



**EPR**I

ELECTRIC POWER  
RESEARCH INSTITUTE

## The Role of Dynamic Pricing in Fostering the Efficient Use of Electric Sector Resources

Presented to

**Kansas Corporate Commission  
Workshop on Energy Efficiency**

**March 25, 2008**

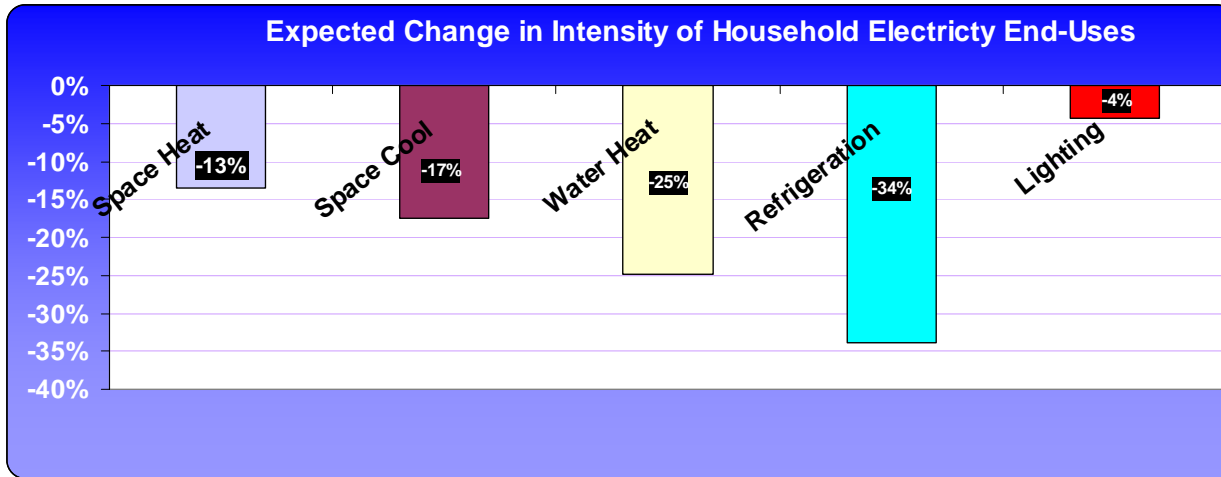
Presented by:

**Bernie Neenan**

# Topical Outline

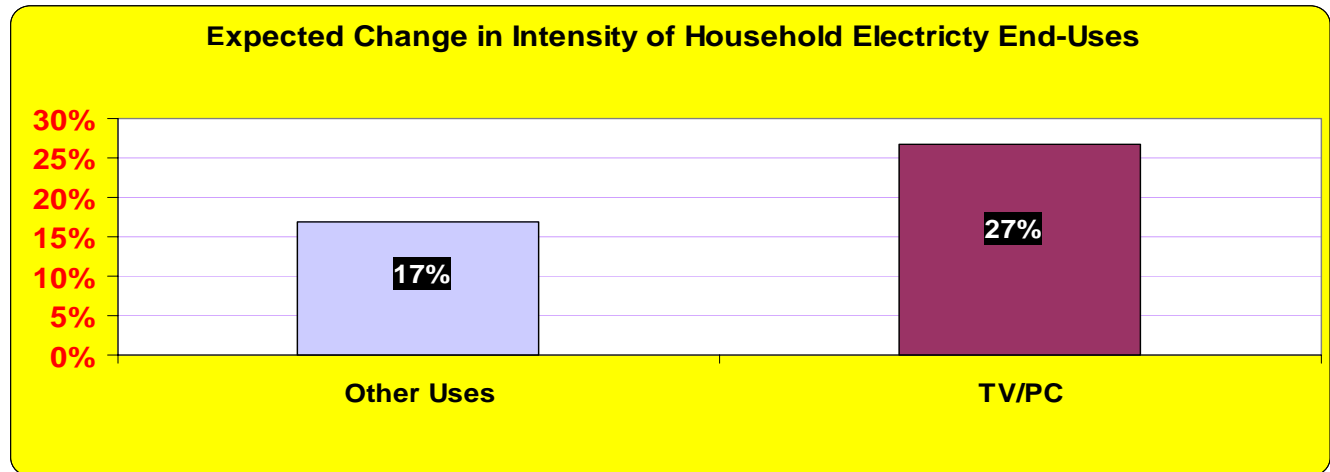
- **Trends in residential electricity usage**
- **The impacts of dynamic pricing**
- **Feedback as a incentive to conserve**
- **Assessing price response**

# Trends in Household Electricity Consumption



The relative energy intensity of many household devices is going down

But, we may be swimming against the proliferation of devices with high energy and power usage



# Impact of Disruptive Technologies

- **Increased market penetration of large-screen TV**

Plasma uses 2-½ the energy of CRT and 23% more energy than LCD

- **Higher saturation of video games that have exceptionally high power requirements**

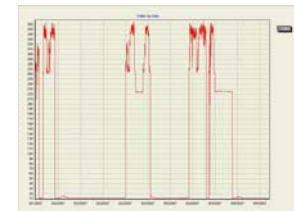
A Video Game @ 360W is like another plasma TV in the house

- **Digital Photo Frames**

One Digital Photo Frame/ Household Will Require Five 250 MW New Generation Plant

- **Plug-In Hybrid Electric Vehicles**

A PHEV will need 2,500-3,000 kWh/yr. – the timing of charging will determine the system impacts



# Roles for Pricing and Demand Response

- **Efficiency.** Setting price = marginal supply costs achieves the optimum allocation of societal resources
  - Time-of-use
  - Real-time pricing
  - Market-participation pricing (ISO/RTO, direct or indirect)
- **Rationing.** Allocate available capacity resources efficiency
  - RTP
  - Critical peak pricing (CPP), Peak-time rebate (RTR)
  - ISO/RTO emergency programs
- **Avoidance** – load as a resources to reduce the overall system infrastructure needed to serve consumers' needs
  - Demand call options
  - Critical peak pricing (CPP), Peak-time rebate (RTR)
  - ISO/RTO installed capacity programs

