Net NEB Multipliers for Economic Impacts: Detailed Analysis of Differences by Program Type and State

Karen Imbierowicz, Lisa A. Skumatz, and John Gardner
Skumatz Economic Research Associates, Inc.

ABSTRACT

Research indicates that the value of non-energy benefits (NEBs) can outweigh the bill or energy savings from energy-efficiency programs. However, a large proportion of the benefits hinge on several key social benefits, including economic multiplier and job creation benefits from program expenditures. Although the literature indicates these NEBs can be large, much of the literature contains flaws that may overstate the impact of economic NEBs. We conducted research to develop more defensible estimates of these benefits categories for residential energy-efficiency programs. This study used input-output analysis to update the economic multipliers for NEBs in several ways.

- Developing net estimates of the multipliers (rather than gross factors, correcting a flaw in much of the existing literature)
- Estimating multipliers for different states vs. the entire US and examining differences
- Developing estimates based on different types or categories of programs (e.g., weatherization vs. appliance programs, etc.), and different assumptions about where the expenditures are transferred from for the net analysis

Using an input-output model, we develop more realistic values for the economic impacts of key categories of DSM programs. The revised figures have been used to compute more reliable and tailored estimates of economic non-energy benefits, and we present improved and more credible numbers that can be applied in regulatory tests. The study corrects and provides improved estimates of the economic impacts from DSM or other energy-efficiency programs, and examines differences by state and program type.

Introduction

Demand-side management (DSM) and other energy-efficiency programs can have wide impacts beyond reduced energy demand and cost-savings on gas and electricity. Program participants may experience an array of non-energy benefits including greater comfort and aesthetics in the home, reduced noise from appliances, and intrinsic benefits from participating in environmentally friendly activities. Simultaneously, utilities may experience decreased costs associated with fewer shutoffs, reactivations, late notices, etc

In addition to the agent-specific impacts listed above, energy-efficiency programs can lead to societal benefits that accrue to those with no direct relationship with those programs. These benefits generally fall into two categories: economic benefits and environmental benefits (Imbierowicz and Skumatz 2004). The environmental benefits mainly take the form of reductions in emissions (these NEBs are not addressed in this paper). The economic benefits, on which this paper focuses, can include:

- Increased direct and indirect economic activity
- Job creation
- Increased employment earnings and related tax revenues

Several authors and agencies have worked to create estimates of the extent of such economic non-energy benefits (Brown 1993, Pigg 1994). Our review of these studies demonstrated a great deal of variability in the level of economic activity that can be attributed to comparable energy-efficiency programs.[1] The studies that we reviewed concluded that:

- Direct economic multipliers (those not considering inter-industry demand changes) for efficiency programs lie within the 43% to 91% range
- Total output multipliers (those considering all economic changes) for such programs range between 74% and 320%
- Between 5.6 and 71 jobs are created for every $1M USD spent on efficiency programs

However, as Imbierowicz and Skumatz (2004) note, a key assumption of these, and most, economic impact studies of energy-efficiency and related DSM programs is that they represent the investment of new funds, rather than a transfer of funds that would have otherwise been spent elsewhere – most likely in other economic sectors. The latter scenario, that the funds used to pay for a given DSM program would have otherwise been spent elsewhere, is more persuasive.

Accounting for this aspect of new DSM programs – and finding net, rather than gross, economic impacts – creates more accurate estimates of the real economic value of those programs, and illustrates that previous estimates that fail to perform such an accounting overvalue the impacts that can be considered attributable to programs. Accurate valuations are crucial for administrative and marketing aspects of energy-efficiency programs, as well as long-term planning for an energy-efficient economy.

This approach to economic impact estimation for demand-side efficiency programs is introduced in Imbierowicz and Skumatz (2004). This paper extends the analysis to include both weatherization assistance and appliance replacement programs, and utilizes both state and national data to present a fuller picture of the economic impacts associated with energy-efficiency programs.

