The Development of a Local Electric Energy Efficiency Economic Impact Model for Use in Integrated Resource Planning

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Many utilities are beginning to incorporate environmental externalities into Integrated Resource Planning (IRP). But few have attempted to quantify and model local economic externalities. The City of Austin has developed one of the nation's first local DSM Economic Impact Models. This paper will present Austin's methodology and issues confronted in developing a DSM economic impact model.

For many economies, generation is primarily built outside the local area, with fuel purchases made from outside the local economy as well. Such expenses leave the local economy. Energy efficiency, on the other hand, is labor intensive and implemented by local firms. An electric energy efficiency economic impact model is designed to quantify economic externalities (whether positive or negative for the locality in question) so that these can be included in the resource acquisition decision.

The Austin Electric Energy Efficiency Economic Impact Model is based upon the use of Input-Output (I/O) multipliers and output from the California Standard Benefit-Cost Model (California Public Utility Commission and California Energy Commission). The Austin Economic Impact Model uses Austin specific multipliers to compute the total economic impact of DSM programs in terms of income and employment.

The economic impact analysis of Austin's 1989-1990 DSM investment was done for several scenarios. Accounting fully for the counter-factual (how else the money would have been spent) and the most conservative assumptions, the municipal utility's investment of $4.3 million yielded a <u>net</u> increase to the economy of $3.7 million, an 87 percent return on the investment.

Introduction

Many people throughout the country recognize that in many locations the purchase of fuel to run electric generating plants causes local money to leave the economy while energy efficiency improvements are often conducted by home-grown businesses. Energy generation is often built outside the local area, with fuel purchased from outside the local economy as well (e.g., for the City of Austin, coal from the western states, natural gas from south Texas). Energy efficiency improvements, on the other hand, are implemented by local firms. Although equipment and supplies may often involve purchases from outside the local economy, installation of equipment, insulation and air infiltration measures are labor intensive projects that utilize local labor. The Environmental and Conservation Services Department of the City of Austin has just completed a two-year effort to develop a model to estimate these effects.

Only one other government agency or utility in the nation, the Michigan Public Service Commission, was found to have built a modeling approach to quantify economic externalities of energy efficiency programs. A residential audit program was funded in Michigan by a rate surcharge to all customers. Some industrial customers argued that the rate surcharge increased the cost of doing business in Michigan and implied the surcharge was a disincentive to new business formation and existing business expansion in the state. In 1986, the Michigan Public Service Commission developed an economic impact model. The finding from Michigan was that the value added to the community was significant when compared to the investment.

The City of Austin developed an economic impact model specific to the local Austin economy, the demand-side management (DSM) programs offered by the City, and specific to the Austin Electric Utility. The primary new data input required for this analysis are specific input-output multipliers. The model is then developed to use California Standard Benefit-Cost input and output as input. The model also uses several other program evaluation components. The model was established and tested using two different cases and two different scenarios, each of these vary the assumptions of economic flow inclusion.

This paper discusses the basic input-output considerations, the money flow examined in the model, the results found with the City of Austin's 1989 DSM investment, and how this information will be included in the City of Austin's Integrated Resource Planning process.

Basics of Input-Output Multipliers and Their Use for DSM

Following Michigan's lead, the City of Austin's model is based upon the use of Input-Output (I/O) multipliers. The economic multiplier recognizes the cyclical nature of spending and income. When an individual receives a dollar of income it is either spent or saved. If it is spent, it may go to a retailer or grocer who now has one more dollar than before. The retailer, for example, will use that dollar to pay for labor costs (in-city purchases) and for products to sell, some of which are purchased in-city and some are out-of-city goods. A multiplier is the sum of the in-economy or in-city effects of the original dollar. It is simply a factor which, once estimated, can be applied to an investment or an expenditure so that an approximation of the total effect on an economy can be determined (White and Crandall 1989).