• **But, do prices convey the full cost to society of supplying electricity?**

# But, will Consumers be Responsive to Dynamic Pricing?

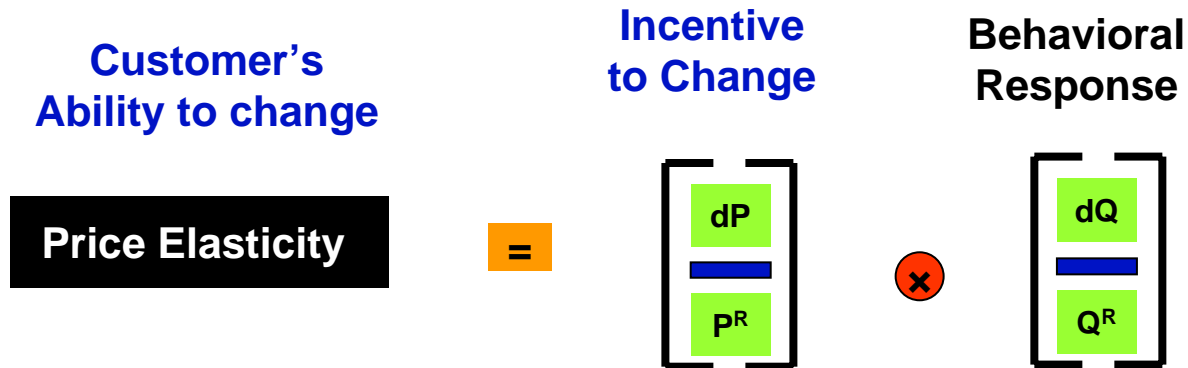
## No

- Electricity is too insignificant a cost to be bothered with
- Electricity is too essential, and there are no substitutes
- Electricity is not consumed directly (indirect demand)
- Conservation trumps price response in terms of benefits
- Insufficient inducement/incentive to respond
- It's too hard to respond
- Paying consumers to curtail is more effective

## Yes

- Electricity expenditures are equal to those of telephone service, more than cable and internet
- Indirect demand is true of communication services
- Price repose may result in a different level of service
- Reflects utility and regulatory preferences, not necessarily those of customers
- Pilots in CA, IL, Canada and IOS/RTO program report response with no enabling technology
- Prices do a better job of rationing

# Defining Price Elasticity

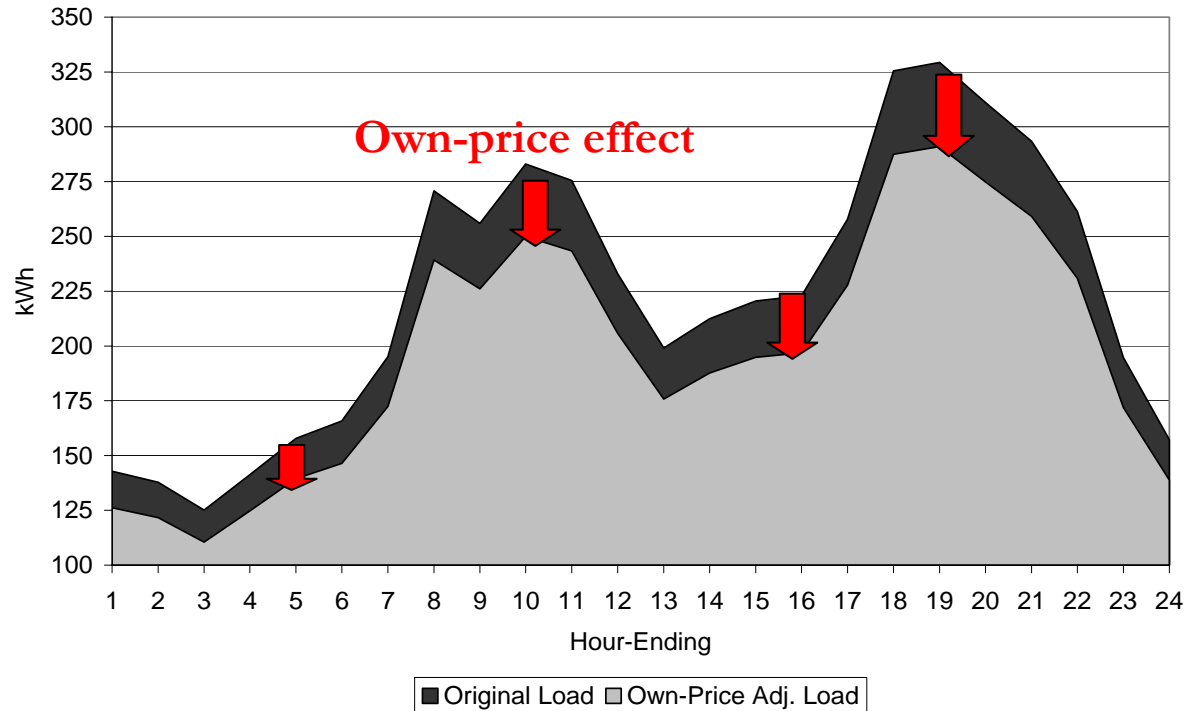


**Price Elasticity - % change in usage induced by a 1% change in price**  
**0 ≤ Price Elasticity ≤ over 5.0 (absolute value)**  
**Elasticity =1 yields changes in proportion to load**

**Own-Price Elasticity**  
 adjustment of overall expenditures in response to change in the price of electricity (*goods/output swapping*).  
**Negative values**

**Shifting Elasticity**  
 adjustment of overall expenditures in response to change in the price of electricity (*temporal/input swapping*).  
**Positive or negative values**

