Explaining the Energy Paradox

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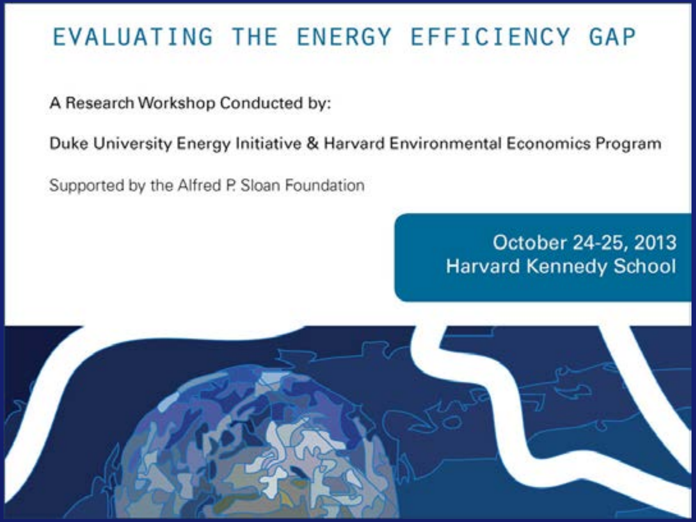
Background

- *Builds upon* a joint project of the Duke University Energy Initiative and the Harvard Environmental Economics Program, "Evaluating the Energy Efficiency Gap"
- *Global energy consumption* is on a path to grow 50% over next 25 years
  - increased CO_2 emissions, local air pollution, and oil consumption
- *Energy efficiency improvements* are mechanism for decreasing energy use (account for nearly one third of CO_2 cuts globally in cost-effective scenario)
- Key questions:
  - How do people & businesses make energy efficiency decisions?
  - What are the effectiveness, costs, and benefits of energy-efficiency policies?