Most multipliers are developed with input-output (I/O) models. With the use of surveys and/or secondary data, these models are constructed to account for all of the major interactions in an economy. The data is used to construct transaction tables that describe how much and from whom one industry purchases from another. These tables are sub-divided by estimating imports and local purchases. Then from these tables, multipliers are derived that estimate, given the current local economic structure and fixed relative prices, the direct and indirect income and employment creation for a given level of increased investment (demand) into the local economy. As such, it is important that the multipliers used are specific and representative of the economy under study. For instance, state multipliers will normally be higher than metropolitan ones due to the larger number of suppliers for a larger variety of raw materials and goods-in-process at a state level than a metropolitan level. Therefore, if policy makers want to know local economic impacts, then local multipliers must be used.

Furthermore, multipliers are also specific to industries. How much industry details are needed for input-output tables depend on what questions are being asked. In the case of a DSM investment, the expenditures pattern of conservation businesses are important. The conservation sector does not have its own Standard Industrial Category (SIC code). Therefore, national, regional and various government-produced input-output models do not have conservation sector multipliers estimated. Thus, additional work is needed to produce these.

For this project, Austin specific multipliers were developed by a consultant under a contract to the City of Austin. Energy conservation sector multipliers were developed from a contractor survey conducted by City staff. The City developed an Austin specific model to compute the total economic impact of the City's energy efficiency programs in terms of income and employment.

There are two types of multipliers that are commonly used in I/O analysis: Type I and Type II. Type I accounts for direct and indirect impacts, whereas Type II includes induced effects as well.

Direct (primary) effects are the first wave of project impacts (beneficial and adverse) accruing to those in the economy that are the first recipients of project action. Indirect effects come primarily from changes in output of suppliers responding to the changes in output of producers (U.S., Regional Development 1978). The direct and indirect effects correspond to Type I multipliers. For energy efficiency, a Type I multiplier would measure the impact of the expenditures made from the conservation sector and the resulting expenditures made by the conservation sector.

The direct and indirect effects lead to changes in income, which in turn will induce changes in consumption. These changes in consumption are the induced effects (Yan 1969). Type II multipliers include Type I plus this induced effect. Therefore, for energy efficiency, a Type II multiplier would include everything in Type I plus the effect of expenditures made by the employees from the increased earnings they get as a result of the increased business activity. To account for total impacts, the City of Austin decided to use Type II multipliers.

Three varieties of multipliers were estimated by the consultant for the City of Austin. They pertained to output, income, and employment. An output multiplier of a sector provides an estimate of total output that all sectors of the economy must collectively produce for that sector so that it is able to sell one dollar worth of goods to final customers. Output multipliers are also frequently referred to as final demand or gross output multipliers. An income multiplier estimates the total change in household income per dollar change in the direct income payments to households. Similarly, an employment multiplier is an estimate of the total employment generated in the economy per a one unit change in employment in a particular sector of the model (U.S., Regional Development 1978).

In order to estimate the net benefits of conservation programs, it was necessary to examine the economy with and without DSM. Therefore, two sets of multipliers were estimated by the consultant that represented the economy with and without conservation.

Though industries might differ in how they are affected by conservation expenditures, the economy was aggregated into four sectors to simplify the analysis. They were the Electric Utility sector, the Commercial sector, the Household sector, and the Conservation sector. (The Commercial sector is an aggregate of many non-utility related sectors.)

Structure of the Austin Electric Energy Efficiency Economic Impact Model

The Economic Impact Model was used for two different cases. The first case assumes that conservation expenditures by the household and commercial sectors will reduce their spending for other goods and services across the board by the same amount spent on conservation. The second case presumes that expenditures on conservation will not change the demand for other goods and services (these cases will be referred to as Case 1 and Case 2 for the remainder of the paper.) The reality, probably, lies in between. Expenditures on conservation, most likely, will postpone other capital investments such as buying a new car. Such capital investments bear with them relatively lower multipliers than what the first scenario assumes. Therefore, the two cases present the ends of a spectrum, where reality falls somewhere in the middle.

