Closing the Gap:

Promoting Residential Energy Efficiency Investment in Rhode Island

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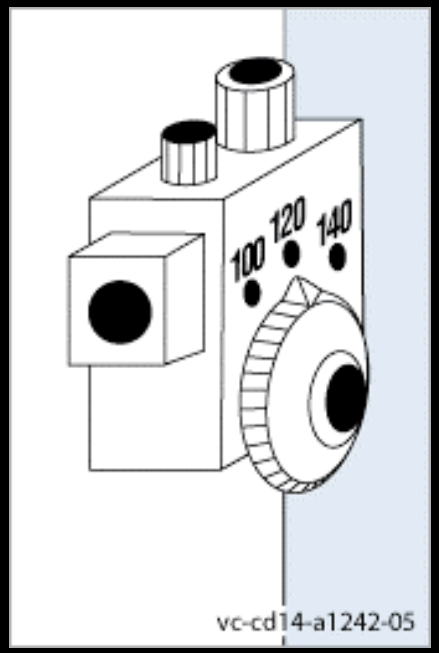
What is the Energy Efficiency Gap?

- Gap between a consumer's actual investments in energy efficiency and those that appear to be in the consumer's best interest
- Potential causes:
  - Poor household decision-making
  - A dearth of information
  - Limited access to capital
  - Problems in the market for supplying efficiency improvements



An extreme example

Questions:

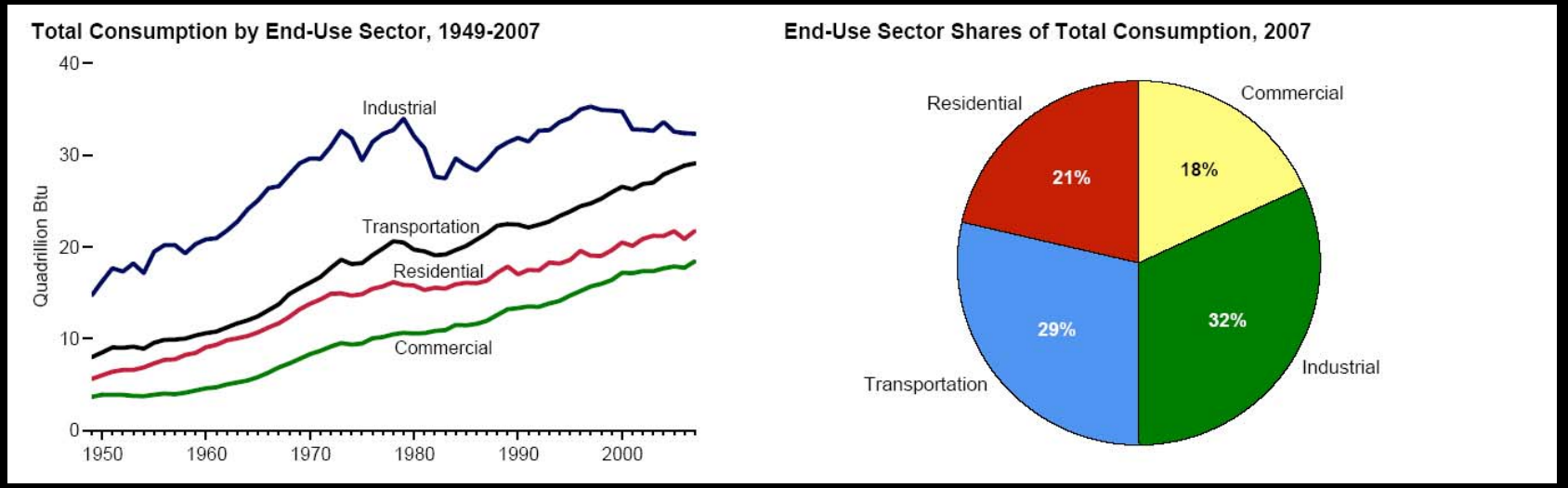
- Why do households not invest in the efficiency of their homes in an economically efficient manner?
  - What can be done to encourage households to invest more?
  - What programs are being implemented in RI to help households use less energy?
  - Do these programs align well with information and insight gathered from literature?
  - What new programs or program modifications could be introduced in RI to encourage households to save even more energy?

