EPRI | ELECTRIC POWER RESEARCH INSTITUTE

2006 Summer Seminar

Advancing the Efficiency of Electricity Utilization

Steve Specker

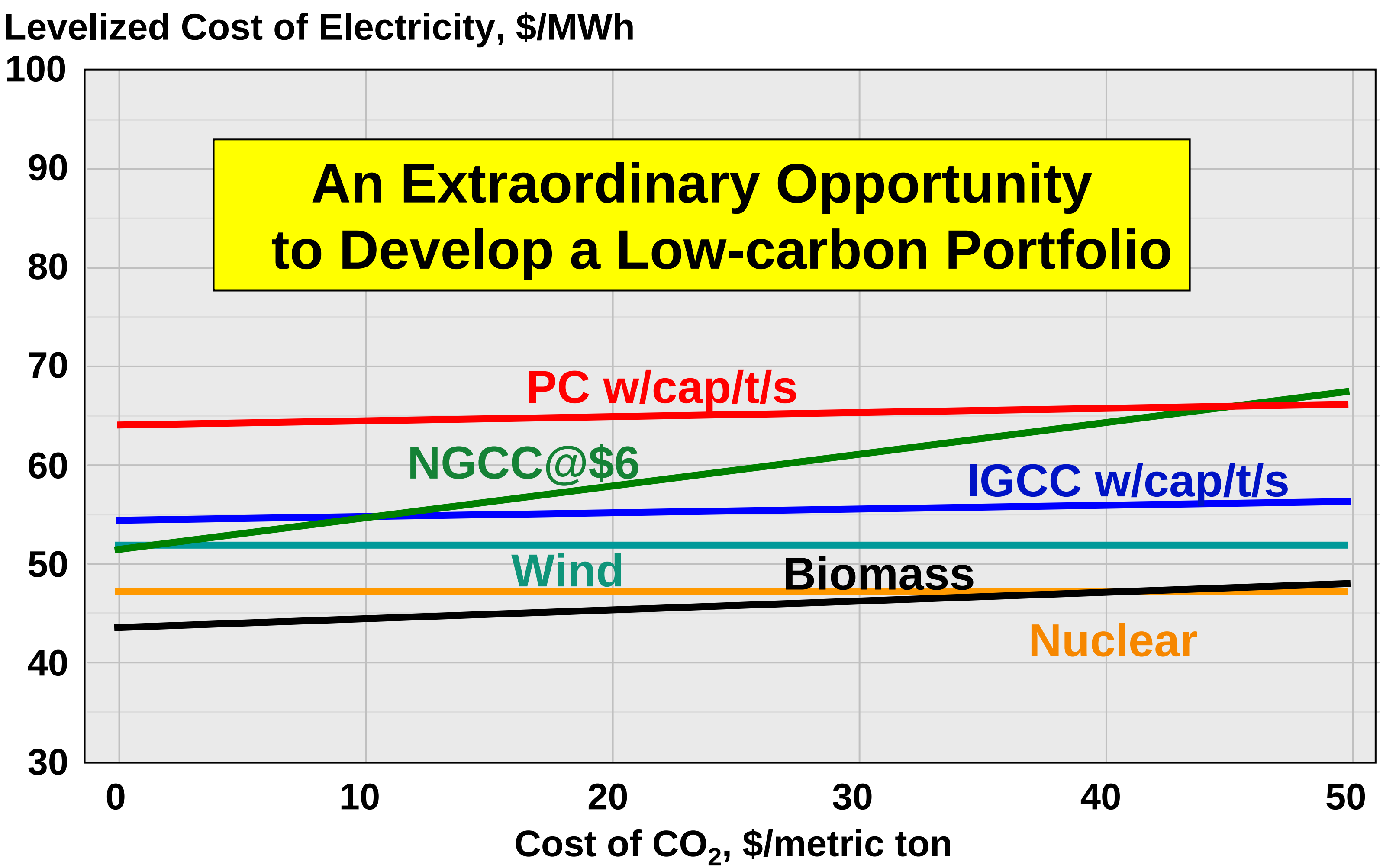
Summer Seminar

A Look Back…2005 Summer Seminar

Generation Technologies in a Carbon-constrained World

Provided a forum for objectively discussing generation technologies and investment decisions in a carbon-constrained world