Furthermore, under each of the two cases, two scenarios were examined. The first scenario assumes no induced rate increase. The second assumes the opposite, that the electric utility will increase rates to pay for the investment in conservation and the resulting revenue losses that accompany such investments.

Utilities could invest in energy efficiency to minimize electric rates. Most utilities making significant energy efficiency investments (including the City of Austin), do so to minimize the average customer's bills to obtain the lowest societal costs.

Increasingly, more utilities are expanding their DSM efforts to minimize societal costs by including some form of monetizing the environmental costs of electric generation. Such strategies increase rates. Therefore, to properly bound the economic impacts, the Austin Economic Impact Model is calculated with and without a rate increase to compensate for lost sales revenues. It should be recognized, however, that a rate increase violates the general I/O assumption for multipliers of constant relative prices, but not accounting for this could overestimate the impacts. The expected bias for the impacts in the scenario with rate increase would be negative, such that this scenario should be the lowest end of the range for the economic impacts.

These types of analysis produce a year by year analysis. One analysis was done for the first year and one was done for all of the other impacted years. In the first year, the conservation investment (utility rebates plus additional customer costs) is made. This investment purchases equipment and labor from the conservation sector, which in turn make additional purchases. The customer starts saving on his/her utility bill and spends this money on other things in the economy. At the same time, the utility receives less money (spends less) and must raise rates to cover program costs and the component of lost sales revenues needed to pay fixed costs. In the second year after the investment (and all years through the life of the energy efficiency equipment), there is no money flowing to the Conservation sector. Customers' bills savings, however, are still spent elsewhere in the economy with the electric utility maintaining higher rates and spending less money to cover the component of lost sales needed to meet fixed costs. (The interactions among the four sectors is presented in Figure 1.) The total economic impact to the Austin economy would then be the sum of all these pluses and minuses over the life of the investment (presented in net present value in order to compare to alternative decisions). A graphical presentation of this analysis process is illustrated in Figure 2.

The model begins by listing the four sectors of interest-Conservation, Electric Utility, Household, and Commercial sector. The effects for output, income, and employment are obtained by multiplying the change in final demand for each sector with its corresponding direct income and employment coefficients. Total output, income and employment impacts are calculated by multiplying the direct effects by the appropriate economic multipliers. Except for the electric utility sector, all multipliers come from the "economy with conservation" estimates. A simplified graphical description of the model is presented in Figure 3.

The impacts for each program sector (residential and commercial) are measured for first year impacts and future years impacts. These results are then examined for