Outline

- Introduction:
  - Justification
  - Background
    - Costs and benefits
    - Typical efficiency providers
- Literature review
  - Household Barriers
    - Financial
    - Non-financial
  - Supply problems
- Rhode Island
  - Current state of energy efficiency market
  - Two case studies
- Conclusions and recommendations
- Further research

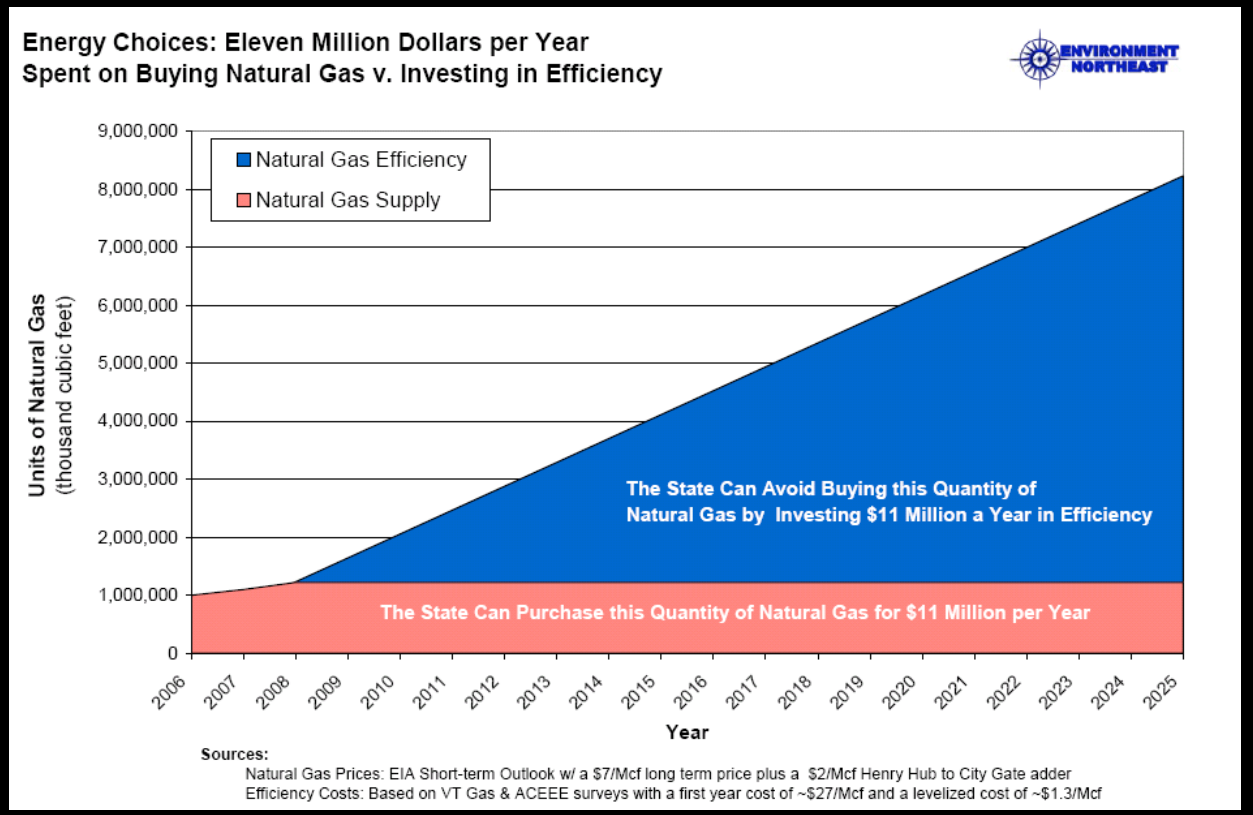
Justification: Building Energy Consumption

- Residential customers in US spent $69.2 billion for heating in 2006
- Just heating US buildings produced 420 million metric tons of CO_2
- CO_2 released just from residential energy consumption equivalent to CO_2 produced by all of Latin and Central America



