The Demand Side: Behavioral Patterns and Unpicked Low-Hanging Fruit

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GHG reduction opportunities widely distributed – 2030 mid-range case

Increased commercial space

Gasoline Price Controls

Compact Fluorescent Penetration

Energy Audits (and followup)

LED: Traffic Lights, Task Lighting

Personal Computer Penetration

Efficient AC-DC Converters

Pigouvian Energy Tax

Congestion Pricing

Some Rail Rapid Transit Systems

Overly Strict Building Standards

Apparal Energy Labeling

Hybrid Gas-Electric Vehicles

Optimized Building Construction

Efficient AC-DC Converters

“Smart Buildings” Controls

Energy Audits (and followup)

Program Thermostat, Tire Pressure, Lights, Driving Patterns, TV Usage

“Smart” Regional Land Development

Old appliance replacement

Efficient AC-DC Converters

“Smart Meters and Feedback

Halt SUV Sales

Plug-In Hybrids (Future)

- LED General Lighting (Future)

- Plug-In Hybrids (Future)

Appliance Efficiency Standards

Enterprise Mgmnt Software

Electric - DC Converters

Hybrid Gas-Electric Vehicles

High Definition TV

Internet Growth

Economic development

High Definition TV

Accessible Business Travel

Increased commercial space

Enhanced Travel Infrastructure

Halt SUV Sales

Gasoline Rationing

Plug-In Hybrids (Now)

Appliance Efficiency Standards

“Smart” Regional Land Development

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LED: Traffic Lights, Task Lighting

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Gasoline Price Controls

Much Incandescent Lighting

Internet Growth

Economic development

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Personal Computer Penetration

Airline Deregulation

Internet Growth

Economic development

High Definition TV

Accessible Business Travel

Enhanced Travel Infrastructure
Why Do Negative Cost Options Continue?

Some Incomplete Explanations
# Market Failures and Behavioral Issues

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<th>Behavioral Issues</th>
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<td><strong>Externalities:</strong> Usage; R&amp;D</td>
<td>Low salience of energy issues ???</td>
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<td><strong>Principal/Agent Problems</strong></td>
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<td><strong>Poor Information about Prices and Energy Use</strong></td>
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<td><strong>Incomplete markets for energy efficiency</strong></td>
<td><strong>Managerial Priorities</strong></td>
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<td><strong>Systems Issues (E.g. Chicken &amp; Egg)</strong></td>
<td><strong>Lack of Energy-Related Information Systems</strong></td>
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<td><strong>Distortionary regulatory and fiscal policies</strong></td>
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Principal/Agent Problems

- **Examples**
  - New Building Construction
  - Rental vs Owner-occupied buildings
  - Consumer Product Design
  - Consumer Product Marketing

- **Information/cognitive limitations generally central to agency problems**
  - Electricity Use by TVs, passive chargers
  - Digital set top recorders
Market Penetration of Energy Efficiency Measures in Owner-Occupied and Rental Housing in California (CEC 2004)

- Insulated walls
- Insulated attic
- Double pane windows
- Programmable thermostat
- Compact fluorescent lamps
- Low-flow showerheads

Market penetration (%)
Fraction of Homes With Efficient Technologies or Behaviors

- Well Insulated Home
- Low-E coating (Double or Triple Pane)
- Some Windows Replaced
- Have Programmable Thermostat
- Reduce Temperature During Day
- Reduce Temperature During Night
- Lower Heat When Unoccupied
- Lower Heat At Night

Source: Calculated from the 2005 RECS survey, by Anant Sudarshan
Behavioral Issues: Salience/Cognitive

• **Low Priority of Energy Issues**
  – Often stated: energy costs are so small that it is not worth the effort to try to optimize.
  – Transactions costs of optimizing are greater than marginal gain.
  – But I doubt that is end of story.

• **Cognitive issues**
  – Probably very important for residential, small commercial, and individual transportation decisions
  – 2004 study. Only 20% of Americans own programmable thermostats. Of those, 70% have never programmed their thermostats.
About 3% of GDP

Electricity includes non-primary energy costs of electric system
Poor Information: Prices and Energy Use

• Electricity Use: Point of Purchase
  – Ease of Information about use (TV, Communications Equip.)
    • When appliance is on
    • When appliance is off
  – Appliances purchased in emergency
    • Water heaters
    • Furnaces
  – This problem need not be: e.g. refrigerator cost labeling

• Electricity Use By Appliances: Time of Use
  – Monthly electricity bills
    • What is link between what you do and the monthly bill?
    • What is the price structure you face for electricity?
How To Deal With Problems?

• There is not just one problem
  – Therefore there is not going to be a single solution
• Can we match solutions to the particular problems?

• One Solution: Go beyond the economics
"It runs on its conventional gasoline-powered engine until it senses guilt, at which point it switches over to battery power."
Some Motivational Approaches

• Pricing
  – A carbon price would have pervasive effects on energy use in all sectors
  – However, carbon prices will not address many of the market failures nor the information and cognitive issues
  – Navy experiment with base housing: benchmarks and charges or payments for deviations in energy use from the benchmarks
  – Gasoline taxes in Europe vs US motivate purchase of smaller more fuel efficient vehicles
Some Motivational Approaches

• Information
  – Labeling; e.g. Energy Star
  – Building performance rating and rating disclosure.
    – E.g., California mandatory building ratings
  – Easily processed economic data

• Information systems
  – New genre of enterprise-wide energy and carbon accounting and management software.
    – E.g., C3, Hara. Make it less costly to find energy efficiency options in large distributed organization, allow central management of energy and carbon savings, allow alignment of incentives with management energy goals
Other Motivational Approaches

• Feedback (immediate information linked to decisions)
  – Smart meters, sensors, energy information appliances
  – Google/Stanford experiment with Google Powermeter
  – Three levels of possible feedback
    • Consumer use of appliance/technology
    • Consumer purchase of appliance/technology
    • Manufacturer supply of appliance technology
Other Motivational Approaches

• Stochastic Rewards
  – Balaji Prabhakar congestion experiment with Infosys in Bangalore, India
  – Goal: incentives for Infosys commuters to travel at uncongested times
  – Infosys employees given chance for one month extra salary each time they took bus to arrive one half hour earlier than rush hour, two chances for arriving one hour earlier.
    – Expected value per ticket was 20 rupees – 10 cents.
    – Roughly 15% of employees decided to come one-half hour or one hour early.
Other Motivational Approaches

• Social norms
  – Billing information that compares electricity use to neighbors or other norms. E.g. OPower mailings.
  – Navy housing experiments mentioned in last slide
Analogies

• Smoking. How did US move from nation of predominantly smokers to predominantly non-smokers?
• Motivating obesity solutions
  – If most of your friends are obese, then obesity is seen as norm
• Motivating litter reduction
  – Robert Cialdini work
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