2005 Summer Seminar…Year 2020 Take-away



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2006 Summer Seminar

Advancing Energy Efficiency and End-use Technologies

Provides a forum for objectively discussing technologies, regulations, and markets needed to improve the efficiency of electricity utilization

Definitions and Metrics

Improving the Efficiency of Electricity Utilization

- Provide the same or greater level of end-use services:
  - with less delivered energy…**kWhs, barrels of oil, and ft^3 of natural gas reduced**
  - with less environmental impact…**tons of CO_2 NO_x, SO_x, and Hg reduced**
  - at the lowest cost to the consumer…**$’s saved**
- Improve system reliability…**reduced # and duration of interruptions**
- Delay need for new generation…**MW of avoided capacity additions**

Goals are economy-wide and can be in conflict

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Strategies for Efficient Electricity Utilization

Three Interrelated Strategies

- Energy Efficiency (EE)
- Demand Response (DR)
- Dynamic Systems (DS)

Implemented through an Electricity Efficiency Infrastructure

Strategic Framework

<u>At any instant in time:</u>

MW of Supply = MW of Demand

Strategic Framework

At any instant in time:

Base Load Generation + **Load Following Generation** + **Interruptible Load**

= **Built-in Demand** +/– **Demand Response** – **Renewable Generation** – **Fuel-based DG**

Total Demand with Time-independent Prices

Incremental Demand (+/-) with Time-dependent Prices

Negative Load

Energy Efficiency

Base Load Generation + **Load Following Generation** + **Interruptible Load**

Energy Efficiency ↓

= **Built-in Demand** +/– **Demand Response** – **Renewable Generation** – **Fuel-based DG**

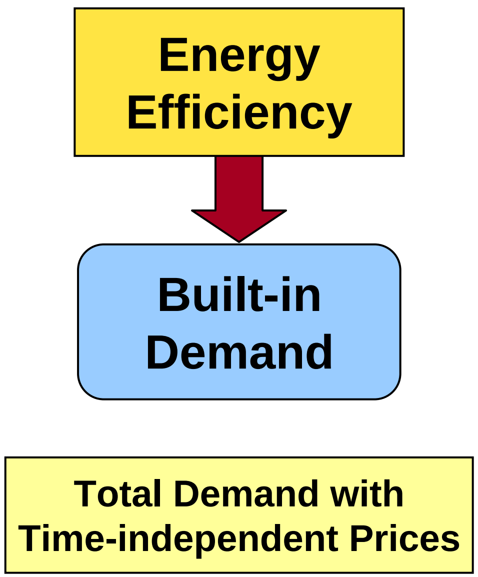
Total Demand with Time-independent Prices