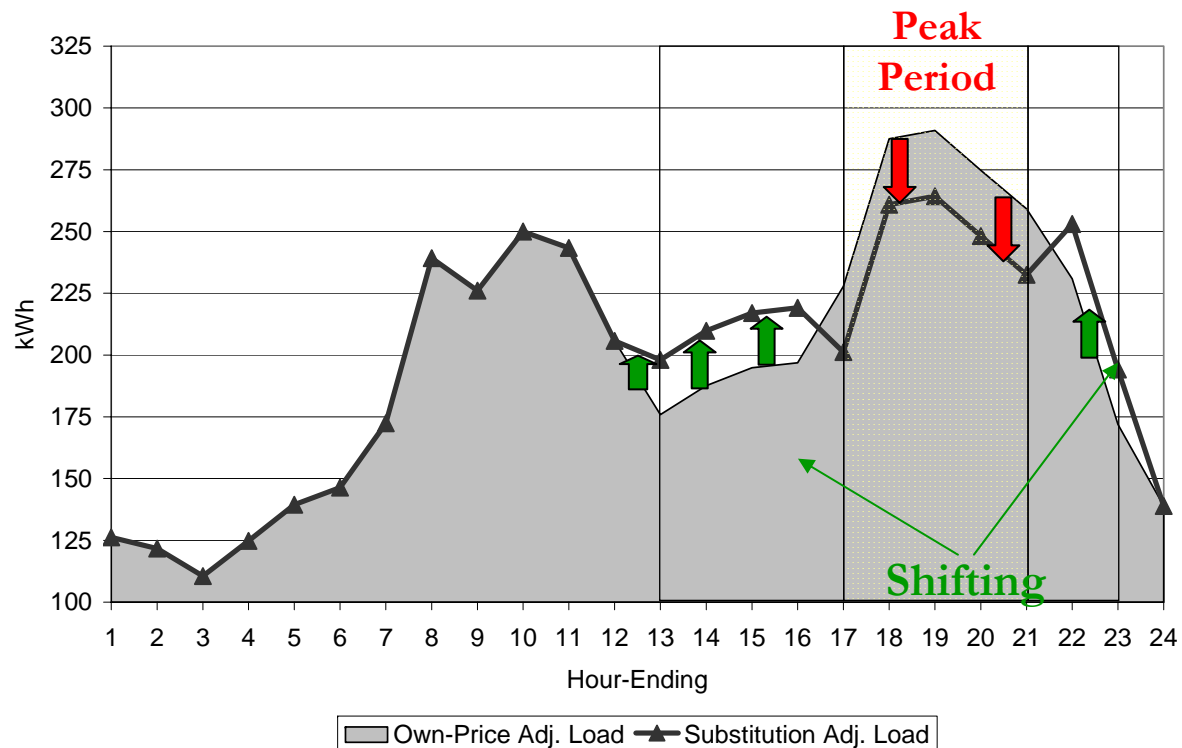
# Example of Own-Price Elasticity of Demand (reallocation of expenditures)



The price increases causes the consumer to shift expenditures away from electricity to other goods and services



# Example of Substitution Elasticity (temporal rearrangement of energy consumption)



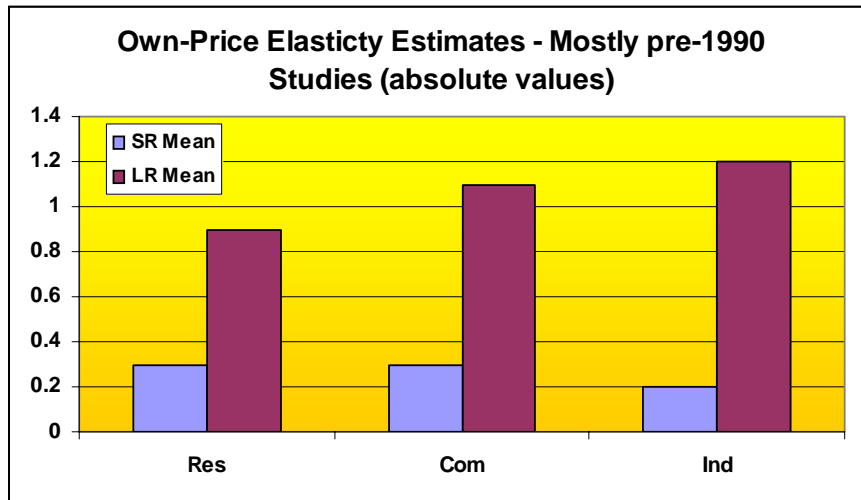
The price spread causes the consumer to shift electricity usage from the peak to the off-peak periods of the day, with virtually no change in total energy consumption (but peak demand is decreased)

# What is the Conservation Effect of Dynamic Pricing?

- **Some TOU and RTP analyses from 1990's found that total energy consumption went up for some consumers**
  - Cheaper off-peak prices induced increased consumption
  - If the demand charge (for C&I) was effectively eliminated, the load increase effect was even greater in some customers
- **Recent TOU, CPP, a PPB pilots found that dynamic pricing induced a “conservation effect”**
  - Shifting observed on extreme price days (CPP, PTR)
  - Overall monthly energy use went down, despite no real change in electricity price outside the high-priced days
  - Some associate this with an own-price elasticity effect

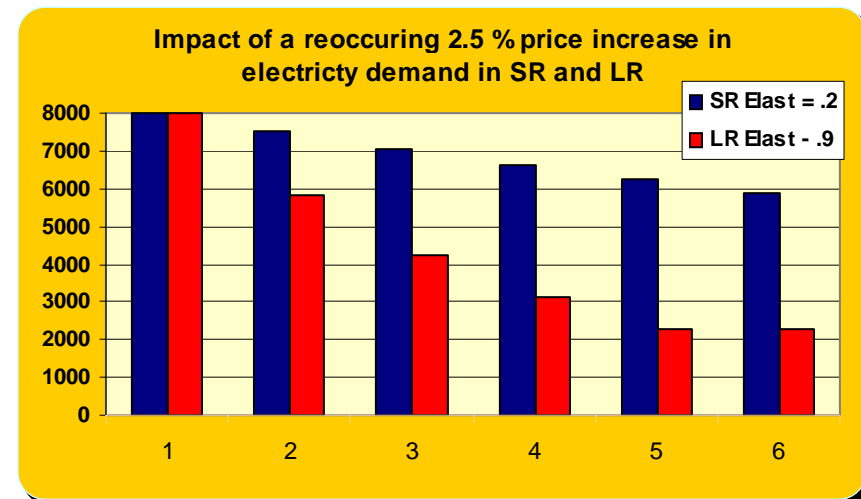
- **TOU- time-of-use**
- **RRTP = real-time pricing**
- **CCP= critical peak pricing**
- **PTR- peak time rebate**

