Economic impacts from energy efficiency programs –Variations in multiplier effects by program type and region

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Abstract

Research indicates that the value of omitted program effects – specifically non-energy benefits (NEBs) – represent a significant share of overall program impacts. One of the largest components of societal benefits is the direct and indirect economic and job creation effects stimulated by the investment in conservation on behalf of the program. The literature has indicated that the valuations assigned to this category of these categories can be large, but much of the literature overstates the impact of economic NEBs. We conducted extensive research to develop reliable and defensible estimates of these benefits categories. This study used input-output analysis to update the economic multipliers for NEBs in several ways.

- Net: Developed "net" estimates of the multipliers (rather than "gross" factors)
- Variations by Region: Estimated multipliers for multiple states and for the entire US;
- Variations by Program Type: Developed estimates based on different types or categories of programs (e.g weatherization vs. new construction vs. appliance programs, etc.),
- Variations in Baseline Assumptions: Different assumptions about where the expenditures are transferred "from" for the net analysis (e.g. from "generation", from a mixed market basket, etc.); and
- Variations over Time: Used data from multiple time periods to examine changes in the size of multipliers over time.

We examined the results by state, by program type, and over time and found dramatic differences in the economic impacts by program type and territory under consideration. The results provide estimates of the economic impacts derived from the program; however, for communities or utilities with economic development goals, the results can be used to help select between program alternatives. The results are new, and the revised figures have been used to compute more reliable and tailored estimates of economic non-energy benefits that can be applied in regulatory tests.

Background on Economic Effects

Demand-side management (DSM) and other energy efficiency programs can have wide-sweeping impacts beyond reduced energy demand and cost-savings on 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., as well as transmission and distribution.

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 2002). The environmental benefits mainly take the form of reductions in emissions. 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 1994, Pigg and Dalhof 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 for efficiency programs lie within the 43-91 % range
- Total output multipliers for such programs range between 74 % and 320 %
- Between 5.6 and 71 jobs are created for every $ 1M USD spent on demand side efficiency programs

However, as Skumatz and Imbierowicz (2002) 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 energy 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 the program. 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 Skumatz and Imbierowicz (2002). 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.

Estimation Approach

We use input-output model methods[2] to estimate the economic impacts of the programs in question. Input-output models are essentially large accounting models that track inputs into making products, and outputs of those products. These models use a matrix representation of an economy (local, regional, national) to predict the effect of changes in one industry on others and by consumers, government, and other suppliers on the economy. The analysis method considers inter-industry relations in an economy, depicting how the input of one industry goes to another industry (as an input), depicting the interrelationships between industries within the broader economy. These models are commonly used as a tool for economic planning; we applied them to identify the net impacts of making changes or transfers in investments from electricity generation (and its inputs) toward two different "template" types of energy conservation programs commonly in place in the US.

Impact analyses run in the input-output model produce estimates of effects in three categories – See Table 1.

The impacts can be further decomposed into (in our scheme): – See Table 2.

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. Specifically, the type SAM multiplier is calculated as:[3] [(Direct + Indirect + Induced) / Direct]. Two of this paper's primary objectives are to compare differences in economic impacts overtime and between national and state-level programs. 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 or 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 demand-side energy-efficiency programs might result in economic impacts above and beyond those related to reduced energy demand and electricity savings for program participants.

We attempt to model the economic impacts of two classes of energy efficiency programs. We used typical design features common to many types of these programs across the US. To provide information on the differences in economic impacts purely due to 1) type of program and 2) region, we assumed the same measures and designs were applied to each program, which we then modelled using input-output data for California, Wisconsin, and the nation. Our basic programmatic assumptions follow

- Weatherization assistance program: We assumed program participants would receive subsets of a number of energy-efficiency measures, including weather stripping, insulation, appliance repair or replacement, CFL bulbs, etc.[4]
- Appliance replacement program: We assumed the program incentivized or encouraged the use of energy efficient household appliances including refrigerators, freezers, washers,

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.

