

ECONOMIC EVALUATION IN ENERGY PLANNING:  
THE EXPERIENCE OF COMMUNITIES  
IN THE  
UNITED STATES

by

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thesis submitted to the Faculty of the  
Virginia Polytechnic Institute and State University  
in partial fulfillment of the requirements for the degree of  
MASTERS  
in  
Urban and Regional Planning

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August, 1983  
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(ABSTRACT)

This thesis investigates the experiences of 25 communities across the United States who are involved in community energy planning, to determine the extent to which communities have engaged in economic study of their energy plans and programs. Case studies are written on each of the community experiences as a means of documenting the economic analysis performed by each. Next, a discussion of the case studies includes conclusions about: the degree of analysis performed to determine effects on the local economy; whether economic analysis facilitates implementation; and if there truly are benefits which can be reaped by the local economy. Finally, the thesis suggests a solution to the lack of economic analysis which is proposed by the hypothesis to exist in community energy plans and programs. The solution is presented in the form of a framework intended to be a means by which communities can assess their energy plans and programs in economic terms.

## ACKNOWLEDGEMENTS

Many thanks are owed to the people who helped make this thesis possible. Much of the data used in this thesis was made available by communities and individuals who responded to my letters requesting information on their energy plans and programs. They all should be commended for their efforts in energy planning and their willingness to allow others to learn from their experiences.

My thesis committee also deserves much credit for guiding me through this process. Drs. Rick Simon and John Levy provided the instruction necessary to guide me through the once unfamiliar economic concepts expressed in this thesis, they are both thanked for their patience and ability to express themselves in terms which could be understood by a non-economist. I would like to especially thank my committee chairman, Dr. John Randolph, whose knowledge of and dedication to community energy planning has been a great influence on me and my thesis. Without his guidance I may never have seen the beginning or the end of this thesis. His continued patience, with my learning of community energy planning concepts and my personal situation which forced me to do much of the thesis at my home in Richmond, is greatly appreciated.

Finally, I would like to thank my family who supported and encouraged me in a number of ways throughout this process. My parents, Harold and Shirley Mushtare, are thanked for sparking the desire to strive for higher education and giving me the confidence to do so. I am also grateful to my mother and father-in-law, Sam and Lillie Ann Flora, whose encouragement and assistance through the rough spots will never be forgotten. Last, but not least, I would like to thank my husband, Paul. Few people possess the kind of patience and understanding which allowed him to withstand my moods, my trips to Blacksburg, and my lack of time for him. I dedicate this thesis to my husband, Paul. It is finally over, honey, we can get on with our lives now!

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Chapter I  
INTRODUCTION

1.1 PROBLEM STATEMENT

There are many communities across the nation which are in the process of, or have already implemented energy programs (Randolph, 1981). Such activity is most commonly considered to be a response to national fuel shortages which occurred in the seventies and their resulting effect on energy prices. Each community involved in energy planning efforts has taken a different approach to plan or program development and implementation, thus creating a wide range of experiences. These experiences vary by the methods and degree of analysis used in plan development. The resulting lack of uniformity among community energy planning efforts is shown in the final products, which range from comprehensive studies to more simple program proposals. It is also indicated in the range of success achieved by the communities in the implementation stage of the planning process.

While the approaches and experiences of each community have varied significantly, there does exist a common rationale for such efforts. Potential economic benefits provide an incentive to many communities approaching

community energy planning. David Morris refers to this in his book, Self-Reliant Cities (1982, p. 6):

"The new technologies give cities the opportunity to seek energy independence. But the opportunity is only grasped when there is a motivation to do so. The impact of rising energy payments on the local economy has proved to be such an incentive. The collective fiscal impact of energy imports on the local economy has become increasingly harmful. By 1980 more than 20 percent of the gross income of a community is paid for energy; 90 percent of these dollars leave the local area."

The literature continues to allude to the benefits of community energy programs to the local economy. However, little quantitative data to support such intuitive claims are provided in planning literature. For example, Alan Okagaki and Jim Benson in their book, County Energy Plan Guidebook (1979, pp. 2-4), refer to the economic benefits associated with dollar savings due to energy conservation in the following manner:

"Besides offsetting inflation, this increase in discretionary income (resulting from a reduction in energy expenditures due to energy programs) further increases the amount of money remaining in the local economy to be spent and re-spent. Money that does not go out of the county circulates through the local economy and has a 'multiplier effect' where it creates more jobs, finances more investments, and pays more wages. Money spent on local goods and services usually goes to small businesses which create more employment per dollar of income than large businesses."