Data and Methods

We use input-output model methods to estimate the economic impacts of the programs in question.[2] Impact analyses run in the input-output model produce estimates of effects in three categories:

1. **Direct effects:** Changes to the industries in which the final change in demand was made
2. **Indirect effects:** Changes that occur between industries as the initial industries respond to changing demand

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[1] Note that the programs covered by these studies were weatherization assistance programs. Our work attempts to model similar weatherization programs as well as appliance replacement programs.

[2] We used a commercially-available input-output modeling system to estimate the economic impacts. Our impact analyses use type SAM (Social Accounts Matrix) multipliers that account for direct, indirect and induced effects, including interactions between institutions (such as taxes paid by households to the government, etc).

3. **Induced effects:** Changes in household spending behavior as a response to income fluctuations as a result of changes in production.

The impacts can be further decomposed into (in our scheme):

- **Employment:** The number of jobs created (or destroyed)
- **Labor income:** Increased (decreased) wages due to demand changes
- **Output:** Increased (decreased) economic output due to demand changes

Throughout this paper, we report changes in employment, labor income and output in absolute levels, although for the impacts that are measured in dollars (labor income and output), the dollar amount divided by $1M can be considered a multiplier.

The primary objective of this paper is to compare differences in economic impacts over time, across different types of programs, and in different geographical areas. To this end, we use three datasets (1998 California data, 2002 Wisconsin data and 2002 United States data, combined with the national input-output structural matrices for 1998 and 2002.)

Although a more rigorous approach to comparing results across time, between states, and among state- and nation-wide program scopes would be to use 1998 and 2002 data for the same states and the nation as a whole, we did not have access to such data at the time this research was prepared. Nevertheless, we believe that the data used and the results presented meet a standard of reasonable commensurability. Our purpose is not to present a complete valuation of any specific program, but to show, in general, how two general classes of energy-efficiency programs might result in economic impacts above and beyond those directly related to reduced energy demand for program participants.

We attempt to model the economic impacts of two classes of energy-efficiency programs:

- Weatherization assistance programs, through which program participants receive one or more energy-efficiency measures, including weather stripping, insulation, appliance repair or replacement, CFL bulbs, etc.
- Appliance replacement programs, through which household appliances including refrigerators, freezers, washers, dryers, lamps, and the like might be replaced with more energy-efficient models

Our approach to approximating these impacts, while incorporating the fact that funds spent on the types of programs described above most likely come at the expense of investment in other areas, is to run impact scenarios in which $1M is invested in an industry appropriate to the program type and the same amount is removed from the electricity generation, transmission and distribution sector.[3]

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[3] The assumption that the whole of the funds invested in the program come at the expense of the electricity generation, transmission and distribution sector is an oversimplification. In reality, a proportion of the investment comes from that sector as a result of decreased energy demand, and the remainder comes from other sectors where public or private funds may have otherwise been invested. However, the source of this remainder will differ according to regional, temporal and political differences. In addition, not all of the funds will be transferred to program implementation – some will go the program's sector, and some of the increased household income that results from reduced energy use will be spent on other goods and services.

For each impact scenario, regardless of region and year, funds are removed from the electricity generation, transmission and distribution sector.[4] The sector where those funds end up, however, varies depending on program type and data source.

For weatherization assistance programs, we assume that funds are invested in the residential maintenance and repair sector. Our experience in evaluating weatherization programs has shown that a great proportion of the work implemented through such programs is related to household maintenance and repair measures such as insulation, draft remediation, and similar activities. Although the measures available through any weatherization program will differ depending on, inter alia, climate zone and program budget, and may include more drastic measures such as appliance repair and replacement, plumbing, heating, HVAC and other measures that do not fall under either the Standard Industrial Classification (SIC) or North American Industry Classification System (NAICS) categories for maintenance and repair, we limit our impact to one industry for simplicity.

For appliance replacement programs, we assume that the industries most likely to receive the direct demand shock are those related to the wholesale distribution of household appliances. Both the SIC and NAICS systems have classifications for household refrigeration and freezers, cooking equipment, and heating and cooking equipment. However, the industrial taxonomy used for both 1998 and 2002 collapses all wholesale trade into one aggregate sector.[5] We assume for simplicity that this sector performs reasonably well as a proxy for the specific wholesalers impacted by any residential appliance replacement program.

