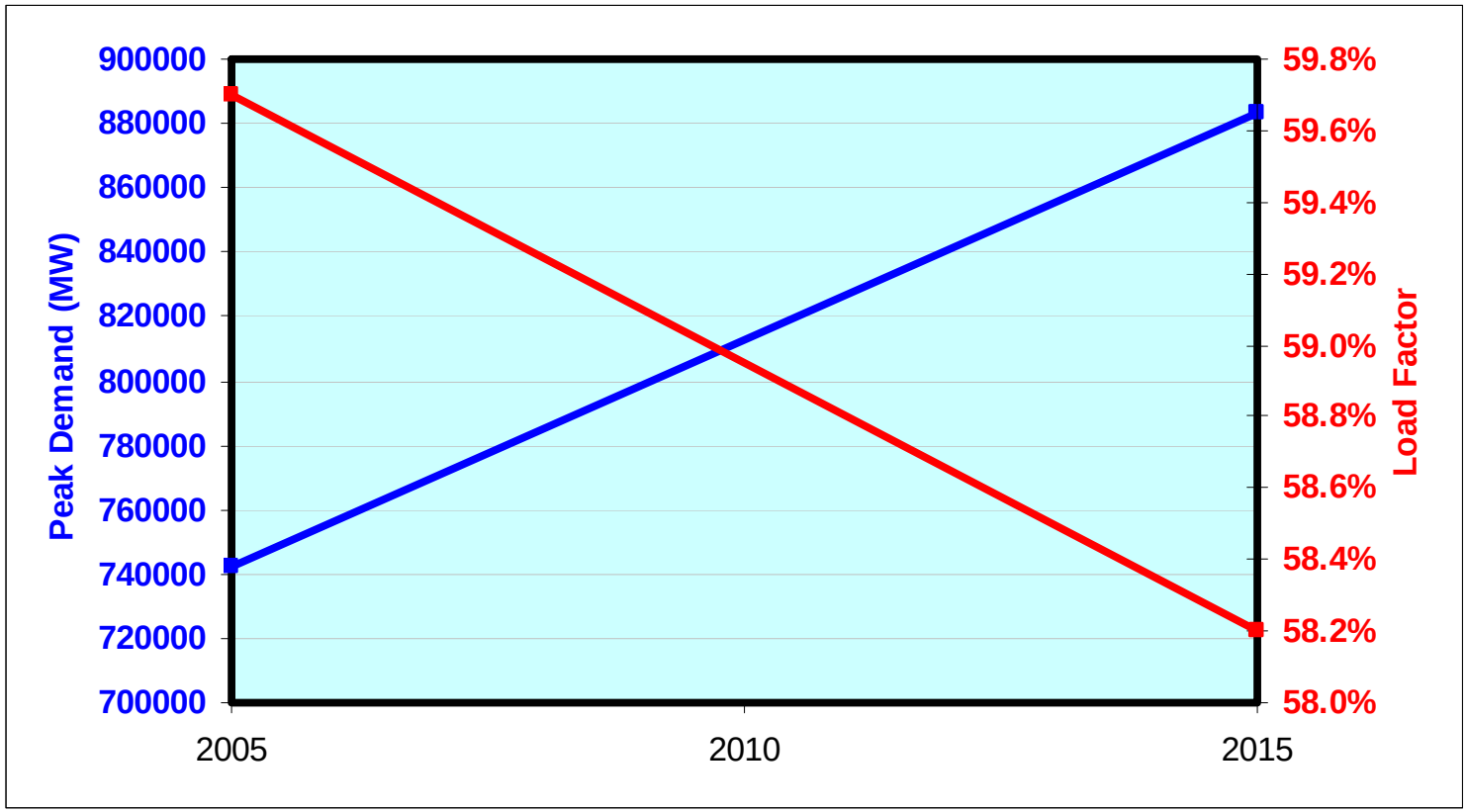
Growing Demand and Improving Load Factor – KEPCO Example



Load Factor Improved from 74.0% to 77.7% from 2000 to 2003 as Peak Demand Grew from 41GW to 47.4GW; Without Load Factor Improvement Demand Would Have Grown to 49.8GW