# Report Highlights – Own Price Elasticity (OPE)

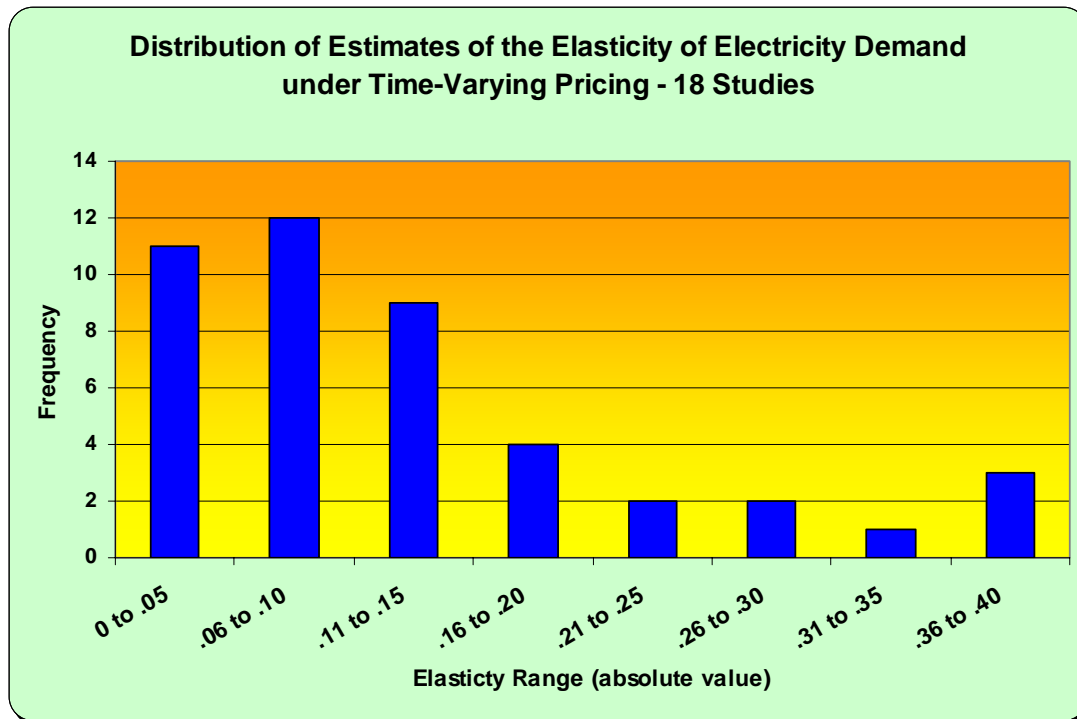


- Very high price elasticities were found  $-.05$  -  $-.120$
- Most estimates of OPE are from pre-1990 studies
- Very little price variation results in a high level of specification error

- Impact of a 2.5% re-occurring price increase on res. usage
- Are these results credible?
- CA dynamic pricing study using values of  $.02$  -  $.04$  (absolute values)