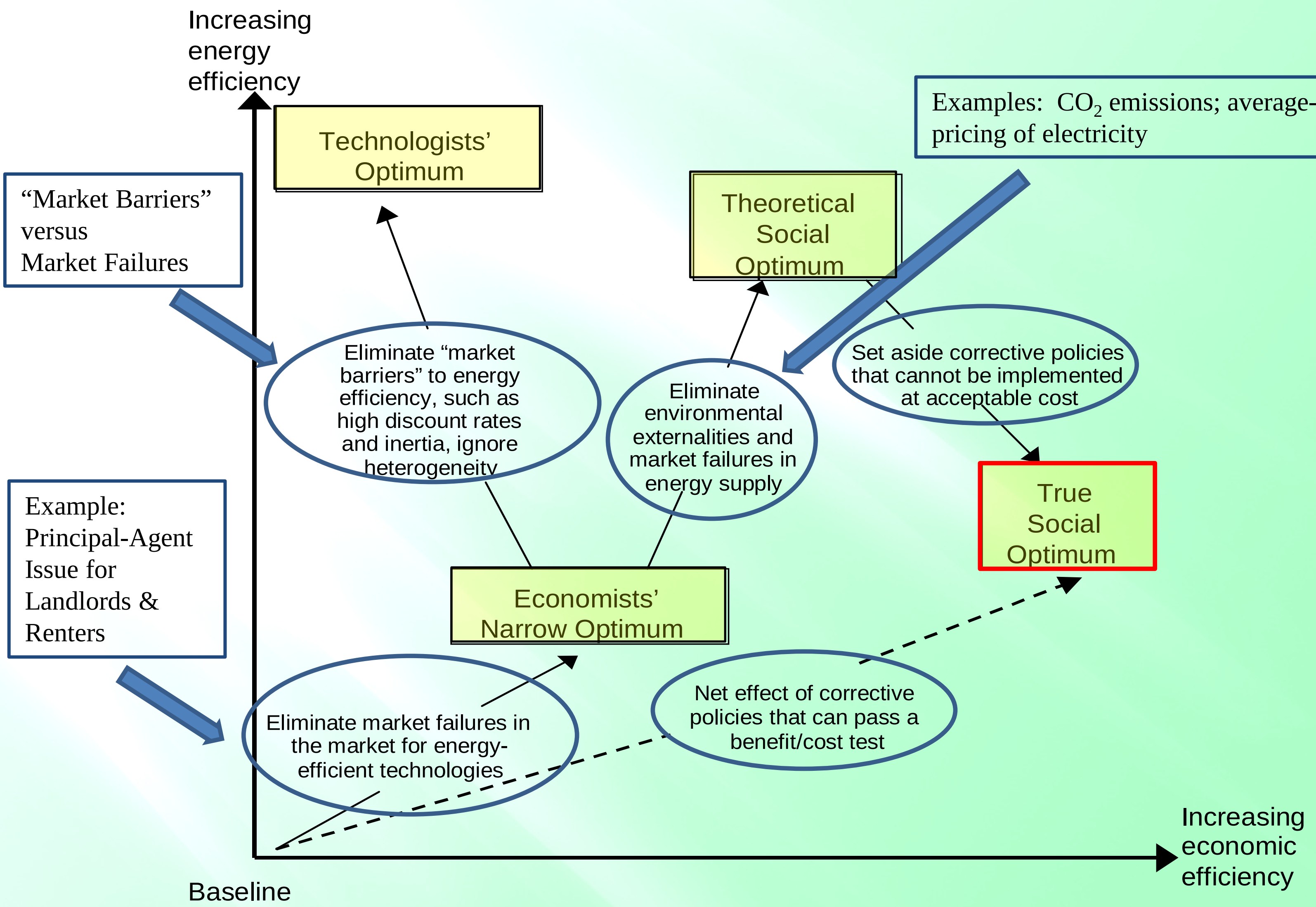


- Central issue: the "energy paradox" or "energy efficiency gap" (Shama 1983; Jaffe & Stavins 1994) ….

What is the "energy paradox" or "energy-efficiency gap?"

- The *apparent* reality that energy-efficiency technologies that would pay off for adopters (in terms of energy cost savings) … are nevertheless *not* adopted
  - Seminal studies by Hausman 1979, and Dubin & McFadden 1984
  - Distinguish between paradox (private) and gap (public) -- later
- Let's be clear about what *adoption* means …
- Three stages of technological change (Schumpeter 1939)
  - *Invention* – creation of new equipment (in the laboratory)
  - *Innovation* – commercialization, i.e. taking it from the laboratory to the showroom floor
  - *Diffusion* – gradual process of *adoption* (purchase) of product
  - [And, of course, *utilization* – use of the adopted product]
- Energy paradox is mainly about *diffusion*, …
  - … but there are multiple interpretations of the "gap" ………

Alternative notions of the “energy-efficiency gap”



Deconstructing the Energy Efficiency Paradox/Gap

- **Basic definition (energy *paradox*):** the *apparent* reality that some energy-efficiency technologies that would pay off for adopters … are *not* adopted

- **Broader definition (energy-efficiency *gap*):** apparent reality that some energy-efficiency technologies that would be *socially efficient* are not adopted

- ***Why*** are such technologies **not adopted**? What explains the paradox/gap?

- Answers have very important policy implications.

- Let’s sort potential explanations into 3 categories …

Deconstructing the Energy-Efficiency Gap:
Conceptual Frameworks and Evidence

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Energy-efficient (EE) technologies offer considerable promise for reducing the financial costs and environmental damages associated with energy use, but these technologies appear not to be adopted to the degree that appears justified, even on a purely private basis.

We present two complementary frameworks for understanding the EE gap. First, we build upon previous literature (Jaffe and Stavins 1994; Gillingham, Newell, and Palmer 2009) by dividing potential explanations for the gap into three categories: market failures, behavioral explanations, and model and measurement errors. Second, we examine the elements of cost-minimizing EE decisions, the typical benchmark used in assessing the gap's magnitude.

