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**Electrification: The Link between
Markets, Consumer Behavior and Public
Policy**

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What is Electrification(E)?

- A *consumer-choice activity* whereby energy consumers decide to choose electricity over natural gas and other fossil fuels in meeting their *demands for energy services*
- These services include transportation, space heating, water heating, cooking, and agricultural pumping
- The decision can involve conversion from natural gas or other fossil fuel to electricity in an existing home (business) or installation of electricity technology in a new home (business)
- Energy-choice decisions are complex, involving myriad factors that are both customer- and site-specific

Composition of Residential Energy Consumption by End Use

End Use	Percentage of Total Energy Consumption
Refrigerators	4.8%
Air conditioning	6.2
Water heating	17.7
Space heating	41.5
Other appliances and lighting	29.8

Source: U.S. Energy Information Administration, *Residential Energy Consumption Survey*, Table CE3.1, 2015, at <https://www.eia.gov/consumption/residential/data/2015>.

Growing Dialogue on Electrification

- Increased concern over climate change
- Technological advancements are moving in a direction that favors E with its emphasis on digitization and clean energy
- Electric vehicles (EVs) and heat pumps are the “E” technologies that have received the most attention so far
- The push for E has spawned from two odd bedfellows: environmentalists and electric utilities
- Climate change advocates consider electrifying the energy sector and powering it by low carbon electricity as a key decarbonization pathway
- Some observers believe that the pace of E should proceed faster than what would occur under a business-as-usual scenario

Core Economic Issues

- Does E pass an economic “smell test”?
 - ❑ Do the benefits exceed the costs?
 - ❑ Does it make economic sense to “rapidly” transform the energy sector away from fossil fuels and toward electricity?
 - ❑ Who pays for new required investments and who benefits?
- New technology diffusion
 - ❑ S-shaped path
 - ❑ Explanations
- Market and consumer-behavioral problems
- Traits of a well-functioning market, and how well end-use energy markets stack up

Economics of Electrification

- Two different economic tests
 - ✓ Cost-effectiveness
 - ✓ Cost-benefit
- Distinguishing technical from economic feasibility for new or fringe technologies
- Different factors of energy-technology choice
 - ✓ Initial cost
 - ✓ Energy and other operating costs
 - ✓ Non-cost conditions such as climate and reliability
 - ✓ Expected future benefits and risks
- Effect on both natural gas and electric utilities

Market and Consumer-Behavioral Problems

- Assumptions of neoclassical economics are incompatible with real-world realities
- Alleged market failures – the example of energy efficiency
 - Environmental externalities
 - Inefficient pricing of energy
 - Lack of information
 - Principal-agent problems

All can lead to inefficiently low levels of investment in energy efficiency or a “energy efficiency gap”

- The relevant question here is: Is there an “electrification gap” for similar reasons?

Market and Consumer-Behavioral Problems – *continued*

- Consumer-behavioral problems
 - ❖ Consumer actions that are inconsistent with energy-service cost-minimization
 - ❖ *Behavioral economics* relaxes the classic neoclassical assumption of rational choice and replaces it with bounded rationality or other heuristic decision-making methods
 - ❖ Experimental and real-world evidence shows that consumers are not perfectly rational – even when given perfect information
 - ❖ For end-use energy markets, the most relevant and common rationality assumption is consumers minimizing expected present-value costs for the demanded level of energy service

Explanations for “Non-Optimal” Consumer Behavior

- Consumers have imperfect information
- Consumers' chief concern is the economic effect on themselves, not on society as a whole (e.g., the environment)
- Consumers undervalue future benefits
- Inertia (“status-quo bias”) reflects the reluctance of consumers to change energy sources because of uncertain outcomes that could make them worse off
- High transaction costs add to the cost or inconvenience of consumers switching energy sources
- Consumers might worry about electricity price volatility and view the environmental benefit as trivial
- Inefficient rate designs that deviate from the full costs of producing and delivering energy
- Heuristics or so-called rules of thumb over-simplify the decision-making process.
- Energy consumers choosing appliances and other durable goods tend to focus on the initial installation cost, not the life cycle cost

Some of these reflect rational consumer behavior, others not

Public Policy Options

- Without a national policy to cap or tax carbon emissions, the fostering of low or zero emitting energy technologies through a combination of standards and incentives has become the principal policy strategy for mitigating climate change
- For E, similar policies would include restricting or discouraging the consumption of fossil fuels for end uses, and handing out subsidies (say) to consumers who choose electricity for space and water heating
- Some label this as soft or libertarian paternalism: Preserving people's freedom of choice while guiding them in a direction that improves their lives

A Multistep Approach for Evaluating Policy Options

Step	Comment
Review the end-use energy market	Need for better understanding of the market before taking any action
Evaluate its economic efficiency	Comparison of the actual market with a well-functioning market
Detect undue barriers (“E gap”)	Obstacles to E, segmented by normal market forces and artificial barriers
Identify the preferred policy response	Alignment of the best policy response with a specific undue barrier
Conduct cost-benefit analysis	Measurement (to the extent possible) of the benefits of a policy response along with its costs
Execute policy action	Cost-beneficial action to improve market performance (i.e., economic efficiency and societal benefits)
Evaluate action ex post	Periodic review of action in light of changing market and other conditions

Closing Comments

- *Primary question:* Do end-use markets for energy operate well and in the interest of customers and society at large?
- With minimal market and behavioral problems, little justification exists for out-of-market intervention
- But sometimes markets fail to operate in a socially optimal way for various reasons, justifying consideration of outside action
- Policymakers should exhibit prudence, as poorly designed and executed intervention is likely to fail a societal cost-benefit test

Closing Comments – *continued*

- It is not yet prime time for E, although it is more imminent for transportation (light duty vehicles and short-range heavy duty vehicles)
- Probably the two biggest barriers to E today are high upfront costs and low fossil fuel prices
- In the absence of a carbon tax or a cap-and-trade plan, policymakers find it difficult to know the cost-effectiveness of E relative to (1) other carbon-mitigation options and (2) the continued use of fossil fuels as a major energy source

Closing Comments – *continued*

- Research and development (R&D) plays a critical role in the long-term economic viability of new technologies, including “E” technologies
- “Artificial” E induced by subsidies and other monetary incentives would be a win-win for electric utilities and the environmentalists, but questionable for the rest of society
- Policymakers need to do more homework before they extol the wonders of E
- In the meantime, they can capture the low-hanging fruit by identifying any undue obstacles to socially-beneficial E