3. This formula applies for both job creation and changes in labor income and output.

4. We are not modeling any impacts of participant energy savings money spent and "multiplied" though additional expenditures. Nor did we assume any direct rebates were "spent". These impacts are purely the transfer of the money spent by the "utility" or agency on power generation, transferred to the economic sectors affected by the energy efficiency program.

Table 1.

Type of Effect	Definition
Direct Effect	Changes to industries in which final change in demand was made
Indirect Effect	Changes that occur between industries as the industries respond to changing demand
Induced Effect	Changes in household spending behavior as a response to income fluctuations as a result of changes in production

Table 2.

Effect	Definition
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

dryers, lamps, and the like, replacing existing equipment 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 impacts 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.[5]

For each impact scenario, regardless of region and year, funds are removed from the electricity generation, transmission and distribution sector. 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 repair 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.[6] We assume for simplicity that this sector is

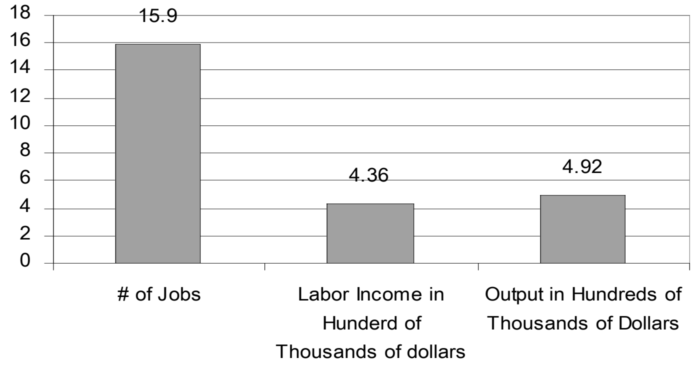

Figure 1. Total Impacts of the California Weatherization Program, 1998 Data

performs reasonably well as a proxy for the specific wholesalers impacted by any residential appliance replacement program.

Estimates of Economic Impacts from Weatherization and Appliance Programs

WEATHERIZATION PROGRAMS

The results from our simulation of a $ 1M US investment in a weatherization assistance program in California[7], using 1998 data, are presented in Figure 1.[8] The weatherization program we model assumes installation of a number of energy-efficiency measures, including weather stripping, insulation, appliance repair or replacement, and CFL bulbs in participating homes. The model suggests 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 other economic output on the order of $ 492,240, or $ 927,840 in total.

5. 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. Ultimately, we believe that our investment scheme represents a reasonable approximation of the transfer of funds to DSM programs.

6. 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 either classification system.

7. Again, note, we used a "combined" template program, and modeled the same programs and sectors affected in three locations – California, Wisconsin, and the US so that we could attribute differences in impacts to the economic multipliers in the locations, rather than to variations in program design between the states.

8. Note that these results exactly replicate those reported in Skumatz and Imbierowicz (2002). 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.