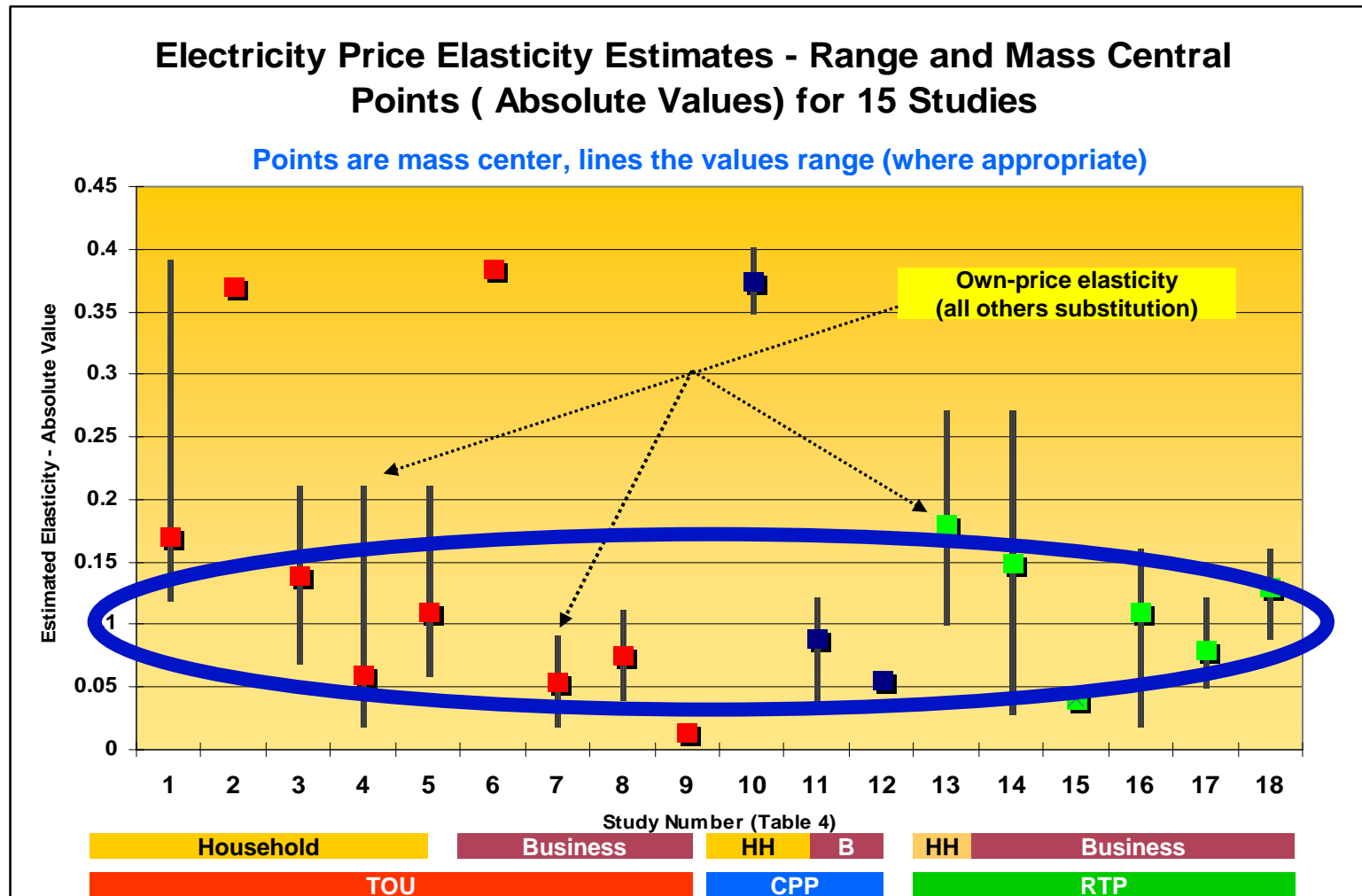


# Report Highlights – Shifting Price Elasticity

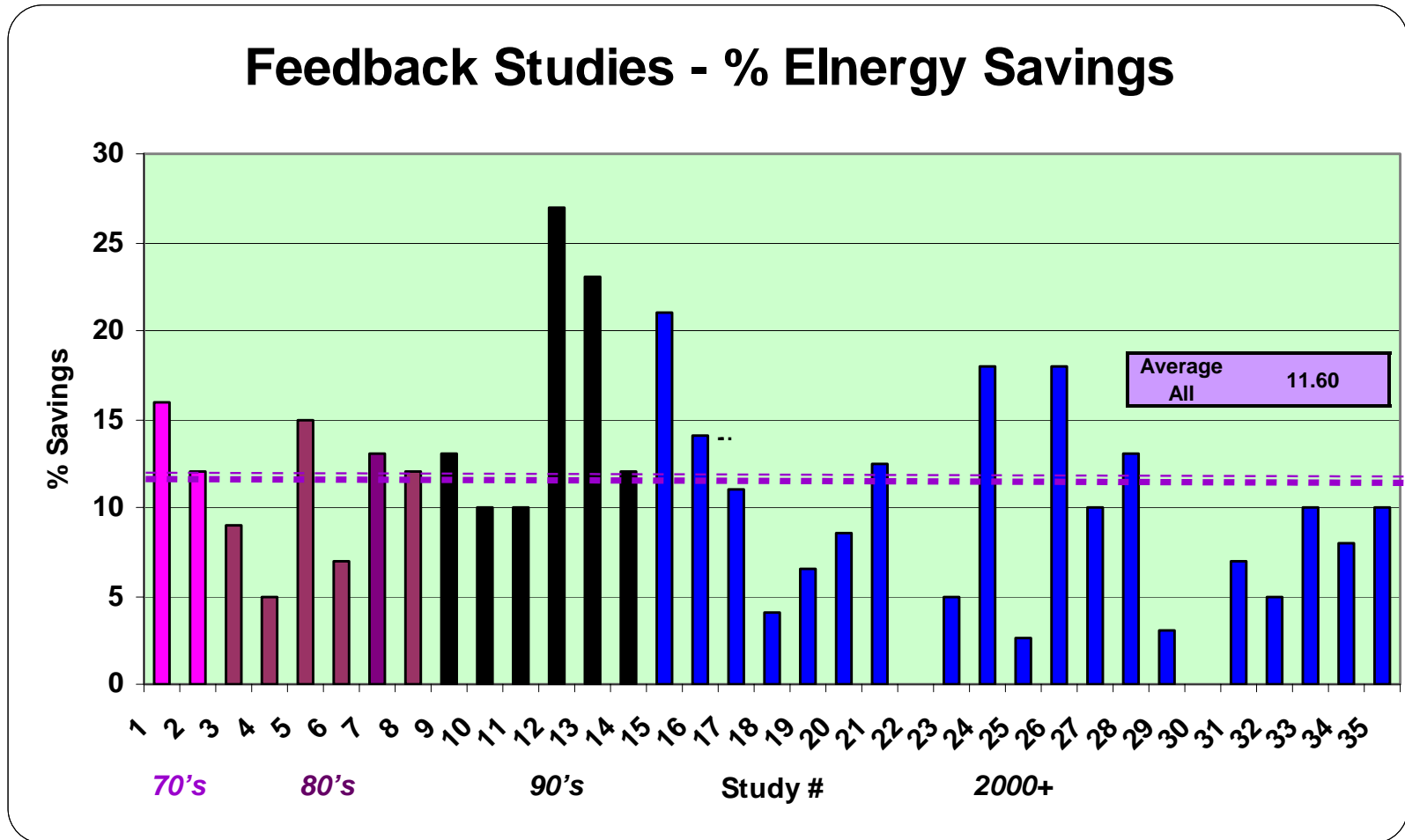


- 72% of reported values for shifting elasticity are .15 or below
- Many studies report 20-25 % of participants contribute 75% or more of the measured response