Source: KEPCO Annual Report

Growing Demand and Decreasing Load Factor – Long Term Forecast for US Power System



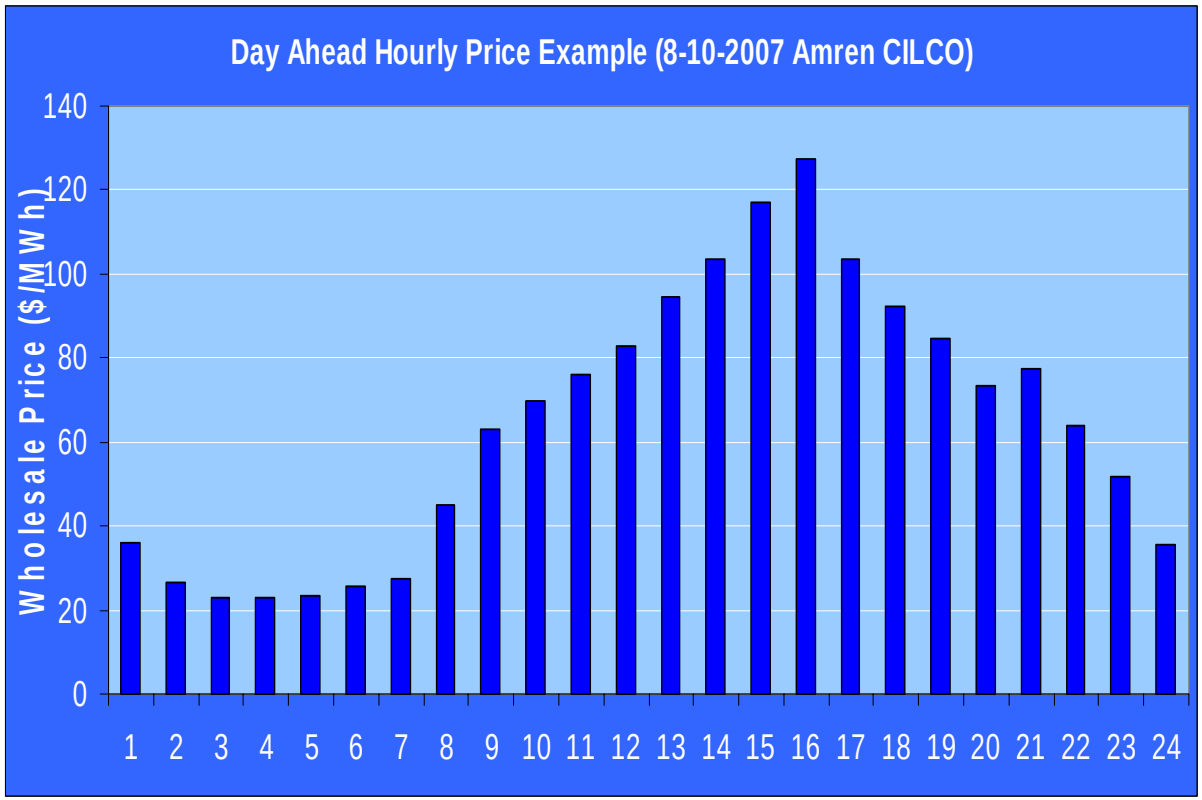
Peak Demand from 2006 to 2015 is Expected to Grow by 141GW and Load Factor to Decrease from 59.7% to 58.2%; Peak Demand Growth can be Levelized by Improving Load Factor to 69.2% in 10 years

Source: NERC 2006 Long Term Assessment and DOE/EIA AEO 2007

Role of Energy Storage

- Electric energy storage goal of the industry
- Cost-effective energy storage would benefit all areas of the energy value chain: generation, transmission, distribution, and end-use
- Key applications: firming large penetration of intermittent renewables, grid support, end-use load shifting, etc.
- Current energy storage systems are only marginally cost competitive. Costs need to come down by factor of 2-5 times.