Morris' Self-Reliant Cities (1982, p. 189) also vaguely refers to economic benefits:

"Communities that reduce their spending for imported energy thereby increase the amount of money they can spend for other purposes that may be more beneficial to the local economy."

The question of how the economy will benefit and to what degree is left unanswered in yet another example (Randolph, SLR 1981, p. 254):

"Greater local energy production and efficiency improvements can retain more dollars in the community to fuel the local economy."

Finally, in a study done by J.L. Moore et al. (1981, p. 25) entitled: The Comprehensive Community Energy Management Program: An Evaluation, evidence points to the lack of economic analysis in energy plans and the need for it:

"there may be a need for more economic evaluation than was possible under the CCEMP program. Convincing residents, and businesses especially, of the need for energy efficient improvement requires proof of their economic value. In addition, translation of proposals to easily understandable economic or financial terms is valuable in securing support for program actions."

These examples show that although there is an intuitive perception that energy plans and programs can lead to improvements in the local economy, there is little data to support it. In addition there is little information in the literature on how those engaged in energy planning have conducted economic analyses.

Economic analysis in energy planning includes study of both program cost effectiveness and effects on the local

economy. There is a distinct difference between these two phases of economic analysis which must be understood to follow the use of these terms throughout the thesis. Cost effectiveness studies must be done before effects on the local economy can be determined. The cost effectiveness of an energy plan or program can be determined through one of the following techniques: payback, cash flow, life cycle cost, or benefit/cost analysis. Each is discussed further in Chapter IV. Program or plan cost effectiveness is often determined by a community to demonstrate the feasibility of a program or plan in terms of direct dollar costs and benefits. Communities seldom include the next phase of economic analysis, effects on the local economy, or economy effects, when considering program feasibility. These effects include: direct on-site jobs, increases in local sales, increases in local income, and many other multiplier effects. Both cost effectiveness and economy effects will be discussed further in Chapter IV.

## 1.2 SCOPE OF THESIS

This thesis explores the extent to which communities throughout the U.S. involved in energy planning have engaged in economic studies. Based on case studies of those communities, the following hypothesis is tested:

"Community energy planning efforts in the U.S. do not reflect indepth analyses of effects on the local economy."

In addition, based on the cumulative experiences of those communities, a general framework is developed for economic analysis in community energy planning. Economy effects are often overlooked due to misconceptions about the degree and complexity of analysis necessary. The framework developed here, provides communities with a uniform means of quantifying economy effects often alluded to within energy plans. It is presented in phases which can be followed depending on time, resources, and personnel available to a community.

The thesis also explores other questions, including:

1. Does economic analysis facilitate implementation of energy plans and programs?

A link between the degree of analysis and respective levels of program implementation success in various community energy plans may be established through an examination of such plans. Such a link is referred to in a study done by Randolph (1982, p. 11):

"Seattle produced the most extensive analysis of a conservation program, showing the detailed costs and energy and dollar savings of its Community Energy Redevelopment Plan. This analysis was instrumental in the adoption of the CERP."

2. To what extent do economic analyses conducted in those communities studied support the claim that community energy programs benefit the local economy?

The economic analyses conducted by communities may provide the data necessary to test the viability of such claims made in energy planning literature.

### 1.3 METHODOLOGY

The methodology used in this thesis involves four steps described in the following paragraphs.

1. The data presented takes the form of several case studies which are based on information obtained from communities across the nation who are involved in energy planning. A literature search was done to identify communities involved in energy planning. Further examination of community energy planning experiences led to the identification of those communities which included some degree of economic analysis in their plans. The plans and documents from these communities provided the basis for the case studies.

2. An examination of the plans and documents was done to determine how the various communities had approached energy planning and what degree of analysis had been performed. A case study was then written on each community energy planning experience. These case studies later served as a reference for development of the framework presented in step 4 below.

3. Conclusions were drawn from the case studies in this step. A discussion was then developed in response to the following questions relating to the hypothesis:

A. Do community energy planning efforts in the U.S. reflect indepth analyses of effects on the local economy?

B. Does economic analysis facilitate implementation of energy plans and programs?

C. To what extent do economic analyses conducted in those communities studied support the claim that community energy programs benefit the local economy?