Incremental Demand (+/-) with Time-dependent Prices

Negative Load

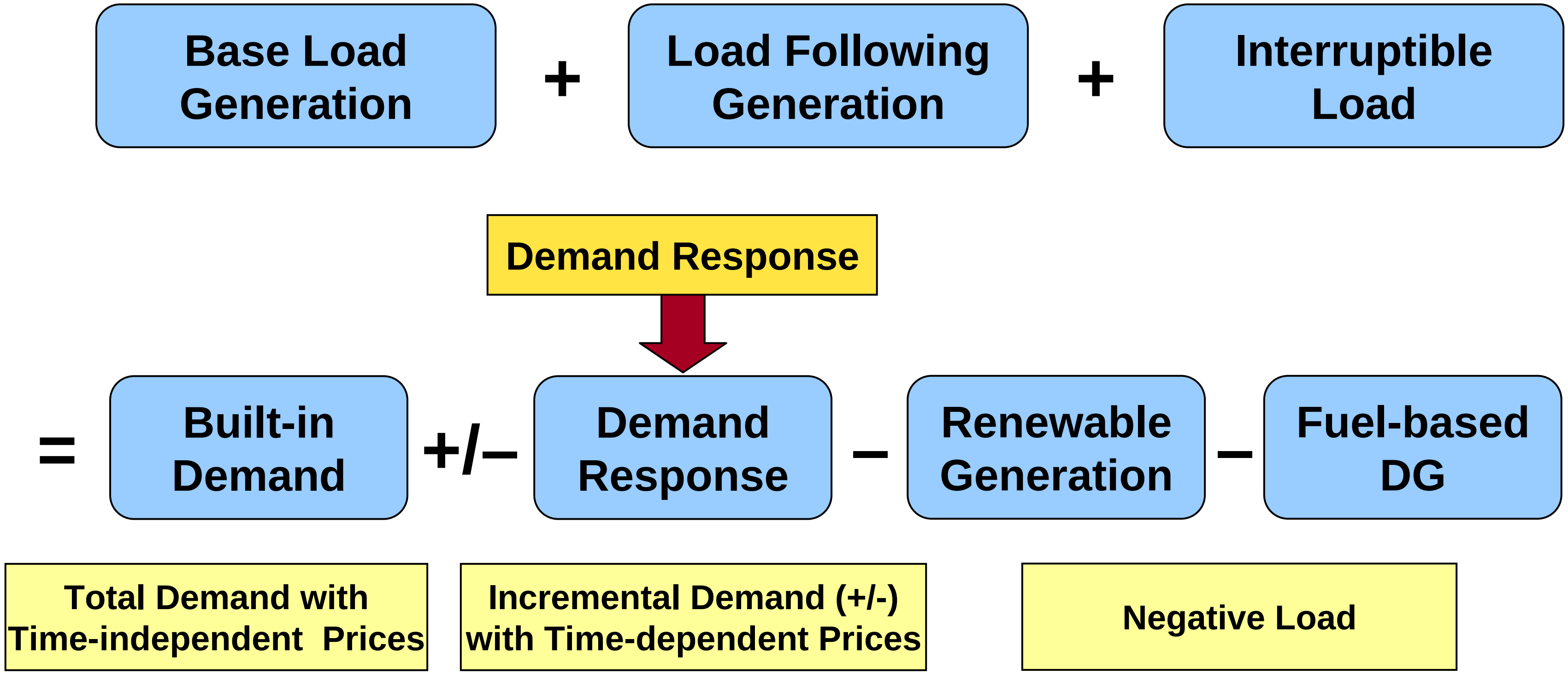
Energy Efficiency

Example: Air-conditioning



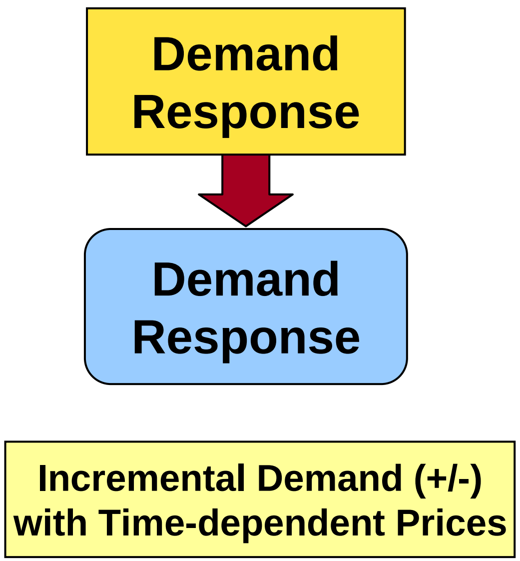
- Consumer has a single time-independent price for electricity
- Consumer installs a new, more energy efficient air-conditioner
- Consumer operates air-conditioner to satisfy personal comfort at any time of the day