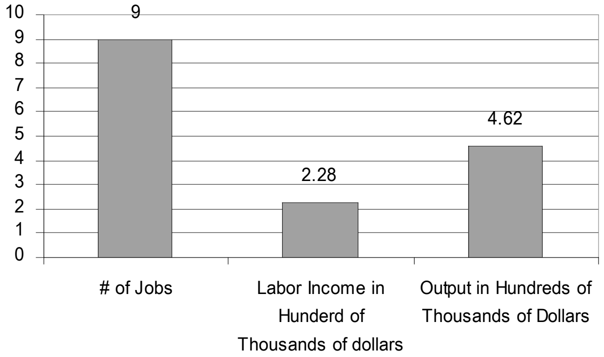

Figure 2. Total Impacts of the Wisconsin Weatherization Program, 2002 Data

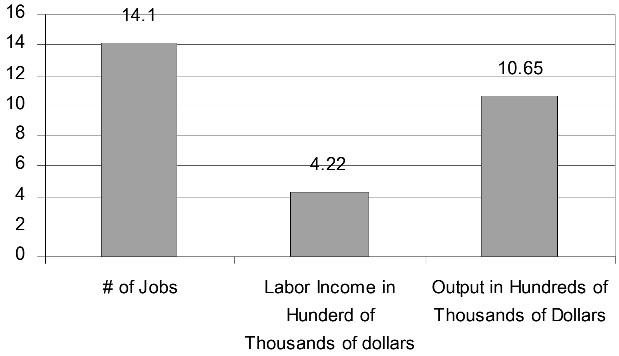

Figure 3. Total Impacts of the Nationwide Weatherization Program, 2002 Data

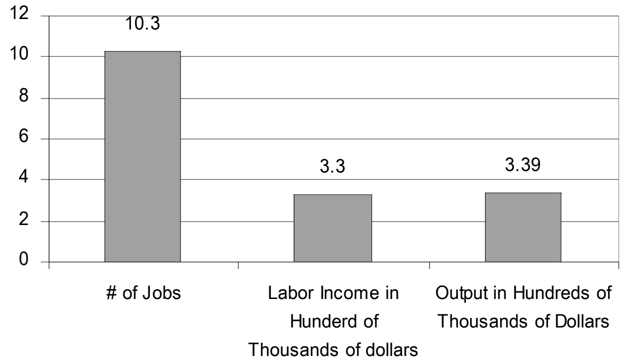

Figure 4. Total Impacts of the California Appliance Replacement Program, 1998 Data

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 an additional $ 462,041 in output (for a combined $ 690,370). These impacts are purely due to differences in the local economies, as we modelled completely similar programs. 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.

Adding the total labor income and output changes for both the California and Wisconsin weatherization program scenarios (and dividing by $ 1M) yields total multiplying factors of about 93 % and 69 %, respectively.[9] These figures are low compared to the total multiplier ranges indicated in the studies that we reviewed (74-320 %). 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 (Figure 3) suggest a greater degree of positive economic impact.[10] Although jobs creation and increased employment income is lower than that for the 1998 California datafile, the total change in output is greater the initial transfer. The combined labor and output changes ($ 1,486,534) represent a total multiplier of about 149 %. 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. Comparative multiplier size notwithstanding, a 149 % multiplier is still smaller than the average total multiplier reported in the studies 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 (33 %).

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 relate to the replacement (either directly or through subsidization) of existing equipment with newer, higher-efficiency equipment, so the associated range of economic activity associated is of particular interest.

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

The immediate conclusion from the 1998 California appliance replacement program is that, on every score, it generates less economic activity than the weatherization program repre-

9. 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 and labor income per million dollars *transferred*.

10. Recall, we are modelling the same program in each of the three locations. We created a template program that included the "basic" measures present in most weatherization programs, and by using the same program design, we could attribute differences in the multiplier purely to the local / regional economic sectors, rather than variations in the programs.

senting the same transfer of funds. Naturally, this conclusion is sensitive to the assumptions in the model, namely the choice of sectors to which electricity generations 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 67 %.

Figure 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 54 % for the program, with only 8.4 jobs created per $ 1M in funds transferred.

The 2002 Wisconsin data exhibits less variation between weatherization and appliance replacement than does the 1998 California data. For both Wisconsin scenarios, roughly the same number of jobs are created, and the difference in multipliers is only 15 %, compared to 26 % comparing weatherization and appliance replacement for California.

Finally, the same impact scenario using the 2002 United States datafile is presented in Figure 6. In contrast to the Wisconsin scenario, the effects of an national appliance replacement initiative are much smaller compared to a similar weatherization initiative. The total multiplier for a national weatherization program, according to our previous analysis, is 149 %, compared to just 61 % for a national appliance replacement program. Moreover, total job creation for the appliance program is 9, compared to 14 for the weatherization program.

In a similar vein, using our modeling scheme, a national appliance replacement program (with the same amount of funds transferred from electricity generation to wholesale) generates less economic activity than the same program administered only in California (ignoring intertemporal differences, that is). The national program produces about $ 610,000 and 9 jobs, while the California-wide program produces $ 670,000 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.