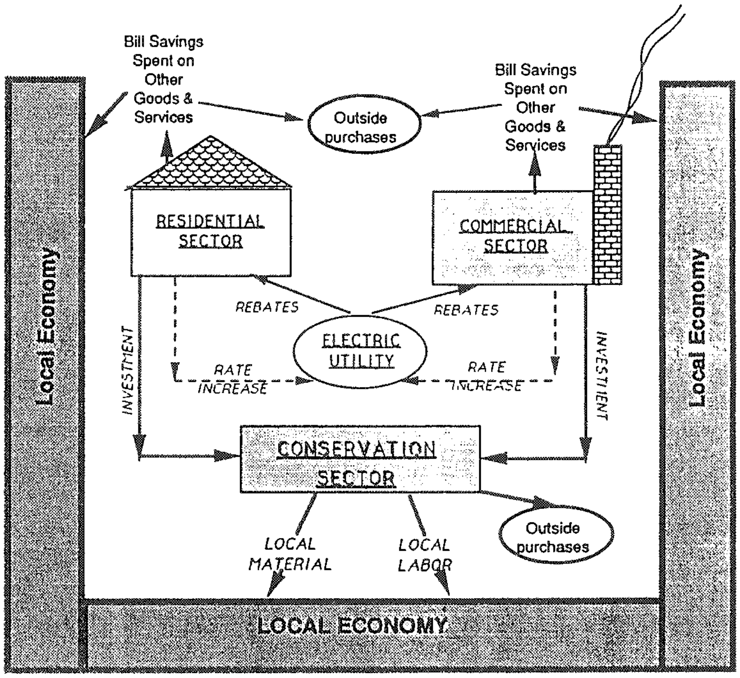

Figure 1. Money Flow Among Sectors

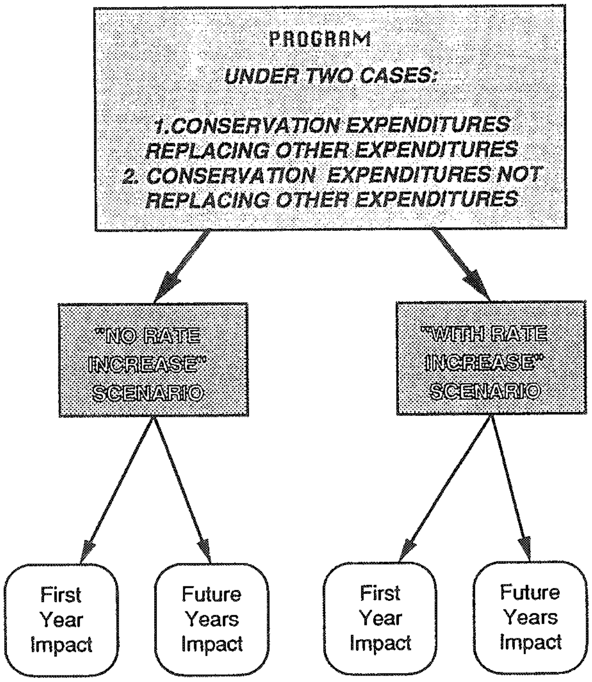

Figure 2. Economic Model Running Process

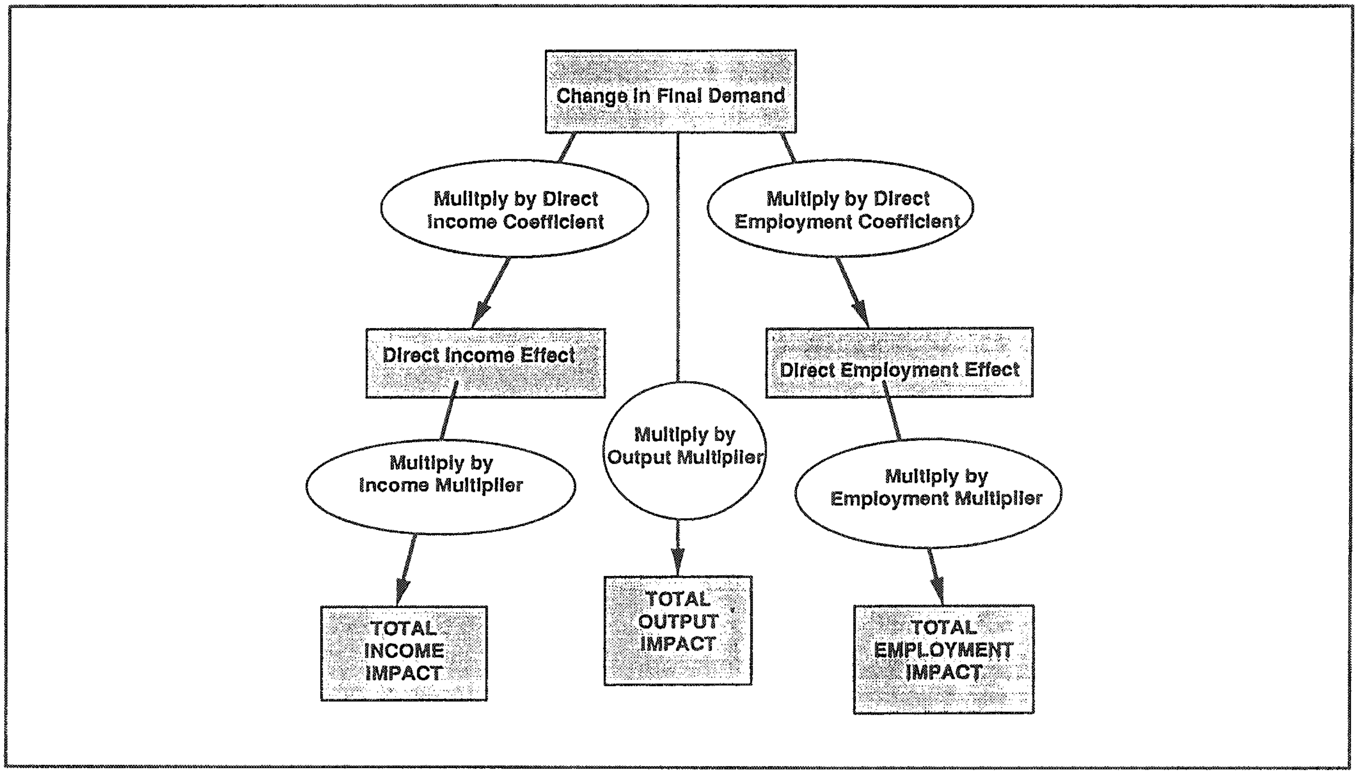

Figure 3. Economic Model Chart

annual employment effects and for the net present value of the income effects. As an example, the formulas for one component of one of the cases examined--for the residential (household) sector in Case 1 with conservation expenditures replacing other expenditures and scenario 2, with rate increase, the input is as follows:

First year impact on income level of residential sector:

(Electric Bill Savings + Gas Bill Savings + Program Incentive) - [Cost of Service Proportion Paid by These Customer Classes * (Electric Revenue Losses + Program Incentives + Program Admin. costs - Avoided Marginal Costs)] - (Conservation Expenditures by Households)

Future years impact on level of income of residential sector:

(Electric Bill Savings + Gas Bill Savings)-[Cost of Service Proportion Paid by These Customer Classes * (Electric Revenue Losses - Avoided Marginal Costs)]

Multipliers are then applied to each sector and impacts are summed across sectors by impact type. The economic impact model is essentially a combination of pluses and minuses times the multipliers, where pluses are additional expenditures and minuses are expenditures that would have occurred otherwise.

Model Results for the Economic Impact of the City of Austin's 1989 DSM Investment

To better understand the results of this type of analysis, if $1 million was moved from one group to another, as long as the two groups spend the same percentage on locally produced goods and services, the economic impact is 0. There is only a gain to the local economy if the City's spending is an investment that changes how much is spent locally, or if the City develops the foundations for increased outside investment into Austin.

The City's 1989-90 investment in energy efficiency programs ($4.3 million in incentives) generates a net present value of $3.7 million in income over the investment life of 20 years and creates 75 jobs in 1990 and 10 additional jobs in Austin for 1991-2009. These conclusions were based on completely including the counter-factual (how else the money would have been spent). This is the most conservative basis and more complete than most economic development analysis (which often does not consider what would have happened otherwise). These assumptions included:

- All money used by consumers to invest in energy efficiency comes from money they would have spent on something else in that same year (perhaps postponing a new car purchase to purchase a high efficiency air conditioner).

- All program costs and lost sales revenues are immediately and completely included as a rate increase.

If no off-setting rate increase is assumed, the City's 1989-90 investment in energy efficiency programs generates a net present value of $8.7 million in income over the investment life and creates 202 jobs in 1990 and 20 additional jobs in Austin for 1991-2009.

Under the more optimistic assumptions of no rate impact and energy efficiency investments not requiring a decrease in expenditures for other goods and services, the City's 1989-90 investment in energy efficiency programs generates a net present value of $15.9 million in income over the investment life and creates 514 jobs in 1990 and 20 additional jobs in Austin for 1991-2009.