I. Potential Explanations

First, potential market-failure explanations for the EE gap include information asymmetries and imperfections in markets for energy, capital, and innovation.

Second, potential behavioral explanations include myopia, cognitive limitations, inattentiveness, loss aversion and reference dependence, and systematically biased beliefs.

Third, there are potential model and measurement explanations. These feature reasons why the adoption rate of EE technology may not be as paradoxical as it first appears. Potential sources of model and measurement error include unobserved costs or overstated energy savings from adoption, ignored product attributes, heterogeneity across potential adopters, use of inappropriate discount rates, and uncertainty.

Determining the validity of candidate explanations—and the degree to which each contributes to the EE gap—are crucial for crafting sensible public policy responses.

An Economic Perspective: Potential Explanations of the Paradox/Gap

- ***Market-Failure*** Explanations

- ***Behavioral*** Explanations

- ***Model and Measurement*** Explanations

Potential Explanations of the Paradox/Gap: *Market-Failure Explanations*

- Information Problems
  - Principal-agent issues (e.g., renters/landlords – Davis 2011)
  - Lack of information, asymmetric information (research on residential construction, Jaffe & Stavins 1995; Palmer *et al.* 2011)

- Energy Market Failures
  - Externalities – environmental, security (Krupnick, *et al.* 2010)
  - Average-cost electricity pricing (Joskow 1976; & others)

- Capital Market Failures
  - Liquidity constraints
  - Particularly relevant in developing countries

- Innovation Market Failures
  - R&D spillovers due to public-good nature of information (evidence from patent studies by Griliches 1992; Jaffe 1998; Popp; & others)

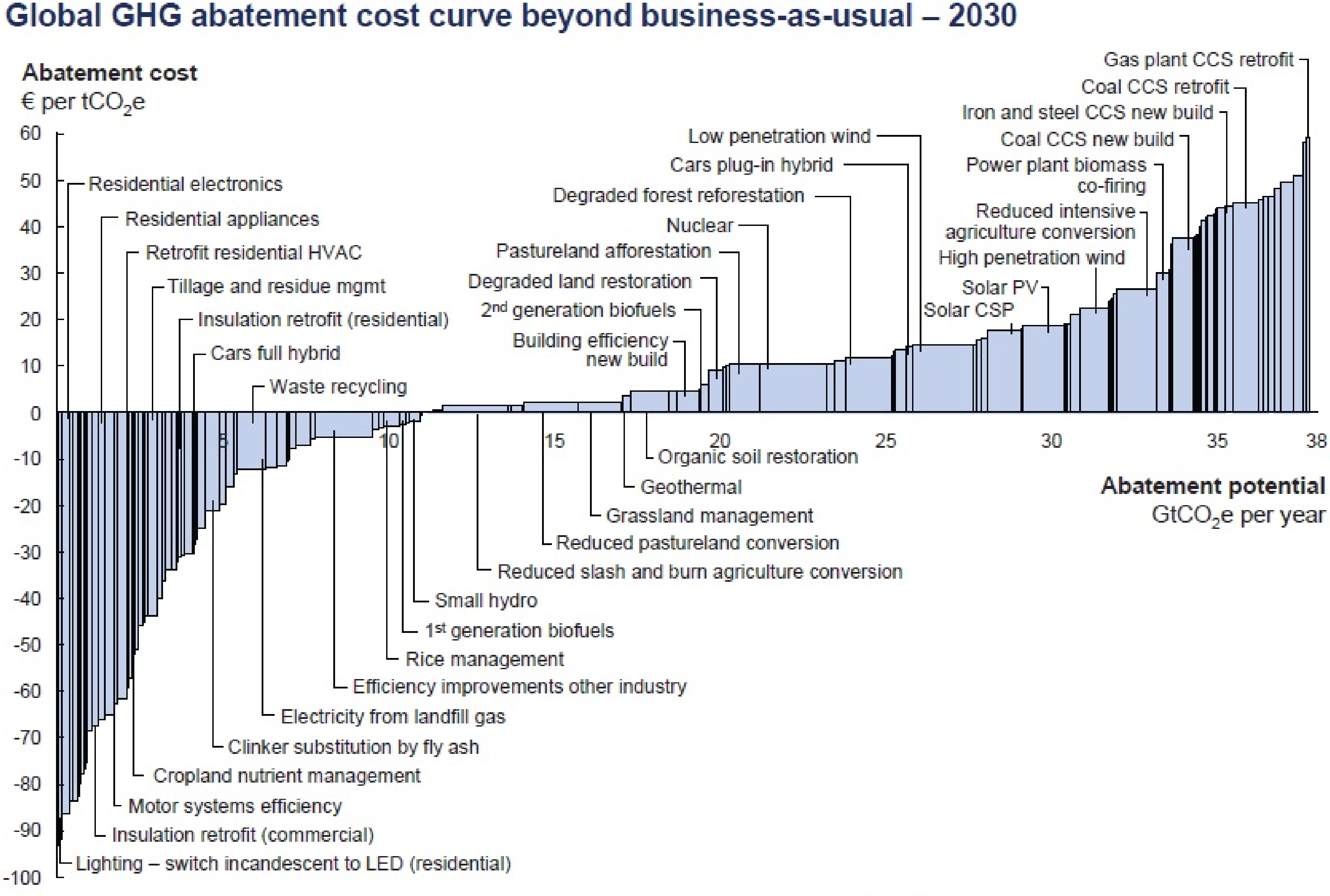
Potential Explanations of the Paradox/Gap: ***Behavioral Explanations***