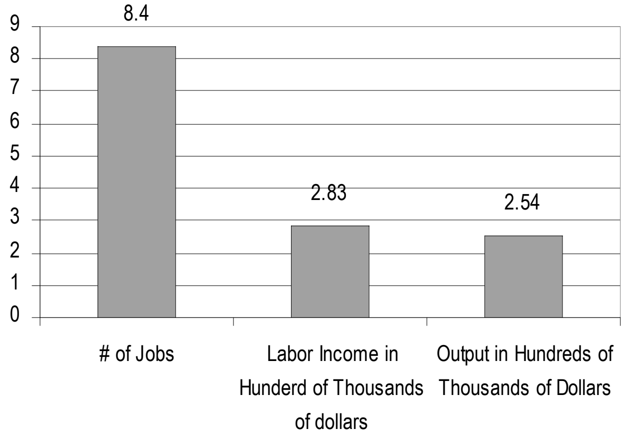

Figure 5. Total Impacts of the Wisconsin Appliance Replacement Program, 2002 Data

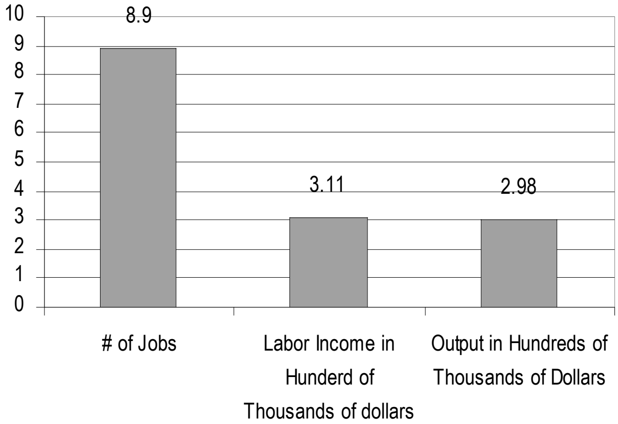

Figure 6. Total Impacts of the Nationwide Appliance Replacement Program, 2002 Data

Summary and Conclusions

This paper presents an update to Skumatz and Imbierowicz (2002), which posits that models of the economic impacts that arise through demand-side energy-efficiency programs should explicitly account for the high likelihood 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. Figure 7 summarizes the estimates of the net output impacts associated with the two program types examined. Figure 8 illustrates the differences in job creation impacts for the programs.

Considerations and caveats associated with the estimation work include:

- The economic impacts produced by our models are not without limitation. The data at our disposal are not completely comparable, and potentially mingle some time effects with area effects. The differences in area are the point of the study; economic differences exist among the study areas and the results indicate the role of the study impact area and the local / regional economic activities on the projected economic multipliers. The data are sufficient 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 purchase new appliances, ignoring the costs of

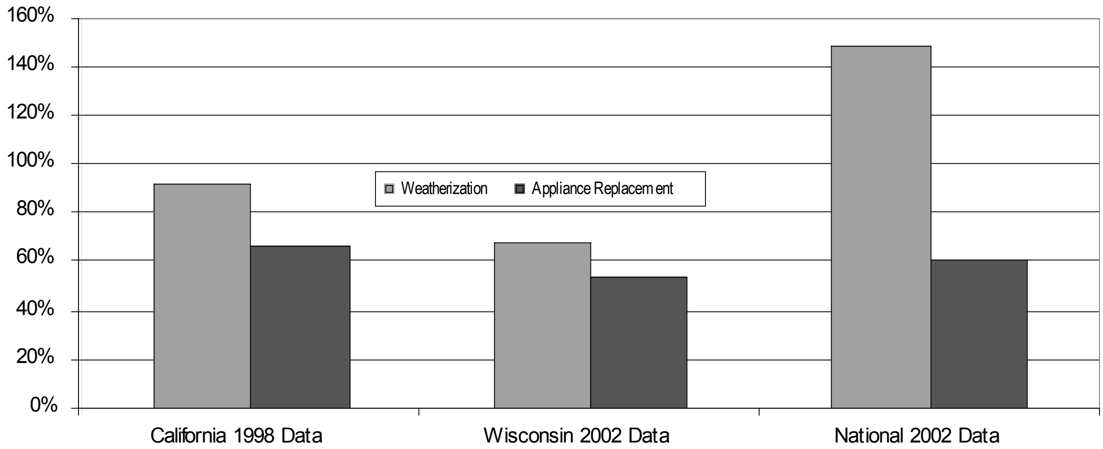

Figure 7. Total Estimated Output Impacts for the Weatherization and Appliance Replacement Programs