4. A general framework for performing an economic analysis of community energy plans and programs was developed in this step. The framework, as stated in the scope of the thesis, was developed in phases which can be followed depending on time, resources, and personnel. The phases are:

A. Phase 1 - Energy Economic Audit Data

B. Phase 2 - Program Cost Effectiveness

C. Phase 3 - Effects on the Local Economy

Each of the above steps is included in the three major chapters of this thesis. Chapter II is composed of the 25 case studies performed on communities across the United States involved in energy planning. The case studies are then discussed in Chapter III as they relate to the three questions stated above. Finally, Chapter IV is a presentation of the framework developed for performing economic analysis of energy plans and programs.

## Chapter II

### CASE STUDIES OF COMMUNITIES ENGAGED IN ENERGY PLANNING

#### 2.1 OVERVIEW

The case studies presented in this Chapter provide examples of various approaches and degrees of community energy planning efforts. The cases refer to both comprehensive energy plans and specific energy programs. Each case study, begins with a brief description of the plan or program, then focuses on any quantitative data and/or analysis relating to economic effects, and how they were calculated. The quantitative analysis provided, will later be used as a reference for the framework presented in Chapter IV. The information from the case studies will also be used in Chapter III to address three important energy planning issues:

1. Do community energy planning efforts in the U.S. reflect indepth analyses of effects on the local economy?
2. Does economic analysis facilitate implementation of energy plans and programs?
3. To what extent do economic analyses, conducted in those communities studied, support the claim that community energy programs benefit the local economy?

The materials used in preparing the case studies consist of various plans, studies and reports. Each was

typically written by and included input from one or more of the following groups: the local planning agency, citizen groups, the local utility company, and private consultants. These case study source materials were obtained through written correspondence with the various communities involved and through library sources.

The selection of communities to be studied began by contacting those communities participating in the Comprehensive Community Energy Management Program (CCEMP). CCEMP was a demonstration project funded by the Department of Energy (DOE), and managed by Argonne National Laboratory (ANL). Ten of the twenty-five case studies discussed are based on CCEMP projects. Those communities which participated in CCEMP produced the majority of the more informative plans discussed here. Because of the funding available to them, these communities were possibly better able to prepare more comprehensive plans, which often contained detailed quantitative analysis. Efforts in several other communities were also investigated. A complete list is provided below; they are grouped according to the degree of economic analysis conducted.

## Group 1 - Little or No Economic Analysis

- |                 |                  |
|-----------------|------------------|
| 1. St. Paul, MN | 4. Ann Arbor, MI |
| 2. Austin, TX   | 5. Oceanside, CA |
| 3. Davis, CA    | 6. Ashland, OR   |

## Group 2 - Analysis of Program Costs and Benefits

- |                    |                          |
|--------------------|--------------------------|
| 1. Palo Alto, CA   | 9. Carbondale, IL        |
| *2. Greenville, NC | 10. Eugene, OR           |
| *3. Knoxville, TN  | 11. Santa Clara Co., CA  |
| *4. Seattle, WA    | 12. San Diego, CA        |
| *5. Richmond, IN   | *13. City of Boulder, CO |
| *6. Dayton, OH     | 14. Portland, OR         |
| *7. Janesville, WI | 15. Springfield, IL      |
| 8. New York, NY    |                          |

## Group 3 - Analysis of Effects on the Local Economy

- \*1. Bridgeport, CT
- 2. Boulder Co., CO
- \*3. Philadelphia, PA
- \*4. Los Angeles, CA

\* CCEMP Communities

## 2.2 GROUP 1 - LITTLE OR NO ECONOMIC ANALYSIS

This section includes those communities which performed little or no economic analysis in their energy plans or programs. Communities in this section may have referred to the economic benefits associated with their plan or program, but provided no analysis to substantiate their statements. In some cases the community was very successful in implementation despite the prior lack of analysis. Others are only in the first phase of program development and expect to analyse specific programs later. There are a few

others which have ignored the issue entirely in their progression toward plan or program implementation.

#### St. Paul, MN

St. Paul's energy planning effort began with the formation of a 100+ member task force divided into five sub-committees. Each sub-committee addressed one of the following subject areas: transportation, existing housing and zoning, new housing and construction, large energy users, and education. They each developed recommendations for implementation in the areas of conservation, alternative energy systems and legislative/administrative changes (St. Paul, 1980). No economic analysis was included in this stage of the Saint Paul Energy Project.

