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Non-energy benefits: Workhorse or unicorn of energy efficiency programs?

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ABSTRACT

Non-energy benefits of energy efficiency programs have been studied as early as 1993, and there have been hundreds of papers and reports published since then, many of them finding that NEB are significant. Yet many U.S. states do not include NEB in their cost-benefit analyses. This article tries to provide some insight into this mismatch between the findings of NEB research and policy by analyzing the empirical basis of such research.

1. Introduction

The debate regarding the economic value of ratepayer- and taxpayer-funded energy efficiency programs is longstanding and still raging (Joskow and Marron, 1992; Felder, 2013). A 2015 study made national news, finding that the federal Weatherization Assistance Program (WAP) in Michigan resulted in costs that were approximately double the energy savings (Greenstone et al., 2016). The response by energy efficiency advocates and other analysts was immediate. The Department of Energy (DoE) rejoined by citing two peer-reviewed papers finding that the WAP is a good investment, with energy savings exceeding costs by a factor of 1.4. The DoE further claimed that if health and safety benefits, i.e., non-energy benefits (NEB), are included in the economic analysis, then the factor increases to 4 (Hogan, 2015).

NEB of energy efficiency programs have been studied as early as 1993, and there have been hundreds of papers and reports published since then, many of them finding that NEB are significant (Brown et al., 1993). Yet many U.S. states do not include NEB in their cost-benefit analyses (CBAs) (Skumatz, 2014). This article tries to provide some insight into this mismatch between the findings of NEB research and policy by analyzing the empirical basis of such research.

2. Definition and scope of non-energy benefits

NEB is an umbrella phrase that covers a wide range of benefits associated with energy efficiency programs. NEB are often categorized both in terms of their type of benefits and the recipients. Commonly cited and monetized NEB include reduced utility bill arrearages, reduced water use and bills, and improved fire safety due to weatherization. There is also a wide variety of non-monetized NEB such as improved comfort in the home. The recipients of these benefits include load-serving entities, program participants, ratepayers, and the rest of society.

Although there are extensive lists of NEB in the literature, they are not consistent and there is no single comprehensive register of NEB; what qualifies as non-energy benefits varies widely across published reports. This is particularly problematic for much of the existing literature on NEB, which focuses on weatherization programs for low-income households. These programs, which typically include multiple air sealing and home insulation improvements, come in the form of subsidized installations targeted towards low-income populations. The distinction that is missed in the analyses is between non-energy-efficiency measures (e.g. carbon monoxide detectors) that result in non-energy benefits and energy efficiency measures (e.g., sealing a house) that produce non-energy benefits such as improved comfort in addition to energy savings. Without making this distinction, some of the benefits of energy efficiency measures may be attributed to non-energy-efficiency factors.

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This in turn has led to a yet-unacknowledged problem: that NEB comparisons are strained because the NEB literature has not addressed the components of incremental benefits and costs. That is, the incremental benefit is the difference in realized benefits from upgrading a baseline technology to its efficient replacement. But, incremental benefits can be broken down by source (i.e. part is due to an NEB-like improved comfort, but another part is due improved energy savings from using an efficient technology). Thus, it is possible that two NEB provide the same monetized benefit, but one may owe much more of its value to a factor like improved thermal comfort while the other simply provides energy/bill savings.

Moreover, disentangling and attributing the incremental costs associated with each of these incremental benefits is a challenge. Nonetheless, any cost-benefit analysis requires the appropriate alignment of costs and benefits in order to be successful. These issues of attribution can become even more complicated. Brown 1993 uses the hypothetical example of changes to indoor air concentrations of radon before and after weatherization. While weatherization decreases indoor air flow, thereby increasing cancer risks from radon, it also decreases the amount of radon that can penetrate the foundation, which decreases cancer risks.

Evaluative difficulties notwithstanding, weatherization programs are good candidates for NEB research because their beneficiaries are a subset of the population whose housing stock is highly vulnerable to inclement weather, and whose energy costs are a disproportionately large portion of their income compared to middle and high-income households.

3. Non-energy benefits papers and findings

About 300 papers have been published that are available online concerning NEB since the early 1990s. The overwhelming majority are literature reviews or theory-based discussions about the potential value of NEB. Of this number, about 50 have been published by Lisa Skumatz of SERA Inc. To our knowledge, none of these reports have been published in peer-reviewed journals, but many have been presented at the American Council for an Energy-Efficient Economy, International Energy Program Evaluation Conference, and European Council for an Energy Efficient Economy conferences and are frequently cited in other reports on NEB.