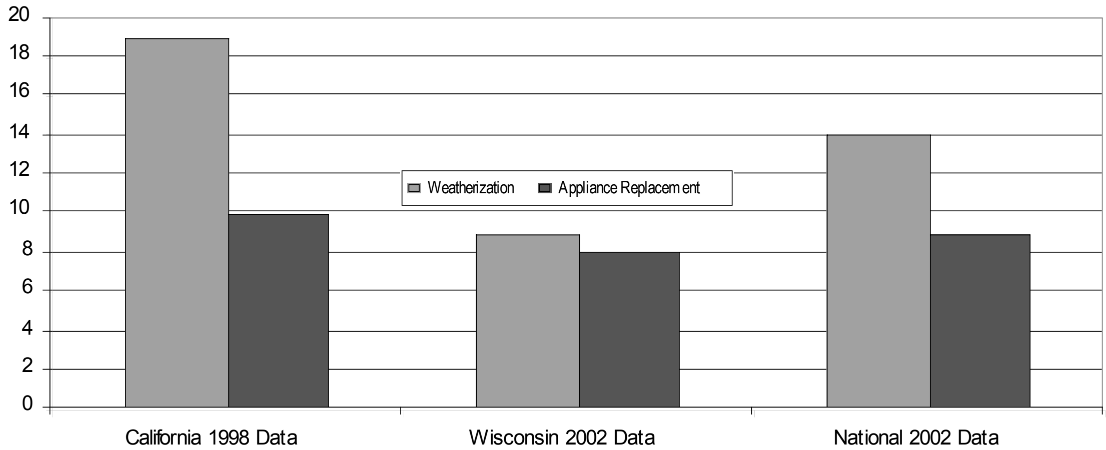

Figure 8. Total Estimated Job Creation Impacts of the Weatherization and Appliance Replacement Programs

installation, administration, etc. We then assume that the collapsed wholesale trade sector definition is a sufficient proxy for household appliances.

Neither assumption is unreasonable, and they both serve to simplify analysis and interpretation. However, different datasets and different sector choices will produce different results. Our experience working with input-output models suggests that these differences will not be substantial.

Conclusions from this work include:

- Previous work may have overstated the net economic effects.[11] The impact scenarios 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 Skumatz and Imbierowicz (2002) imply that gross economic impact estimates overstate program effects, and may do so drastically.
- Economic effects vary based on geographic territory and program type: Our analysis also illustrates the relatively large 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. Economic impacts also vary substantially based on the type of program being studied; labor intensive programs tend to have larger effects.
- Net economic impacts from energy efficiency programs are significant. In addition to the empirical aspects of economic impact valuation for energy-efficiency and DSM programs, this paper used credible (and reproducible) methods for estimating economic outcomes and properly accounting for the source of funding within those predictions.

11. Our approach clearly modeled the differences in economic effects for the funds spent on electricity generation compared to the effects of funds spent on the energy efficiency program. This provides the "net" effect. Several previous studies assumed the money for the energy efficiency program was "new"; we transferred the funds from generation.

This modeling method provided a straightforward and replicable way for us to measure the impacts from energy efficiency programs – using economic standard modeling procedures. Our methods allowed us to detect and attribute differnces between program types in terms of their local and regional economic stimulatory effects. In addition, we clarify that a program is not a program in terms of its economic effects. Instead, the industries in the local economy have a clear and dramatic effect on the economic development effects of investments in energy efficiency programs. Nationwide multipliers are not adequate; local modeling is needed – However, the results demonstrate that energy efficiency programs provide significant effects beyond energy savings, inclding non-energy effects in local, regional, and national economic development.

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