Economic Impact Estimates

Economic Impacts from Weatherization Programs

The results from our simulation of a $1M US investment in a weatherization program in California, using 1998 data, are presented in Table 1.[6] The model shows that a $1M transfer from the utility (the electricity generation, transmission and distribution sector) to weatherization (the maintenance and repair sector) results in the creation of about 16 jobs, labor income on the order of $435,600 and total economic output on the order of $492,240.

Table 1. California Weatherization Program, 1998 Data

Impact type	Direct	Indirect	Induced	Total
Employment (# jobs)	10.2	2.9	2.8	15.9
Labor income ($)	252,877	91,123	91,603	435,603
Output ($)	0	254,781	237,455	492,236

[4] That funds are transferred from the T&D sector is a simplifying assumption. Especially in the case of weatherization programs, a large portion of energy savings will occur due to reduced gas consumption. A modeling scenario in which some funds are transferred from electricity and some from natural gas would be possible with some a priori information about household energy source mix. Due to time and data constraints, we do not attempt to model such a scenario in this paper. Ultimately, we believe that our investment scheme represents a reasonable approximation of the transfer of funds to DSM programs.

[5] The 1998 datafiles are based on the ICS while the 2002 datafiles are based on the NAICS. However, the sectors that we have chosen exist in very similar forms in both classification systems.

[6] Note that these results exactly replicate those reported in Imbierowicz and Skumatz (2004). Rather than reporting first the positive shock to the maintenance and repair sector, then the negative shock to electricity generation, we have combined the results into one impact (hence the direct output impact is 0 for every program and every datafile). This makes the analysis more compact, but does not affect the results.

The same program using the 2002 Wisconsin datafile produced a total employment gain of only 9 jobs, with a concomitant increase in labor income of roughly $228,830 and $462,041 in output (Table 2). A priori, it is not clear why the employment and labor income multipliers are so much lower for Wisconsin. Intuitively, a smaller population or differences in industrial composition and activity between California and Wisconsin might explain a large part of the difference. Nevertheless, the output multipliers are very similar considering the state and time differences between the datafiles.

Table 2. Wisconsin Weatherization Program, 2002 Data

Impact type	Direct	Indirect	Induced	Total
Employment (# jobs)	4.1	3.3	1.6	9
Labor income ($)	72,509	109,811	46,009	228,329
Output ($)	0	323,768	138,272	462,041

Dividing the total output changes for both the California and Wisconsin weatherization program scenarios by $1M (the amount transferred) yields total multiplying factors of about 49% and 46%, respectively.[7] These figures are low compared to the total multiplier ranges indicated in the studies that we reviewed (74% to 320%). In fact, the 2002 Wisconsin scenario is lower than the lowest impact study. We could add to these figures by accounting for avoided unemployment payments as a result of the jobs created, though doing so would have a negligible effect on the totals. In addition, the job creation figures (16 and 9 per million transferred) are in the low end of the empirical results from previous studies (between 5.6 and 71). That the economic effects predicted by our impact analyses are low in comparison with other studies demonstrates the importance of accounting for the fact that DSM spending represents a transfer of funds, not new spending.

In contrast, the results from our national weatherization assistance program model in Table 3 suggest a greater degree of positive economic impact. Although jobs creation and employment income increases are lower than for the 1998 California datafile, the total change in output is still considerable. The total output change represents a multiplier of about 106%. This multiplier is substantially larger than those obtained from the state-level programs, in no small part because leakages are less likely to stop economic interactions within the larger program region. Regional size differences notwithstanding, a 106% multiplier is still considerably smaller than the average total multiplier reported in the studies we reviewed (195%). Once again, the level of job creation resulting from the national program is substantially smaller than even the average figure reported in comparable studies.