Source: EIA, 2007

Efficiency: a cost effective alternative to commodity procurement



Natural Gas

	Range ($/Mcf)	
Natural Gas Supply (city gate) [3]		
Last Year	6	8
September & October 2005	12	16
Natural Gas Efficiency Investments [4]	Range ($/LifetimeMcf)	
Commercial & Industrial		1.0
Residential		2.5

Sources:
[1] From ISO New England
[2] From New England electric efficiency program results
[3] Energy Information Administration
[4] ACEEE and New England natural gas efficiency program results

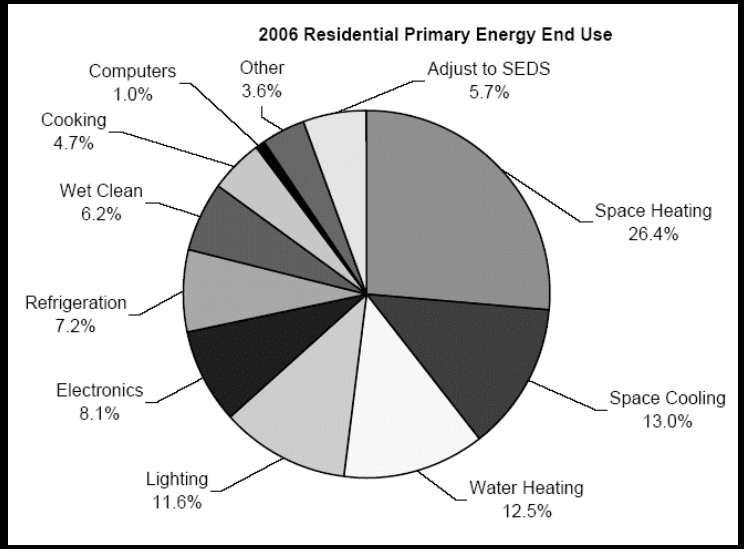
Environment Northeast: http://www.env-ne.org/public/resources/pdf/RI_HEET_Data.pdf

Why Residential vs. C&I?

- Residential energy consumption greater than commercial energy consumption
- Households lack access to financial capital and information that firms have, discouraging investment
- Reduced profit margins on smaller jobs means that market does not cater to residential customers
- Social benefits

Why focus on heating and envelope?

- In homes, heating is the single largest energy end-use, 26.4%
- Envelope investments have long lifetime
- Quality of life benefits as well
- Homes that do not heat with natural gas do not have access to same utility incentives



	Loads (quads) and Percent of Total Loads			
Component	Heating		Cooling	
Roof	-0.65	12%	0.16	14%
Walls	-1.00	19%	0.11	10%
Foundation	-0.76	15%	-0.07	-
Infiltration	-1.47	28%	0.19	16%
Windows (conduction)	-1.34	26%	0.01	1%
Windows (solar gain)	0.43	-	0.37	32%
Internal Gains	0.79	-	0.31	27%
Net Load	**-3.99**	100%	**1.08**	100%

Source, 2008 Building Energy Data Book, DOE

Why Rhode Island?

- As above, many houses do not heat with natural gas
- Manageable size, diffusion of tech and information more rapid
- RI has great diversity within small geographical area
- National Grid has been highly ranked by ACEEE for its public benefits programs

Costs and Benefits of Efficiency Investments

- Costs:
  - Financial/implementation costs
  - Search and transaction costs
- Benefits:
  - Energy savings stream
  - Increased real estate value
  - Reduced maintenance/increased lifetime?
  - Quality of life
  - Others: pollution reduction, job creation, national security, etc.

Energy Efficiency Market

- Weatherization Assistance Program (LIHEAP)
  - Goal is to reduce energy burden of highest-risk households
  - Vast majority of weatherization data from these programs
  - Problem: low-income households bound to be very different from weatherization of other homes
- Utility companies: Demand Side Management (DSM)
  - Peak management cost-effective for utility companies, other energy efficiency program not
  - Role of Public Utility Commissions (PUCs)
  - Huge variety of programs: information and education, audits, loans, rebates, etc.