Economic feasibility studies were conducted on a demonstration 200 megawatt hot water district heating system using waste heat from a downtown power plant operated by the private utility. The studies indicated the feasibility of the project and moves are being made toward implementation (Randolph, 1982).

#### Austin, TX

The City of Austin has produced a comprehensive energy management plan through its "little CCEMP" program operated by the state of Texas. Learning from the experiences of

CCEMP communities, Austin was able to develop their plan in one year and is proceeding toward implementation more quickly than CCEMP communities (Randolph, 1982). The planning effort was primarily undertaken by a volunteer Task Force. The Task Force was divided into six sub-committees to examine six areas of interest: commercial-industrial-educational, land use, production, residential, resource recovery-renewables, and transportation. Each sub-committee identified goals, strategies and implementation activities for their particular area of interest. Further investigation was then conducted to determine the feasibility of specific program proposals (OECRR, 1981). One proposal found to be feasible was the retrofit of the City's Tom Miller Dam for 9 MW of hydropower. The City is presently continuing efforts to develop this proposal further (Randolph, 1982).

#### Davis, CA

Davis has received recognition nationwide for its success in community energy planning. One program of particular interest is their energy efficient building code. Included in the code are exemptions which encourage the use of solar energy in building design. "One local builder who was initially opposed to the ordinance indicated that the regulation added only \$60 each to the cost of 21 homes he

had built since the ordinance took effect" (Randolph, 1981 p. 28). As a result of their efforts, household gas consumption decreased 24% from 1973 to 1979. Electric consumption also decreased during this time period by 10%. Davis' goal is to reduce overall energy use by 50% over a 10 year period (1976-1986) (Vine, 1981). No indication is given as to whether Davis had done any economic analysis on their various programs before they were implemented.

#### Ann Arbor, MI

The City of Ann Arbor produced a comprehensive energy plan containing a number of findings from their energy steering committee (Ann Arbor, 1981). It proposes specific action programs and activities for the city without the use of quantitative background data such as an energy audit. Further action is expected to occur emphasizing energy program promotion and education and expanded quantitative studies (Randolph, 1982).

An existing program which is expected to be expanded in the proposed work plan is the Low-Cost/No-Cost Energy Conservation Home Visit Program. In 1981, the program consisted of a 3+ hour home visit using \$75-\$100 of materials and serving 85 households. It resulted in an estimated 10% to 30% energy savings per household and a collective savings of over \$9,000, representing a payback period of less than two years (Freidman & Frey, 1982).

Oceanside, CA

Oceanside established a Municipal Solar Utility (MSU), the prime element of which includes a Solar Leasing program. Using capital raised from private investors and contracting with private leasing firms, the MSU leases solar domestic hot water systems, enabling local residents to forego the initial investment and maintenance cost of the systems. Taking advantage of the 55% State Solar Tax Credit, a leasee would have a monthly charge of \$11.25 compared to an average cost of \$13-\$19/month for hot water energy from San Diego Gas and Electric. The program is expected to not only benefit consumers but also act as a catalyst to the local solar industry, both in sales and construction (Millenbah & Sansone, 1982). However, no economic analysis is provided in their documents to substantiate this claim.

Ashland, OR

Ashland's success with implementation of their solar access ordinance and performance standards in new developments was partly attributable to the cooperation between planners and the building community (Randolph, 1982). No economic analysis was done to evaluate the effect of these ordinances on the community. It might be concluded, however, that positive participation between

builders and the public sector may not have so readily occurred if the private sector had not perceived the ordinances to be beneficial.

### 2.3 GROUP 2 - ANALYSIS OF PROGRAM COSTS AND BENEFITS

This group of case studies includes communities which examined the potential dollar costs and savings associated with their energy plans or programs. Often, only data is provided with no indication of how the analysis was conducted. The analysis varies, but in all cases an attempt is made to determine if a specific program will be cost-effective. The results are often useful in convincing local citizens and officials of the benefits of the program to be implemented.

#### Palo Alto, CA

Through its municipal utility, Palo Alto has initiated a solar loan program to help citizens finance solar domestic hot water (DHW) systems. Start-up funding for the solar loan program came from the Utility Reserve with additional funds later provided by a line of credit secured by the utility from a local bank (Randolph, 1982).

The following indicates the economic effects which Palo Alto expects to enjoy as a result of the program.