Table 3. Nationwide Weatherization Program, 2002 Data

Impact type	Direct	Indirect	Induced	Total
Employment (# jobs)	4.8	5.2	4	14.1
Labor income ($)	72,769	203,019	146,149	421,937
Output ($)	0	629,269	435,328	1,064,597

[7] This multiplier is something of a construct, since the total amount of direct investment is technically equal to zero. We consider, in this paper, the multiplier associated with change in output per million dollars *transferred*.

Economic Impacts from Appliance Replacement Programs

The non-energy benefit economic impact studies that we reviewed did not include research related to appliance replacement programs or initiatives, so the impacts presented in this section cannot be compared directly to empirical work (that we reviewed recently). A great number of DSM programs include the replacement (either directly or through subsidization) of existing equipment with newer, higher-efficiency equipment, so the associated range of economic activity is of particular interest.

Table 4 summarizes the first impact scenario, in which $1M is transferred from the utility to household appliance wholesalers.

Table 4. California Appliance Replacement Program, 1998 Data

Impact type	Direct	Indirect	Induced	Total
Employment (# jobs)	6.4	1.7	2.2	10.3
Labor income ($)	194,949	64,890	69,847	329,686
Output ($)	0	158,282	180,833	339,116

The immediate conclusion from the 1998 California appliance replacement program is that, on every score, it generates less economic activity than the weatherization program representing the same transfer of funds. Naturally, this conclusion is sensitive to the assumptions in the model, namely the choice of sectors to which electricity generation funds are disbursed. Still, the impact scenario's outcome strongly suggests that the economic non-energy benefit associated with weatherization activity is substantially greater than that associated with appliance replacement. The total multiplier for the program is 34%.

Table 5 presents the results for the same program, using the 2002 Wisconsin datafile. The California-Wisconsin pattern for our appliance replacement impact scenario is similar to that from the weatherization scenario – substantially smaller economic effects for Wisconsin in 2002. The total economic benefits multiplier is about 25% for the program, with only 8.4 jobs created per $1M in funds transferred.

Table 5. Wisconsin Appliance Replacement Program, 2002 Data

Impact type	Direct	Indirect	Induced	Total
Employment (# jobs)	5.4	1.1	2	8.4
Labor income ($)	193,415	34,024	56,443	283,882
Output ($)	0	84,382	169,629	254,011

The same impact scenario using the 2002 United States datafile is presented in Table 6. The total multiplier for a national weatherization program, according to our previous analysis, is 106%, compared to just 30% for a national appliance replacement program. Moreover, total job creation for the appliance program is 9, compared to 14 for the weatherization program.

Table 6. Nationwide Appliance Replacement Program, 2002 Data

Impact type	Direct	Indirect	Induced	Total
Employment (# jobs)	5.2	0.8	2.9	8.9
Labor income ($)	191,358	13,764	106,200	311,323
Output ($)	0	-17,743	316,334	298,591

In a similar vein, using our modeling scheme, a national appliance replacement program (with the same amount of funds transferred from electricity generation to the wholesale appliance sector) generates less economic activity than the same program administered only in California. The national program produces about $299,000 and 9 jobs, while the California-wide program produces $339,000 and 10 jobs. Given the differences in the datafiles, however, the national and California-wide programs are much more similar in their effects than the same program administered throughout Wisconsin.

Conclusion and Discussion

We have presented an update to Imbierowicz and Skumatz (2004), which posits that models of the economic impacts that arise through demand-side energy-efficiency programs should explicitly account for the fact that funds spent on DSM programs are allocated from other sectors. We apply the methodology from that paper to a variety of statewide and national datafiles from both 1998 and 2002, creating impact scenarios for both weatherization assistance programs and appliance replacement programs in different contexts. Table 7 summarizes the outcomes from those models.