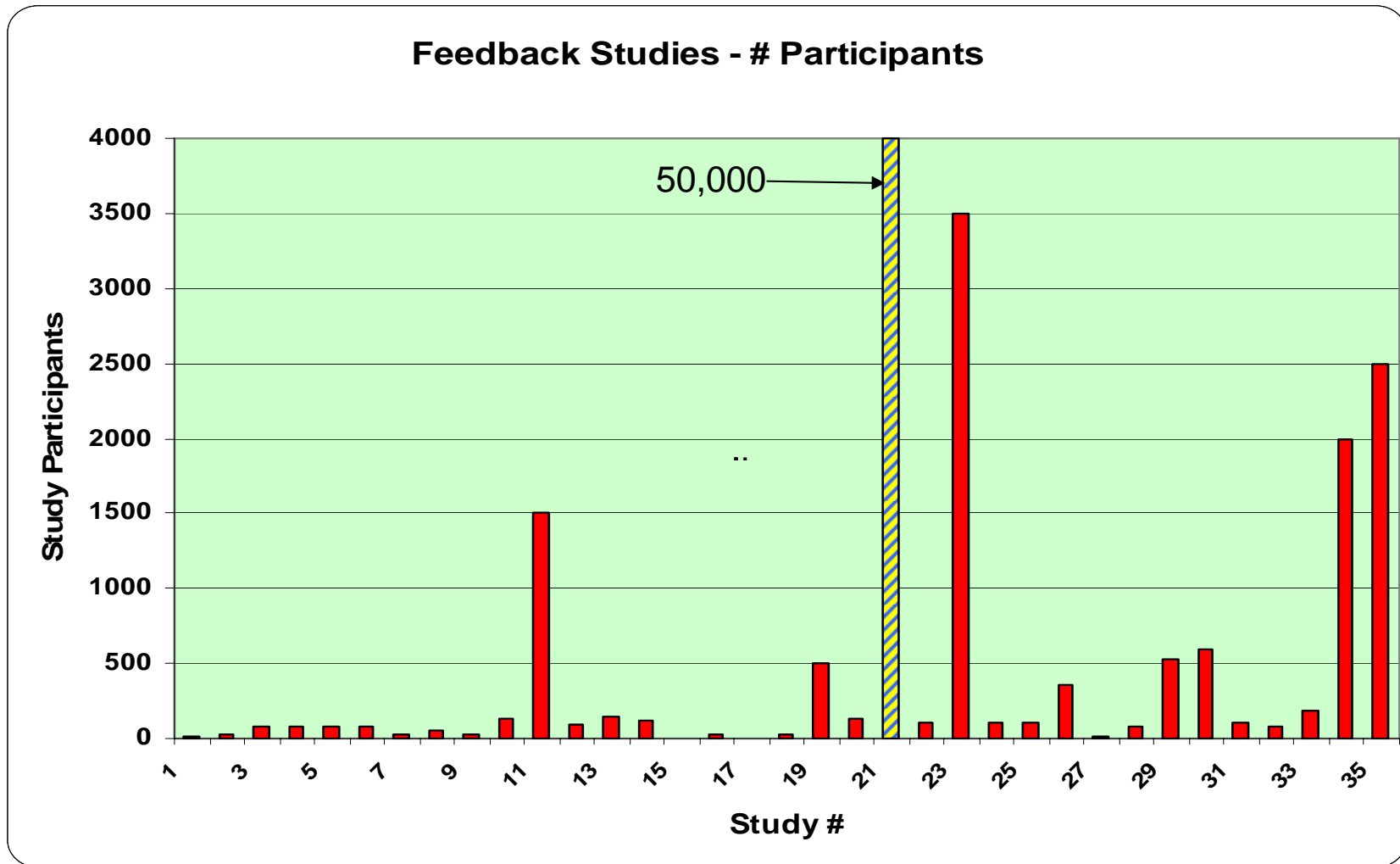
# Composite of Price Elasticity Estimates



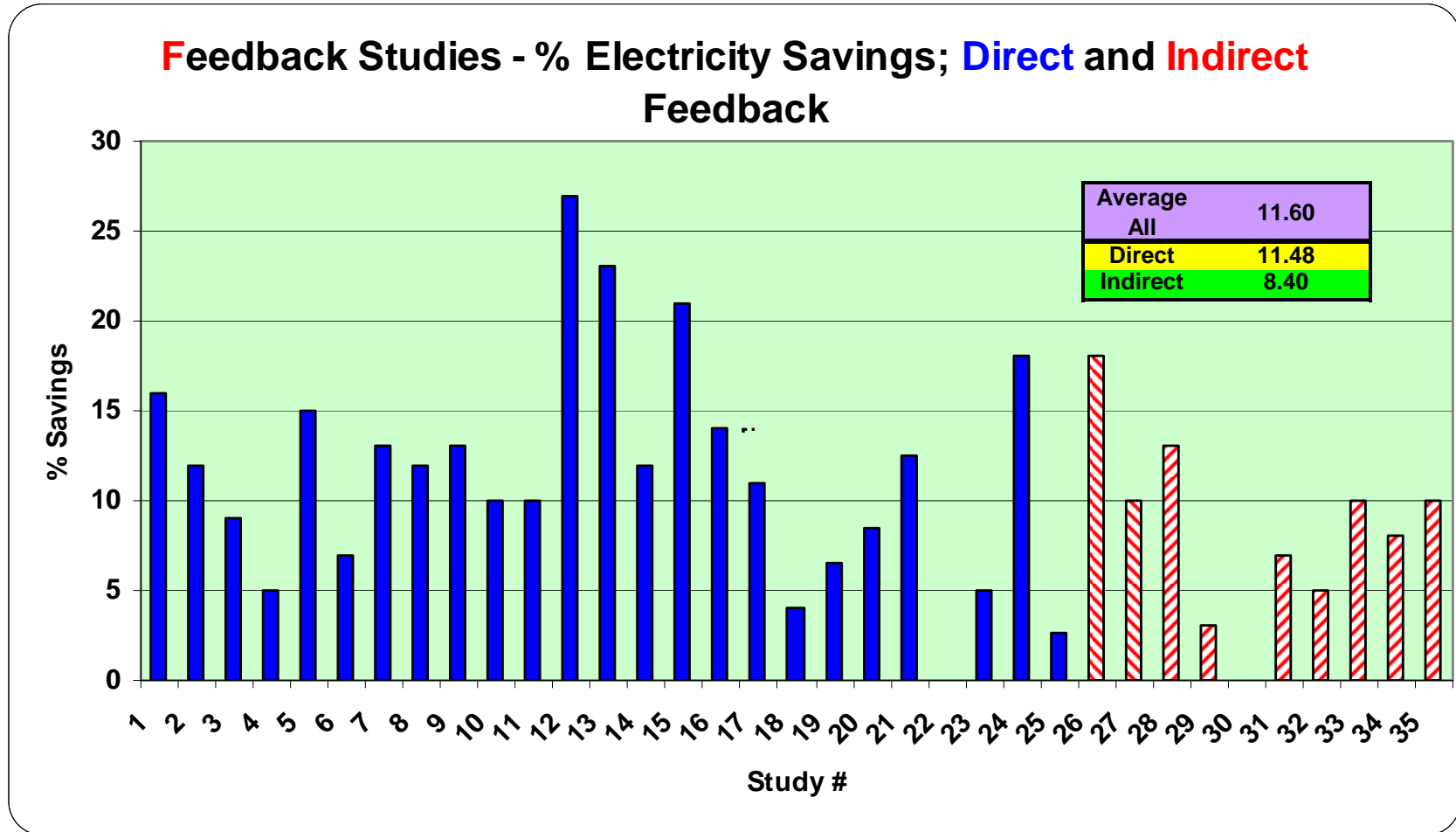
# Evidence that Feedback Influences Energy Use