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- **Literature review**
  - Household Barriers
    - Financial
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- Rhode Island
  - Current state of energy efficiency market
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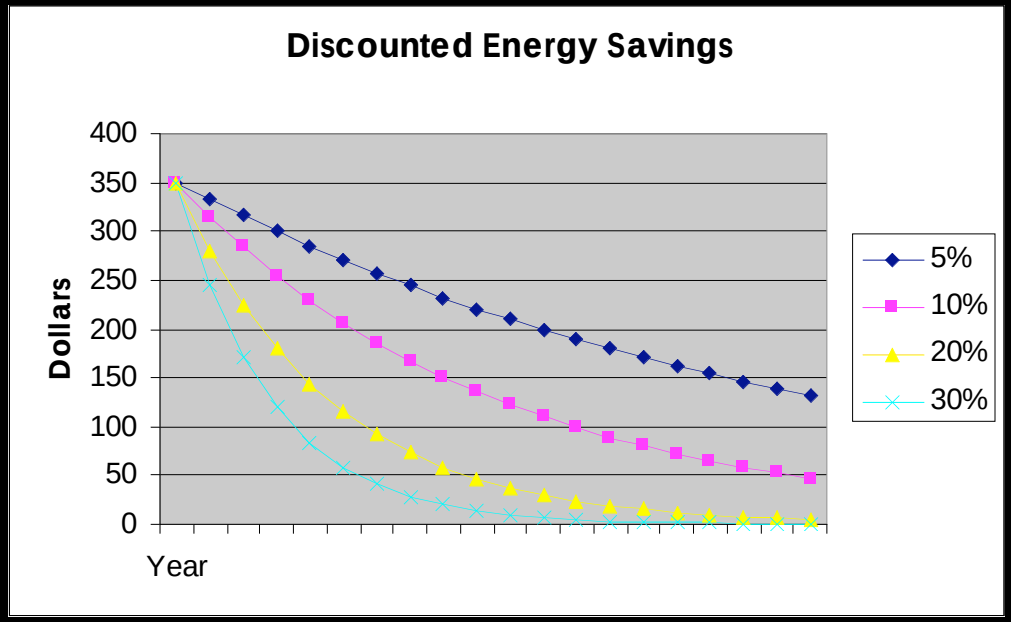
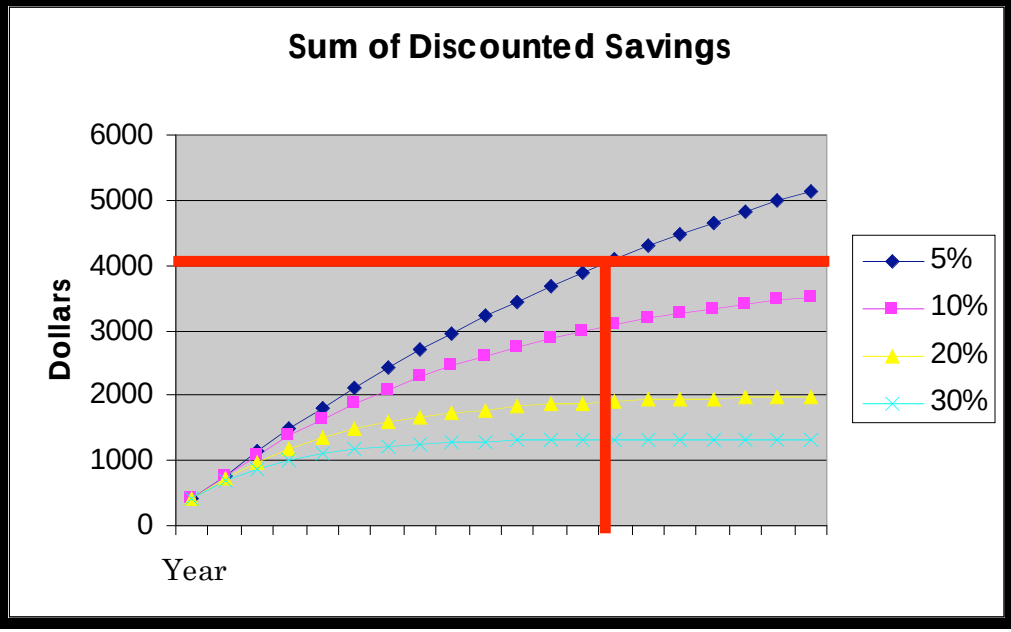
Household Barriers: Financial

