Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Program

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Abstract

Conventional wisdom suggests that energy efficiency (EE) policies are beneficial because they induce investments that pay for themselves and lead to emissions reductions. However, this belief is primarily based on projections from engineering models. This paper reports on the results of an experimental evaluation of the nation's largest residential EE program conducted on a sample of more than 30,000 households. The findings suggest that the upfront investment costs are about twice the actual energy savings. Further, the model-projected savings are roughly 2.5 times the actual savings. While this might be attributed to the "rebound" effect – when demand for energy end uses increases as a result of greater efficiency – the paper fails to find evidence of significantly higher indoor temperatures at weatherized homes. Even when accounting for the broader societal benefits of energy efficiency investments, the costs still substantially outweigh the benefits; the average rate of return is approximately -9.5% annually.

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tends to over-predict pre-retrofit energy use and retrofit energy savings.[46] Indeed, we found in our data that the NEAT program predicts baseline natural gas consumption that exceed actual consumption by more than 25% prior to weatherization. This suggests that the auditing tool could be under-estimating the efficiency properties of the average home prior to weatherization, which may partly explain the over-statement of the benefits of upgrading to a given efficiency standard.

Overall, our findings suggest that the NEAT audit tool over-estimates returns by a significant margin. Further, this overestimation of savings does not appear to be due to behavioral responses. This is an important finding in its own right; NEAT is widely used by state and local WAP sub grantees, utility companies, and home energy audit firms.[47]

7 Conclusion

We conducted a large-scale randomized encouragement design experiment on a sample of over 30,000 households presumptively eligible for participation in WAP in the state of Michigan. Approximately one quarter of these households were randomly assigned to a treatment group that was encouraged to apply for the program and received significant application assistance. The control households were free to apply for WAP but were not contacted or assisted in any way by our team. We also analyze corroborating evidence from a quasi-experimental analysis covering over twice as many weatherizations as well as a survey of indoor conditions at weatherized and unweatherized homes.

We document three primary findings. First, the aggressive encouragement efforts were disappointing. This encouragement increased take-up rates from less than 1% in the control group to about 6% at a cost of over $1,000 per weatherized household. Second, we find that WAP participation reduced energy consumption by 10-20% among participating households. However, the upfront cost of the energy efficiency investments are about twice the cost of the realized energy savings. Further, the projected savings are about 2.5 times the actual savings. Third, while the

[46] For example, a recent report found that modeling software consistently overestimated energy consumption; mean modeled total annual use was 40% greater than billed use (SBW, 2012).

[47] While more sophisticated building simulation models exist, an appeal of NEAT is that it can be inexpensively used by the thousand of implementers who have a wide range of skills and technical training. Indeed, the DOE cites one of the primary benefits of NEAT as its accessibility to non-technical users (EERE, 2010). While more complex models exist, they are very likely to be more expensive to use.

modest energy savings might be attributed to the rebound effect, when demand for energy end uses increases as a result of greater efficiency, the paper fails to find evidence of economically or statistically signicant increases in indoor temperature at weatherized homes.

Overall, the energy efficiency investments we evaluate are poor performers on average across a variety of metrics. From a household's perspective, the annual internal rate of return that would rationalize these efficiency investments is -2.2%. The household's perspective differs from society's because it fails to recognize the benefits of greenhouse gas and local pollutant emissions reductions and because the retail prices for natural gas and electricity exceed their marginal costs of delivery. Accounting for these two factors, the annual social internal rate of return that would justify these investments is -9.5%, which is even less favorable. Finally, we also calculate the average cost per ton of avoided CO_2 under a range of assumptions. The most plausible estimates are approximately \$329/ton, which is about an order of magnitude larger than the U.S. government's estimate of the monetized benefits of avoided emissions (i.e., the social cost of carbon) of roughly \$38.

This study demonstrates that the returns to common residential energy efficiency investments are negative both privately and socially among low-income households in Michigan. The results are striking because Michigan's cold winters and the likelihood that the weatherized homes were not in perfect condition suggests that it may have been reasonable to expect high returns in this setting. Regardless of one's priors, this paper underscores that it is critical to develop a body of credible evidence on the true, rather than projected, returns to energy efficiency investments in the residential and other sectors. The findings also suggest that the last several decades may have seen too much investigation into the why of the energy efficiency gap and not enough into whether there really was one.

From a policy perspective, WAP does not appear to pass a conventional cost-benefit test, although its full-set of goals may not be reflected in such tests. On the broader question of optimal climate change policy, this paper's findings indicate that residential energy efficiency retrofits are unlikely to provide the least expensive carbon reductions. Future research should examine whether the real world returns to energy efficiency investments differ so starkly from engineering projections in other settings.