"The installation of 3000 solar systems by the year 1985 would result in energy savings of at

least 880,000 therms per year. The 1980 dollar savings would be equivalent to \$962,000 annually. Moreover, utility price projections for gas indicate that the value of the gas savings could amount to \$2,232,000 (1980 dollars) in annual savings by 1990. The impacts on the local economy are also impressive. Well over \$10 million will be spent purchasing solar systems. Sales will involve solar businesses and contractors, primarily in the Peninsula and South Bay area" (Palo Alto, 1980).

Palo Alto identified the high cost of energy as a problem and sought a means of addressing it. Unlike many other communities, they had the advantage of a city owned public utility to administer the program. This may have facilitated implementation, precluding the necessity of further analysis. Palo Alto has shown they are aware of the economic effects, but provided little analysis to substantiate their data.

#### Greenville, NC

The City of Greenville participated in the Comprehensive Community Energy Management Program (CCEMP). The resulting plan contains recommendations for energy conservation and energy production from renewable sources of energy. The plan suggests that "supply options combined with moderate energy conservation could reduce the outflow of energy dollars by nearly one-half. This alone could create 2500 jobs not including the multiplier effect"

(Greenville, 1981, p. S-2). The plan also indicates that with development of their own energy supplies and use of the existing energy distribution company, the Greenville Utilities Commission, Greenville could substantially decrease their dependence on outside energy sources. In 1978, the per capita energy expenditure was \$615, \$.10 on every dollar earned, or \$33 million for the community. This is expected to exceed \$1200 per capita, \$.17 on the dollar, or \$105 million for the community by the year 2000 if current levels of consumption continue (Greenville, 1981).

The Appendix to the plan includes an economic assessment of alternative energy options. Based on other studies, cost/unit of power is provided for nine types of systems, such as municipal solid waste conversion. In Phase Two (yet to be printed) of their work, Greenville has selected four of these options for further energy and economic analysis, including: multifuel cogeneration and district heating, municipal solid waste energy recovery, cogeneration using internal combustion engines, and large-scale solar thermal energy.

Greenville provides no methodology to explain how they derived their economic data. They also seem to have based the cost/unit of power produced by various energy systems on data from other studies.

Knoxville, TN

The City of Knoxville and Knox County also participated in CCEMP. They have developed a Community Energy Action Plan which stresses conservation and management of energy. It is stated in the Plan that "nearly all the energy used locally is produced outside of Knox County, every energy dollar we spend on energy 'leaks' out" (Knoxville, 1980 p.1). They also point out that 20% of per capita income is spent on energy in one form or another. Knoxville's Plan is expected to be a means of addressing this increasing problem.

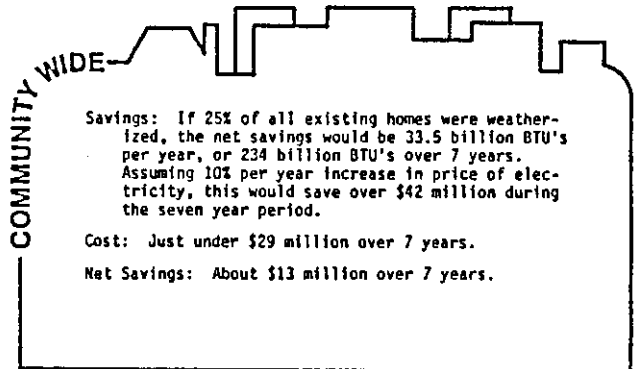
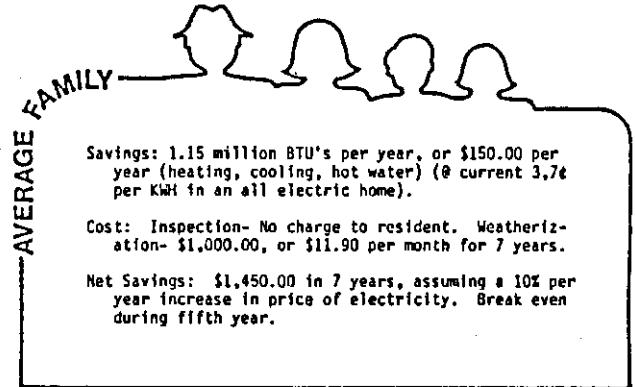
The Action Plan consists of objectives, actions, and results, such as in the example shown in Figure 1. The results indicate cost and savings for each Action, including both household and community effects. The numbers are very basic and no methodology is provided to indicate how they were derived.