The Discount Rate: Discounting Future Savings

- Example:
  - Initial Investment: $4,000
  - Annual savings: $400
  - Measure lifetime: 20 years
- At 5% discount rate:
  - Payback period: 13.5 years
  - NPV: $1,132
- Other measures:
  - Annual ROI: 10%
  - IRR: 8.2%





Interpreting Discount Rates

- Most formally, discount rate represents cost of capital, i.e., interest paid on a loan
- But discount rate can also be attributed to other issues
- A high discount rate means that there are other costs associated with the investment that make it less attractive than other investments with similar returns
- A high discount rate might suggest uncertainty, insufficient information, high transaction costs, imperfections in the real estate market, principal-agent problems, or other issues (Horowitz, 1990; Jaffe, 1994)
- Lower-income households tend to have higher discount rates (Golove, 1996)
- Some studies show discount rates appropriate for energy efficiency (Horowitz, 1990), others show discount rates unreasonably high (Golove, 1996)

Uncertainty and Risk Aversion

- Regarding performance of measure
  - Without pre-installation monitoring, hard to accurately predict savings (Jacobson, 2007)
  - All engineering calculations, to some degree, are based on averages, so some households will save more, some less (Jaffe, 2004)
- Regarding energy prices
  - Especially problematic, because it is impossible to diversify within energy efficiency investments
  - Heating fuels, oil and gas, tend to be more volatile than electricity (Horowitz, 1990)
- Unjustified
  - About 16% of the population consists of “laggards” who are “hostile to innovation” (Reed, 2007)
- Potential solutions?

Irreversibility

- Problems associated with making an investment now instead of waiting to make it later:

Potential Solutions

- Market transformation

Liquidity, Access to Capital

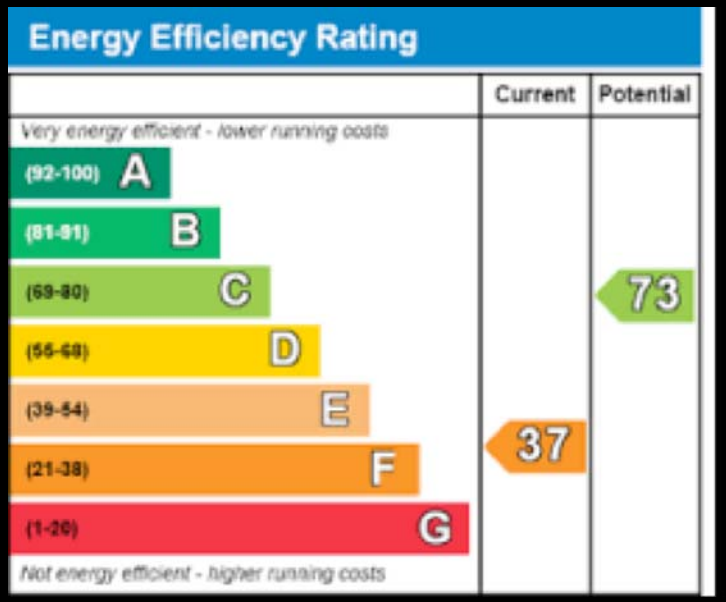
- For a risk-adjusted price, the market should provide capital for all investment needs
- Problem: mortgages don't take into account the cost of operating the home; efficiency should reduce risk to lender
- Problem: loans more expensive for low-income households

Potential Solutions

- Focusing on rebates and grants to minimize first cost
- Pay-as-you-save (more on this later)

Split Incentives/Principal Agent Problem

- Economic benefits of efficiency investment do not accrue to the party that made the investment
- Those who make investment decisions (landlord) do not receive full benefits of investment



Potential Solutions

- Increase information!
- Pay-as-you-save

http://www.commercialenergyassessorsukltd.co.uk/page2.html

Household barriers: non-financial

- Awareness:
  - Household unaware it is using excessive energy
  - Want to save energy but don't know how
  - Importance of awareness: many retrofits done on short-notice

"Household's information is often not only incomplete, but systematically incorrect." *(Reed, 2007)*