# Participation in Feedback Pilots



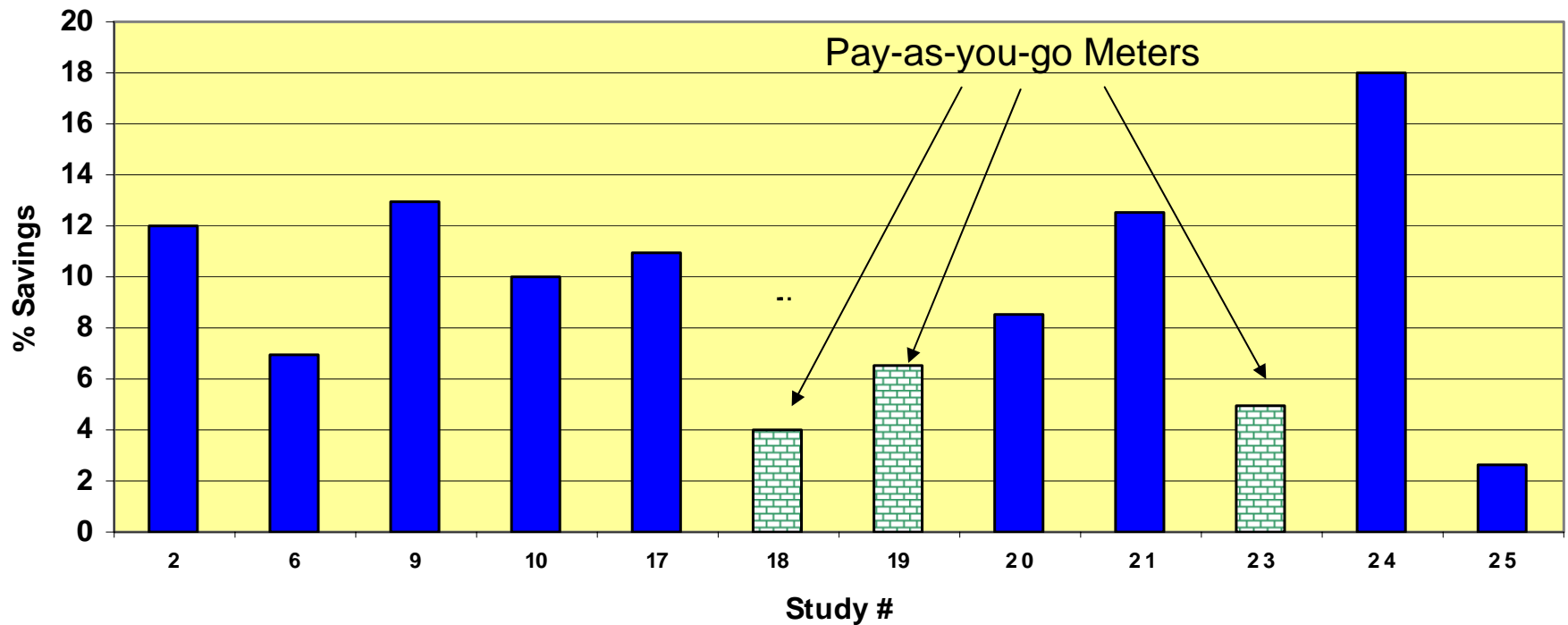
# Feedback Savings: Direct and Indirect





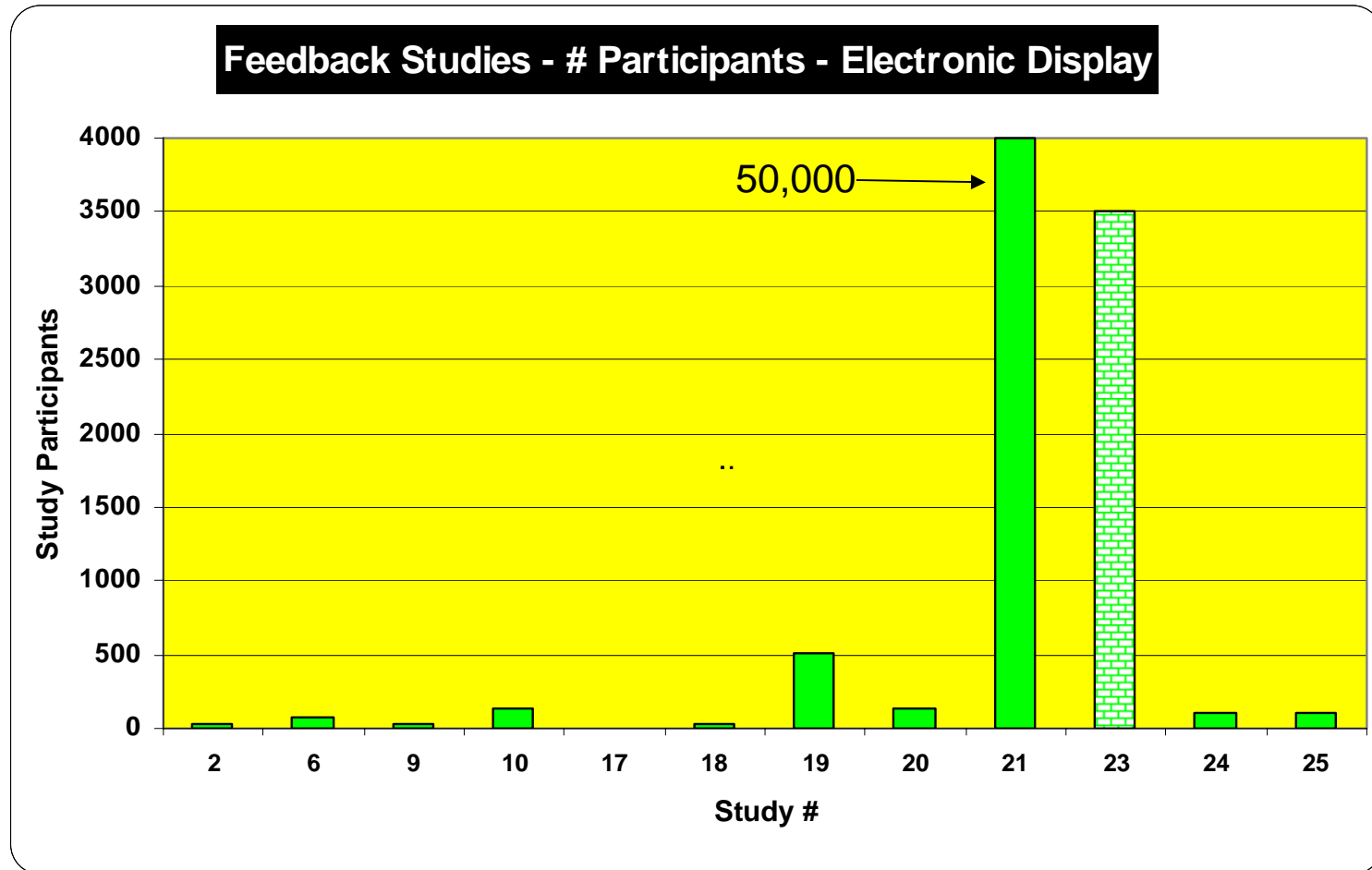
# Reported Direct Feedback Savings – Electronic Display