Seattle, WA

The Seattle CCEMP plan focuses on an electricity conservation program, the Community Energy Redevelopment Plan (CERP). The CERP program is a "voluntary, incentive-based, community-focused marketing strategy, designed to achieve maximum cost-effective energy savings in all of Seattle's 150,000 buildings over 30 years" (Randolph, 1982,

**OBJECTIVE:****RESIDENTIAL BUILDINGS (Cont.)****SPECIFIC ACTION**

- #2. Improve the weatherization standard in existing homes. (See pp. 20, 30).
- \* Dramatically increase participation in TVA/KUB/LCUB Home Insulation Program (HIP) thru continued education of its benefits.
  - \* Continue the Knox County Community Action Committee Low Income Weatherization Program.
  - \* Offer economic incentives to community residents by exempting energy saving home improvements from increases in property value when the property is reassessed.

**RESULTS**

Source: Knoxville/Knox County Metropolitan Planning Commission. "Community Energy Action Plan- Volume II." December 1930.

Figure 1: Specific Actions and Results

p.5). The City of Seattle estimates that it can save \$395 million by the year 2010, if their energy plan is enacted (Seattle, 1981).

Presently, conservation measures are cheaper than any other source of energy for Seattle homeowners, except electricity. The price of electricity, however, is expected to rise sharply and exceed conservation costs if demand continues to increase and new generation facilities are needed. Seattle derived the following energy cost figures comparing various conventional sources of energy against conservation and new thermal generated electricity (Seattle, 1981)( see Figure 2). Because conservation measures are a fixed expense, they will not fluctuate as the cost of other energy sources are expected to.

- Conservation - \$7.88/million BTU
- Natural Gas - \$9.15/million BTU
- Oil - \$13.83/million BTU
- Electricity - \$4.75/million BTU
- New Thermal Generated Electricity - \$12-\$15/million BTU

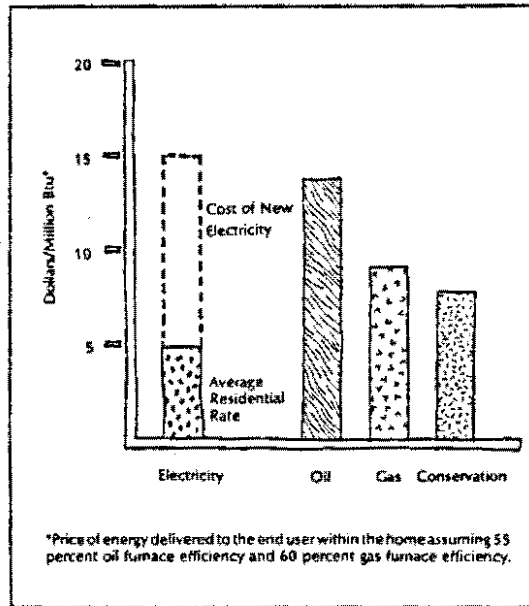
Seattle has prepared an energy plan which if implemented can potentially save both energy and energy dollars. Figure 3 shows that these dollars saved are expected to stimulate the local economy by the circulation of conservation and local energy production costs back into

the economy creating an import substitution effect through the resulting decrease in energy imports. However, no economic analysis is provided to substantiate this intuitive concept.