New York Times: "Utilities Turn Their Customers Green, with Envy"

- Potential Solutions:
  - Importance of energy use feedback: makes energy use visible
  - Presenting household energy usage in the context of reasonable usage (see above)
  - Community-based education: importance of contagion

Search and Transaction Costs

- Effort (opportunity cost) involved with investigating options and implementing energy conservation measure must exceed potential benefits
- Increased complexity = increased search and transaction costs
  - What measures should be taken?
  - Available incentives?
  - Available contractors?
  - Whole-house approach or individual measure?
- Households don't have this specialized knowledge

Potential Solutions

- Households much more likely to act when incentive, energy usage, and contractor information available in one place
- Importance of economies of scale

Opportunism/Asymmetric Information

- Easy to mislead households about potential energy information
- If people believe they might be taken advantage of, they will not invest efficiently, regardless of whether the opportunism is real or perceived
- Vendors do have incentive to overestimate savings when households cannot verify them (Jacobson, 2007)

Potential Solutions

- Use community to spread positive experiences
- Present information and other services through a more trusted entity

STATE OF NEW YORK
Public Service Commission
Garry A. Brown, Chairman

Three Empire State Plaza, Albany, NY 12223
http://www.dps.state.ny.us
FOR RELEASE: IMMEDIATELY

VS

Example: conEd vs. the State of New York Public Service Commission (Craig, 1978)

Other Barriers/Bounded Rationality

- Bounded rationality: rational economic actors?
  - Example: people react more to the potential to avoid losing money than they do to gain money (Stern, 1996)
- Importance of other factors in decision making process:
  - Effective and persuasive presentation of information
  - Tailor message to appeal to appropriate values
  - Community involvement: contagion vs. broadcast diffusion
    - Example: Minnesota efficiency program (Polich, 1984)
- Potential solutions

Supply-Side Issues

- PUC mandates can be overly restrictive
- Profit margin for residential customers smaller
- Limited availability of skilled subcontractors
- Limited perceived demand

A few best practices:

- Flexible yet challenging PUC mandates
- Focusing on specifics of program implementation: "more important than the size or form of the incentive" (Stern, 1986)
- Stimulate demand!

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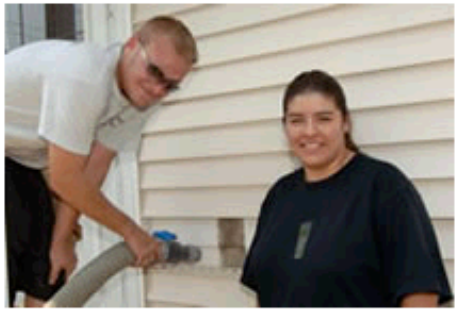
RI: nationalgrid

- Ranked highly by the ACEEE for it's electric DSM program
- Gas efficiency program created after 2006 legislation
- EnergyWise program
  - Free energy audits (but…)
  - Up to $1000 for heating system
  - Up to $300 for hot water
  - 50% of insulation and infiltration work (up to $1500)
- Problems:
  - Program doesn't reach households that don't heat with gas
  - Only incentive is PUC mandates
  - Working with one contractor fails to encourage new suppliers
  - Little data available

Weatherization Assistance Program (WAP)

- Funds from DOE, LIHEAP, and state
- Program administered by Community Action Programs
- Savings range 20-40% of gas bill, according to E. Bay CAP
- Grants based on income, family size, and fuel type (150% poverty)
- Problems
  - Limited funding
  - Limited education component
  - Doesn't create self-sustaining market



"Thanks to BVCAP, my home is warmer and my fuel bill is lower."