Role of Pricing

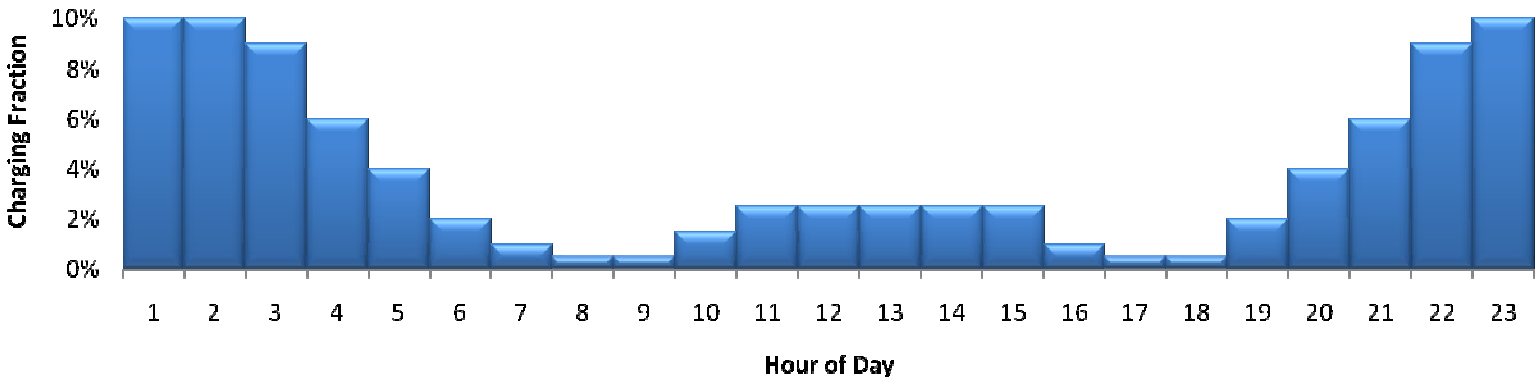


Sample Day Ahead Price Example

Opportunity for Optimizing PHEV Charging Time to Minimize Consumer Cost and Maximize Load Factor

PHEV Charging Profile Assumptions

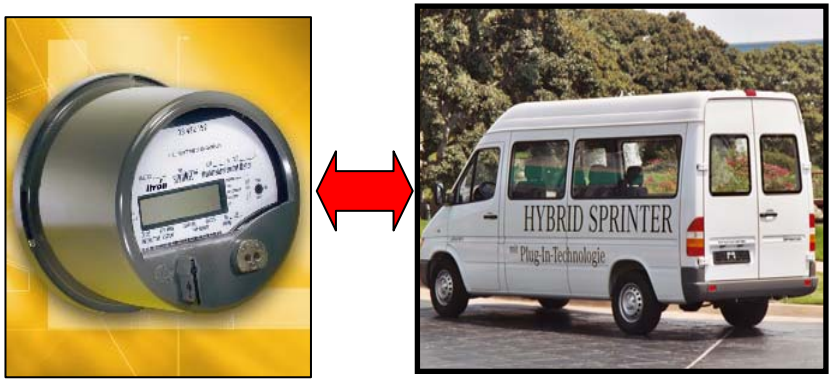
- Vehicle charged primarily, but not exclusively, at each vehicle's "home base"
- Owners incentivized or otherwise encouraged to use less expensive off-peak electricity
- Long-term with large PHEV fleets, utilities will likely use demand response or other programs to actively manage the charging load



EPRI's PHEV Research Activity
Infrastructure Connectivity

Infrastructure Impact Assessment

Consumer/Grid Value Assessment



Intelli-Metering

PHEV-40 Mile Electric

Energy Storage ~ 12kWh

Power ~ 6.6 kW

Deep Cycle ~ 3500

Intelli-Storage

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Potential Value Streams for PHEVs

- *Night time load*
- *Value to Energy Efficient Home*
- *Advanced Energy Storage*
- *Emergency Back Up Power*
- *Peak Period Power*
- *Price Signal Value*
- *Wind and Solar Energy*