Feedback Studies - % Electricity Savings - Electronic Display

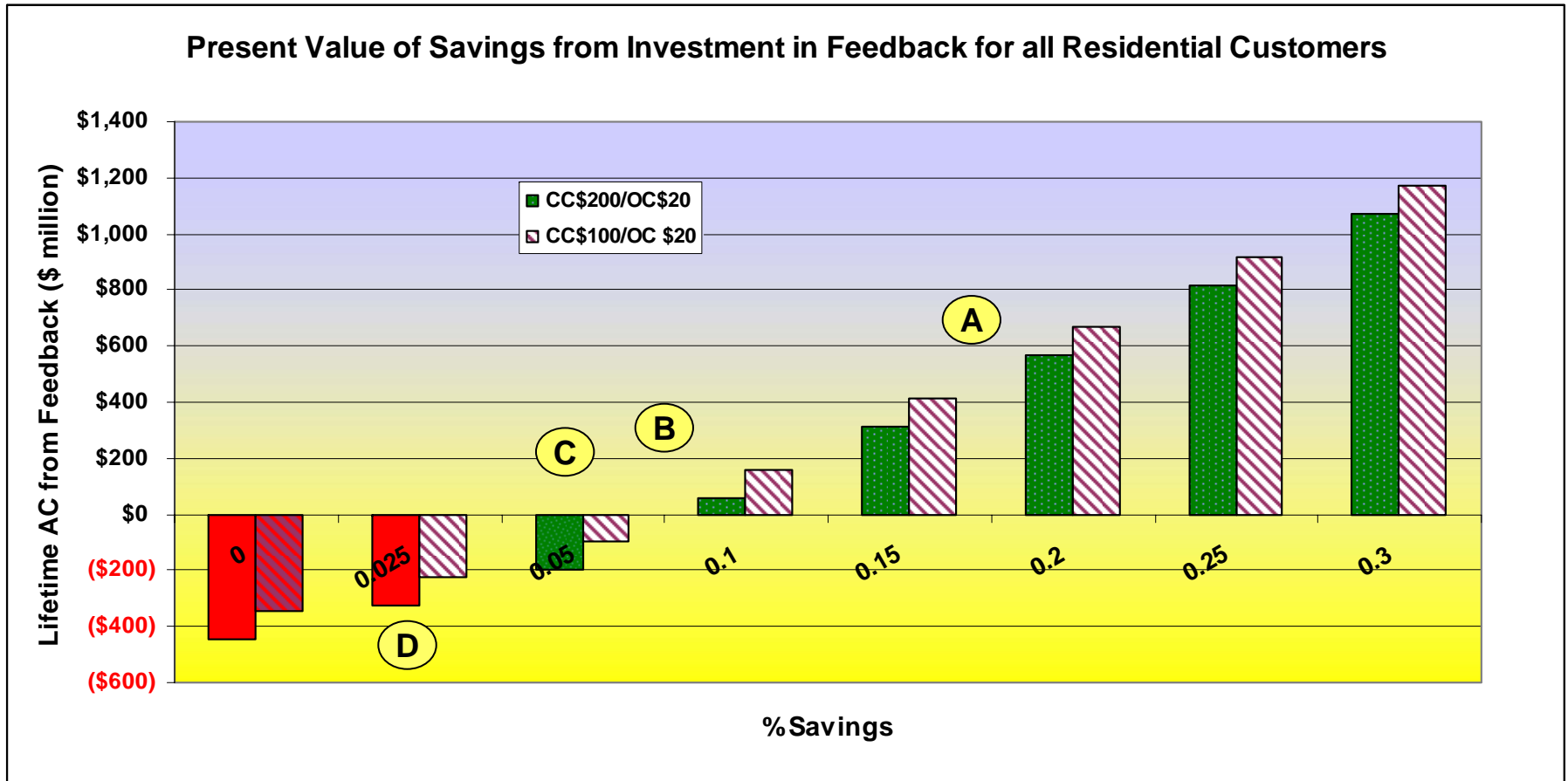


Eliminated – bill stuffers, videos, self-read diaries, flashing lights, community cooperation, expert counseling; also gas or combined gas and electric

# Feedback Participation – Electronic Display



# Net Present Value of Feedback Investment



# Summary and Outlook

- **Price response intensity is relative low and unevenly distributed among households**
- **This is to be expected: the industry has strived for over 75 years to abate price volatility and mask the time-differentiated cost of supply**
- **It will take time (and patience) to elevate electricity expenditures to a more prominent place in household decision making**
- **This is not justification to abandon adopting efficient pricing**
- **Nor is it a rationalization to impose dynamic pricing universally or punitively**
- **It is a call to action for the entire industry**

# A Corrective Prescription - Market Transformation

- ✓ Create opportunities to introduce time-varying pricing and feedback in a variety of situations
- ✓ Centralize the design and evaluation of these offerings to extract the information and learnings
- ✓ Share the experiences widely and purposefully
- ✓ Engage in the development of enabling technologies
  - ✓ *Auto DR* for commercial facilities
  - ✓ Household *Hand- Frees* device controls
  - ✓ Smart and efficient devices
- ✓ Integrate price and demand response into RTO/ISO operations
- ✓ Merge energy efficiency and demand and price response initiatives into cohesive portfolio of