Demand Response



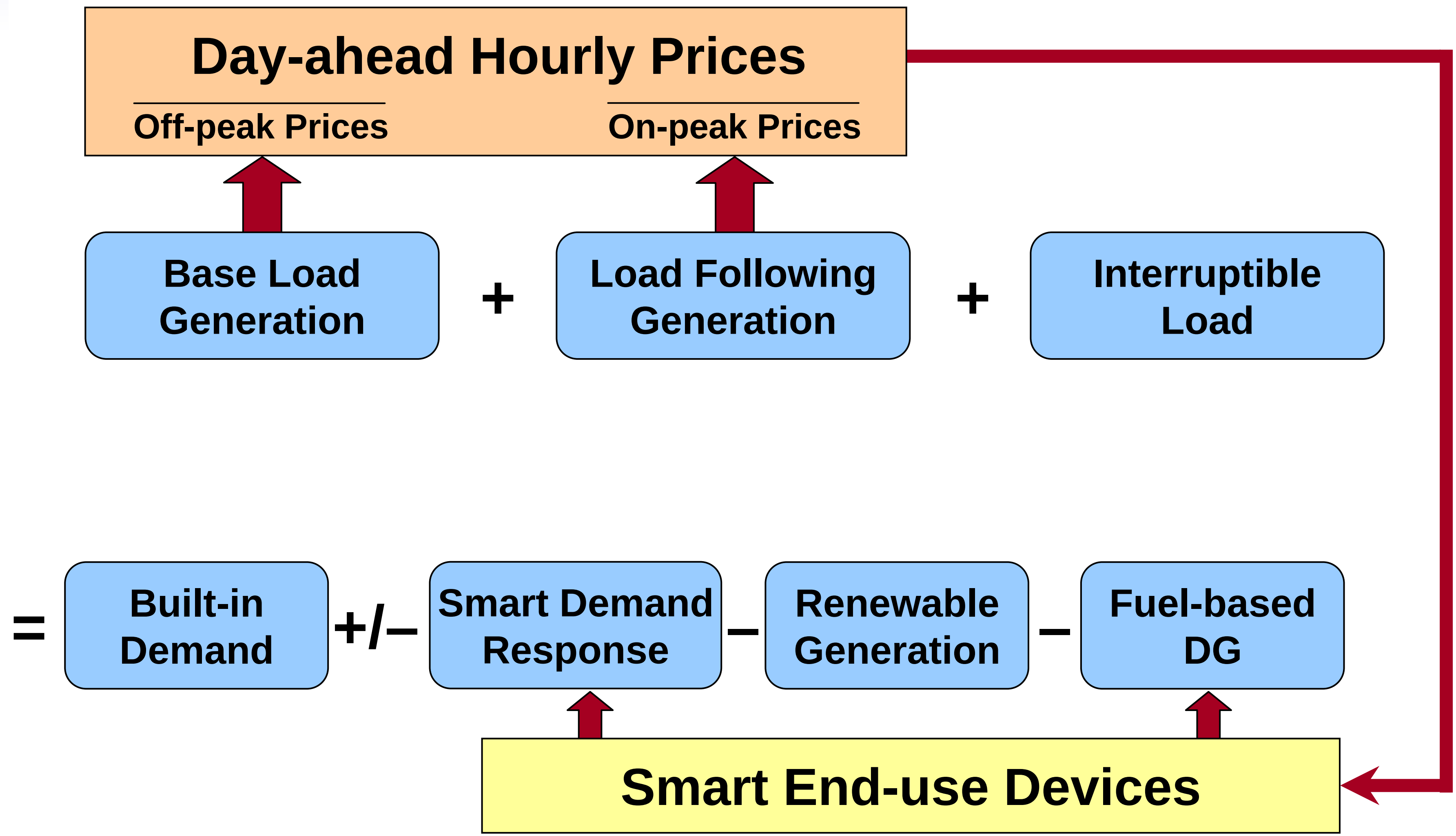
Demand Response

Example: Air-conditioning



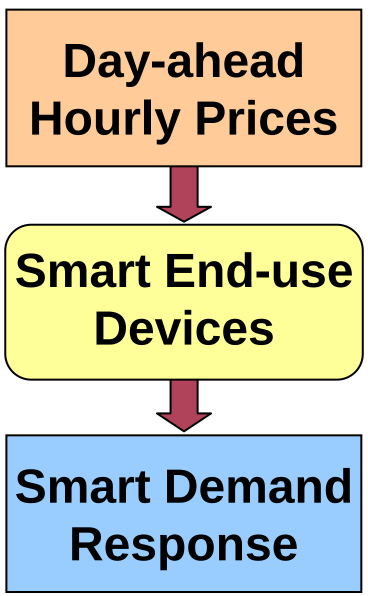
- Consumer has a time-dependent (e.g., Time of Use [TOU]) rate structure for electricity
- Consumer manually adjusts or pre-sets thermostat to a higher temperature during hours of higher electricity price
- Air conditioner electricity demand is reduced during higher price hours from what it would have been with a single time-independent price