The two cases and two scenarios analyzed with the economic impact model allow the "real" answer to be bracketed. The actual experience for the City of Austin Electric Utility entails that reality probably falls in-between the $3.7 million and $8.7 million scenarios. The most conservative assumption, yielding a net increase of $3.7 million, shows a local economic profit of 87 percent return on the City of Austin's 1989 DSM investment of $4.3 million.

Austin's Electric Energy Efficiency Economic Impact Model is designed to build off the details of the program characteristics and participation for each DSM program offered. The analysis is conducted program by program, Whole House Rebate, Appliance Efficiency Rebate, Multi-Family Program, etc. This allows the greatest accuracy to be maintained and also will allow the model to analyze the economic impact differentials between different investment plans (incentives, participation, customer investment levels, and customer savings profiles). The economic impact of the current City of Austin DSM investment profile was generalized by estimating the effects per million dollars of investment. This is presented below in Figure 4. Recognize these impacts will vary with varying investment profiles, such as a greater or lesser participation by commercial demand customers or any other program customer class.

CASE 1: CONSERVATION REPLACING OTHER EXPENDITURES

IMPACTS	WITHOUT RATE INCREASE	WITH RATE INCREASE
TOTAL INCOME ($ Million)	$2.02	$0.85
TOTAL EMPLOYMENT (Jobs)		
First Year	47	17
Future Years	5	2

CASE 2: CONSERVATION NOT REPLACING OTHER EXPENDITURES

IMPACTS	WITHOUT RATE INCREASE	WITH RATE INCREASE
TOTAL INCOME ($ Million)	$3.70	$2.53
TOTAL EMPLOYMENT (Jobs)		
First Year	120	90
Future Years	5	2

Figure 4. Austin Economic Impacts Per Million Dollars of Incentives for Combined Set of Energy Efficiency Programs

Incorporating Economic Impact into Integrated Resource Planning

Energy efficiency investments are long-term and contribute to postponement of generating capacity. As such, budget decisions about energy efficiency should be viewed as capital investments, with local economic impacts as one part of the consideration.

The information provided by the economic impact model will be included in the information used to make long-term Utility planning and investment decisions.

As the City of Austin develops an Integrated Resource Planning process, an expanded matrix of information will be used to more properly analyze the trade-offs between possible investment packages. These investment packages will be comprised of different mixes of energy efficiency improvement programs and various generation alternatives. The information matrix will include costs, as well as impacts on electric rates, the environment and the local economy.

The economic impact model described here is an important addition to the information available for IRP. The nature of the input for this model, however, is static. Input-output multipliers are calculated at a particular point and are not accurate with extrapolation or significant price changes (including rate increases). The City of Austin, therefore, plans to use the economic impact information to assign rankings on alternative investment packages rather than as concrete cost components.

References

City of Austin, Environmental and Conservation Services Department. *1990 Performance Measures of DSM/Energy Efficiency Programs*. Austin, Texas, June 1991.

City of Austin, Environmental and Conservation Services Department. *Loan and Whole House Rebate Survey Results*. Austin, Texas, Spring 1991.

Holloway, M. L., and R. S. Ball. *Austin Input-Output Multipliers for Use With Energy Conservation Economic Impact Model*. Austin, Texas: Southwest Econometrics Inc., 29 July 1991.

U.S. Department of Commerce. *Regional Development and Plan Evaluation: The Use of Input-Output Analysis*. National Technical Information Service, Agriculture Handbook no. 530. Washington, D.C., May 1978.

White, D. S., and G. C. Crandall. *Demand-Side Management and Economic Development: A Practical Discussion*. Energy Program Evaluation: Conservation and Resource Management, Proceedings of the 1989 Conference, August 1989.

Yan, Chiou-shuang, *Introduction to Input-Output Economics*. New York: Holt Rinehart and Winston, Inc., 1969.