http://www.bvcap.org/energy.asp

Example: Ohio Weatherization Assistance Program

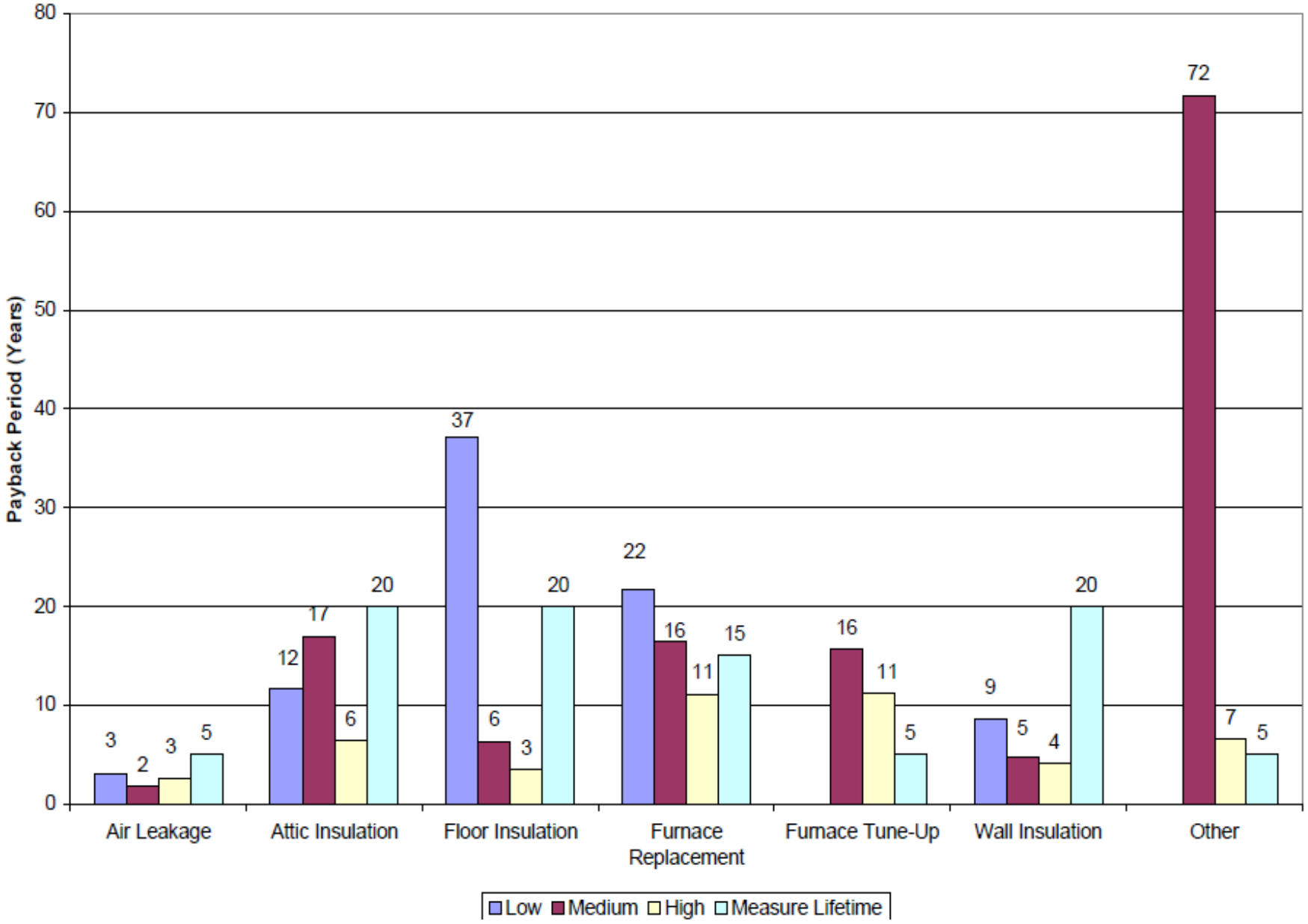
- Consisted of audit, implementation, and verification of homes with poor performance
- Predominantly gas-heated, single family homes
- Stats:
  - Gas usage reduced by 25%, 326 therms (~$360)
  - Average job cost: $2,900
- Lessons:
  - Focusing on high-usage households results in most cost-effective investments
  - Most common and effective measures watt and attic insulation and infiltray reduction

Table 30. Comparison of Cost Effectiveness Results for Gas-Heated Single-Family Homes