Dynamic Systems… “Prices to Devices”sm



Dynamic Systems

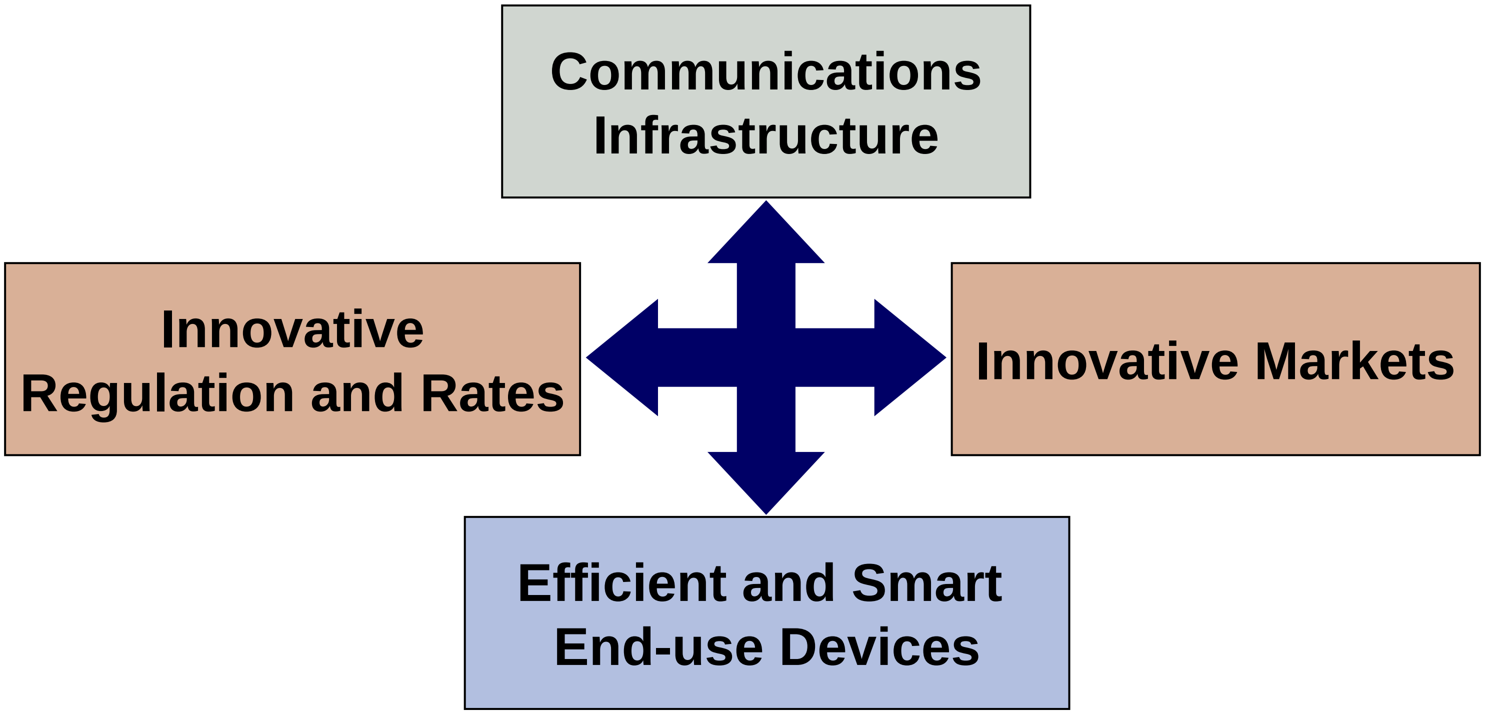
Example: Air-conditioning



- Consumer has hourly day-ahead electricity rates
- Consumer's thermostat receives hourly day-ahead electricity prices and day-ahead weather forecast through a network connection
- Consumer sets thermostat within a "comfort" range
- Thermostat "learns" rate of house cool-down/heat-up based on consumer habits, outside temperature, time of year, etc.
- Thermostat optimizes air-conditioner operation within the comfort range to minimize consumers electricity costs

Building an Electricity Efficiency Infrastructure

The Four Building Blocks



Efficient and Smart End-use Devices

The "Killer App" for the Electricity Efficiency Infrastructure

"Toyota sees hybrids playing a starring role in 21st century"

"Toyota is pursuing a plug-in hybrid…"

USA Today July 19, 2006

My Plug-in Hybrid Electric Vehicle

- **Convenient Re-charging… Anytime and Anywhere**
  - Vehicle meter "handshakes" with network-connected "socket" to identify vehicle and billing information
  - Re-charges with kWh measured by vehicle meter
  - Electronic billing transaction debits vehicle owner's account and credits "socket" owner's account

- **Distributed Energy Storage**
  - Sell stored battery energy to the grid
  - Utilize stored battery energy for short-term back-up power

- **Distributed Generation**
  - Utilize internal combustion engine for longer-term backup power

Electric Vehicle Inductive Charger

My Plug-in Hybrid Electric Vehicle

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Consumers will demand these conveniences
…will the Electricity Efficiency Infrastructure be ready?

Let’s Get to Work …

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