The earliest extensive quantification of non-energy benefits appears in a 1993 DOE-sponsored report entitled *National Impacts of the Weatherization Assistance Program in Single-Family and Small Multifamily Dwellings* conducted by researchers at Oak Ridge National Laboratory (Brown et al., 1993). The Brown report included a literature review that assessed 36 weatherization programs, and concluded that "while there is a good deal of anecdotal evidence on the substantial benefits of low-income weatherization in the areas of affordable housing, health and safety, these anecdotes do not support the assignment of dollar values to the benefits" (Brown et al., 1993). This study is one of the most frequently cited sources in NEB valuations, and debatably set a precedent for examining NEB in the context of weatherization programs for low-income households.

Many current publicly available program evaluations that include NEB cite benefits that have not been updated since 1993 or 1995. Our examination of available literature reveals that very few of the reports contain transparently defined methods for quantifying benefits. Of those, only about a dozen of the 300 reports developed their own algorithms for the determination of benefits; most use concentration-response models and only cover the expected reduction in healthcare costs from abated air pollutants.[1]

The next largest subgroup in that small portion of reports relies on case-specific contingent valuation surveys to value benefits based on the change in the proportion of people who reported differences in comfort, utility bills, or other effects before and after program intervention. Contingent valuation relies on directly asking participants about their behaviors rather than trying to infer them from observed data. This type of "stated preference" survey can be used to value goods that are not typically bought and sold in markets. This method may be controversial because it introduces statistical uncertainty into any findings, as contingent valuation surveys rely heavily on participants' subjective reports and perceptions of program effects.

One of the most transparent contemporary NEB reports is the aforementioned Oak Ridge National Laboratory's 2014 report *Health and Household Related Benefits Attributable to the Weatherization Assistance Program* (Tonn et al., 2014). It combines literature reviews with a proprietary revealed preference survey, and research-supported logic models to estimate the value of benefits like increased work productivity due to weatherization, decreased asthma- and carbon monoxide-related hospital visits, and avoided costs of house fires. Another is the 2001 *Low Income Public Purpose Test* in which evaluation research firm TecMarket Works breaks down proposed equations for NEB monetization by input, suggesting data sources (e.g. utility data sheets and cost records) and literature values for each one (TecMarket Works Inc., 2001). It compares these suggested values with values developed as a product of their own contingent-valuation-driven phone survey of program participants. These studies demonstrate that it is possible to create logical NEB valuation frameworks in spite of the complexities cited by authors on this issue.

One study found that certain monetized NEB represent significant savings to relevant beneficiaries. One relatively large NEB for this group is the value of reduced emergency calls. This number stands at $428 per affected program participant (Dalhoff, 2007). However, benefit values in the hundreds of dollars per participant appear to be infrequent. Benefits valued at the participant level are always lower than their per capita value to society. For example, one Oak Ridge National Laboratories evaluation of the federal Weatherization Assistance program calculated that avoided injuries from fires prevented by weatherization were $1563 per affected participant at the household level, or $35,507 per capita at the societal level (Tonn et al., 2014). This shows that benefits from fire safety are distributed differently depending on whether they are examined from an individual program participant or societal perspective. The "societal" value above is relatively high for three reasons: (1) the cost of fee-for-service healthcare is unevenly distributed (i.e. individuals only pay a small portion of the final value of treatments), (2) the mathematically derived value of a life is $6 million in this study (based on OMB circular A-4), and (3) this benefit is being valued per affected participant as opposed to being averaged across all program participants (OMB, 2003). Regarding the third point, the aforementioned fire reduction benefits, even including avoided property damages, drop to $63 per program participant or $768 per capita to society when averaging benefits over the total number participants.

A select few societal non-energy benefits are prominently featured in multiple program evaluations. The category of tax effects includes avoided costs of unemployment with cited values ranging from $82 per home in one New Hampshire weatherization program to $207 per home in the equivalent Vermont program (Skumatz et al., 2010).[2] The "tax effects" umbrella also includes

[1] For a discussion of a proposed method of quantifying health impacts from air pollution, see Bridges et al., 2015.

[2] Conducting a spot check of some of these references revealed that many reports cited in SERA publications are not available via standard Internet searches.