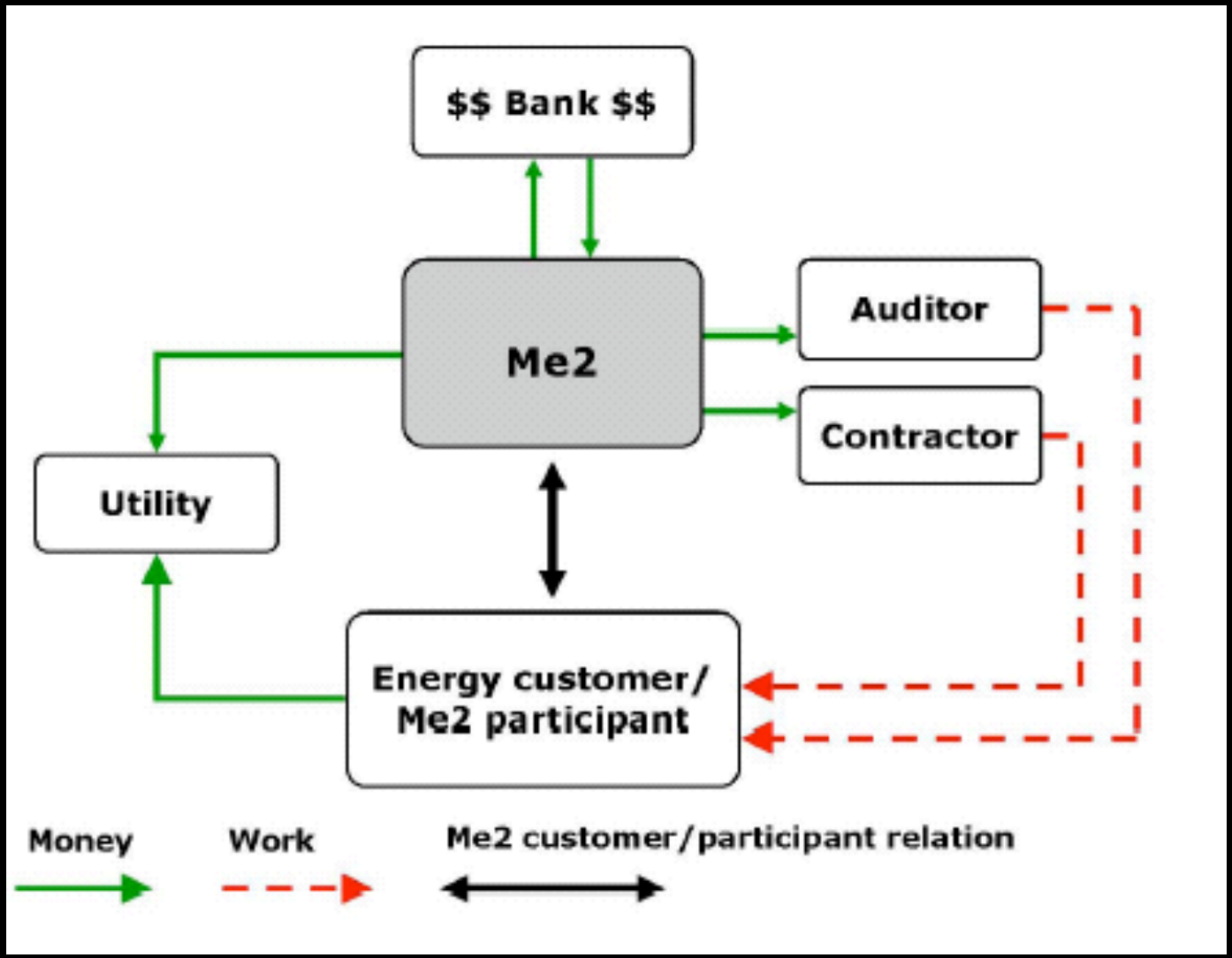
Program	Year	Program Perspective	Societal Perspective
Current Evaluation	2003	1.10	1.87
Oak Ridge National Meta Evaluation	1993-2003	1.30	2.70
Ohio	1994	0.88	0.90*
Washington	1997	0.74	1.20

* Includes only energy and disconnection benefits.

Figure 20. Site Built Single-Family Measure Payback Time by Natural Gas Usage Category[33]



Pay-as-You-Save, NH



Other considerations:

- Pollution (traditional externality)
- Job creation
- Increased social stability