- Inattentiveness/salience issues
  - Electricity billing (Allcott; Mullainathan; Wolfram; Greenstone; & many others)
  - Water billing practices (Olmstead, Hanemann, & Stavins 2007)
  - Regulations may increase effects of prices (Newell, Jaffe, & Stavins 1999)
- Bounded rationality, heuristic decision-making
  - Do consumers make choices on basis of NPV?
  - Rules-of-thumb
  - *What about firms?*

Potential Explanations of the Paradox/Gap: *Model and Measurement Explanations*

- Unobserved costs of adoption
  - An explanation of some "negative costs" in McKinsey cost curve (slide)
- Product characteristics/attributes
  - Hedonics: products as a bundle of attributes
  - First-generation compact fluorescent light bulbs: color & noise
  - CFLs: size, shape, dimmers, etc.
- Heterogeneity in demand across potential adopters
  - Griliches (hybrid corn, 1957; Hausman and Joskow 1982)
  - Ubiquitous phenomenon with virtually all new technologies
- Uncertainty (real, not informational)
  - Future energy prices (theory – Dixit & Pindyck 1994)
  - Empirical analysis (home improvements, Hassett and Metcalf 1994)

The (In)Famous McKinsey Cost Curve



Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.
Source: Global GHG Abatement Cost Curve v2.0

General Policy Implications

- Cause of paradox/gap implies whether & how policy should address it
- What about *conventional*, command-and-control regulations?
  - Major effect -- *remove* some products from market (energy-efficiency standards)
- What about *subsidies* as a diffusion (adoption) policy?
  - Can provide perverse incentive to *increase* energy use (rebound effect)
  - Require large public *expenditures* per unit of effect (infra-marginal units)
- Multiple market failures – in climate change context, environmental *externality* and *public-good* nature of information generated by R&D
  - Pricing of externality is *necessary, but not sufficient*
  - Direct technology policy is *necessary, but not sufficient*
- Major Implications:
  - Innovation & diffusion respond to market incentives (price signals)
  - But multiple market failures may clarify case for combining pricing policies with broader-based public support for technology innovation

For More Information

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