Table 7. Impact Summary

Program/Location	Economic output	Job creation
Weatherization assistance		
CA (98)	$492,236	16
WI (02)	$462,041	9
US (02)	$1,064,597	14
Appliance replacement		
CA (98)	$339,116	10
WI (02)	$254,011	8
US (02)	$248,591	9

Caveats

The accuracy of the economic impacts estimated by our models is limited by several factors. The data at our disposal are not completely comparable, and potentially mingle some time and industry classification differences. Although our modeling scenarios make several assumptions about the nature of the programs simulated, those assumptions are reproduced across region and program type in order to provide indicators of the general direction and magnitude of the economic impacts that can be expected due to different types of DSM programs in those areas.

Second, we have made several crucial assumptions about the destination of funds transferred from electricity generation, transmission and distribution. For weatherization programs, we assume that the residential maintenance and repair sector is a reasonable proxy for the many sectors involved in a typical weatherization program. For appliance replacement programs, we assume first that the wholesale household appliance sector is the correct recipient of the funds that go toward the purchase of new appliances, ignoring the costs of installation, administration, etc. We then assume that the collapsed wholesale trade sector definition is a sufficient proxy for household appliances.

All of the above assumptions serve to simplify analysis and interpretation. However, different datasets and different sector choices will obviously produce different results, but this paper provides some indications of the degree to which these results may vary.

Implications

The impact scenarios presented in the previous section demonstrate the importance of finding the net economic effects of DSM programs. Our economic multiplier and job creation estimates for both statewide and national programs are all small compared to the average figures presented by the comparable literature that we have reviewed. These results, coupled with corroborating results from Imbierowicz and Skumatz (2004) imply that gross economic impact estimates overstate program effects, and may do so drastically.

Our analysis also illustrates the notable differences in economic non-energy benefits that can occur based on program location. Similar programs paid for by identical fund transfers, depending on where they are implemented, may affect the economy of the program region differently. Policymakers and program administrators can use this information to select programs appropriate to their region, or to choose program components in a way that will maximize economic benefit.

Finally, in addition to several important empirical aspects of economic impact valuation for energy-efficiency and DSM programs, this paper demonstrates an easily replicable methodology for predicting economic outcomes and properly accounting for the source of funding within those predictions.

References

Brown, Marilyn A., Linda G. Berry, Richard A. Balzer, and Ellen Faby. 1993. *National Impacts of the Weatherization Assistance Program in Single-Family and Small Multifamily Dwellings*, Oak Ridge National Laboratory, Oak Ridge, TN, ORNL/CON-379, May 1993.

Imbierowicz, Karen and Lisa A. Skumatz, Ph.D., "The Most Volatile Non-Energy Benefits (NEBs) – New Research Results "Homing In" on Values for Environmental and Economic Impacts", Proceedings of the 2004 ACEEE Summer Study, Asilomar, CA, August 2004.

Laitner, John A. "Skip", Stephen J. DeCanio, Johnathan G. Koomey, and Alan H. Sanstad, 2002. "Room for Improvement: Increasing the Value of Energy Modeling for Policy Analysis", *Proceedings from the ACEEE Summer Study*, Asilomar, CA.

Pigg, Scott, et.al. 1994. *An Evaluation of Iowa's Low Income Weatherization Program SLICE*, WECC, MidIowa Community Action League.

Skumatz, Lisa A., Ph.D. 2001. "Non-energy Benefits (NEBs) – The New Standard in Comprehensive Estimation and Modeling of NEBs for Commercial and Residential Programs", *Proceedings of the 2001 International Energy Program Evaluation Conference,* Salt Lake City, UT.

Skumatz, Lisa A., Ph.D. and Chris Ann Dickerson.. 1998. “Extra! Extra! Non-Energy Benefits of Residential programs Swamp Load Impacts!”, *Proceedings of the 1998 ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Washington, DC.

Sumi, David, Glen Weisbrod, Bryan Ward, and Miriam L. Goldberg. 2003. “An Approach for Quantifying Economic and Environmental Benefits for Wisconsin’s Focus on Energy”, *Proceedings for the 2003 Energy Program Evaluation Conference*, Seattle, WA.

Woolf, Tim, 1999. “Environmental Benefits of Efficiency Programs”, memorandum to DTE-100 Cost-effectiveness working group on behalf of Cape Light Compact, Cambridge, Massachusetts.