#### Richmond, IN

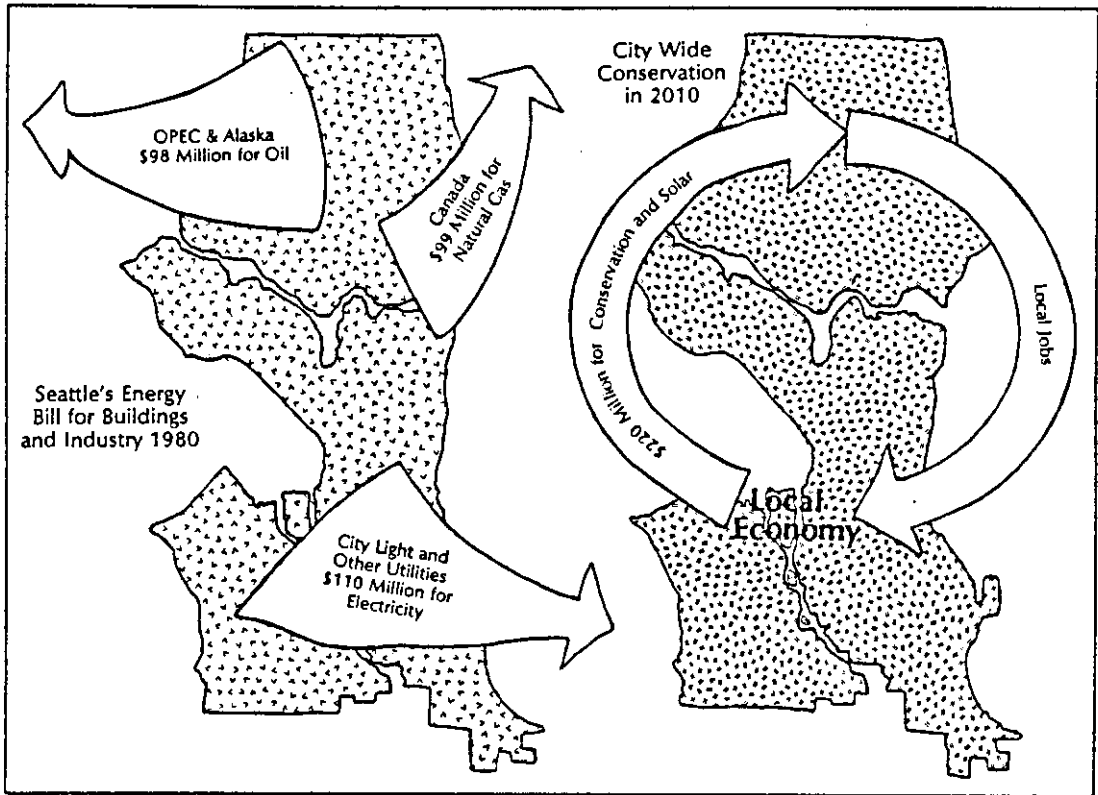
Richmond's Final Action Plan under CCEMP assesses the local energy situation and suggests a general plan of action and the implications involved. Richmond is dependent on foreign imports for 25% of their energy needs. This figure is small due to the municipal utility, Richmond Power and Light, which generates most of the community's energy needs from coal provided within the state. This dependence on foreign imports may be significantly smaller than most communities, however, Richmond's transportation sector is 50% dependent on their imported oil supply. For them, "the implementation of new and alternative energy technology is directed primarily at preserving the economic stability of the City" (Richmond CCEMP, 1981, Part 3).

Richmond's main objective is to conserve and convert energy. The conservation program, is dependent on a conversion program which shifts energy use away from imported oil toward the development of local energy sources including: a district heating system, groundwater resources, and solid waste for energy. An example of the economic



Source: Seattle Energy Office. "Final Action Plan." Seattle, Washington, March 1981.

Figure 2: Comparison of Energy Costs



Source: Seattle Energy Office. "Final Action Plan." Seattle, Washington, March 1981.

Figure 3: Seattle's Energy Dollar Flows

assessment carried out by Richmond on one of their proposed conversion programs, the groundwater management plan, is shown in Figure 4 . No quantitative data is provided which assesses the impacts of Richmond's proposed conservation programs.

#### Dayton, OH

The City of Dayton's CCEMP plan was directed by a 20 member steering committee. Its purpose was to develop an energy plan which would identify and address through energy alternatives, energy problems facing Dayton over the next 5-20 years. The plan approached this task by first doing an energy audit which surveyed the energy end use in Dayton for the year 1978, and then projected energy needs for the years 1985 and 2000. This provided a basis for developing goals and objectives and alternative strategies to implement the objectives.

The Dayton Plan, illustrated future energy problems by computing energy costs as they apply to individual households. Figure 5 indicates how increases in energy costs will eventually leave less personal income to be spent on other uses. This in turn will mean less money to be recycled into the local economy (Dayton, 1981). Table 1 shows those benefits which an individual household can realize if certain conservation measures are implemented.

The Conversion Program

The key to the conversion scenario is that you really don't save BTUs - you convert from gas and oil to a comparably-sized electric-fired system. The savings are monetary, and only over an extended period of time.

A. Groundwater Management Plan

1. Assume:
  - 30° average winter temperature
  - 80,000 BTU/hour house (system sized to provide 80,000 BTU/hour @ 30°, need 40,000 BTU/hour to heat
  - 40,000 BTU/hour x 24 hours = 960,000 BTU/day
  - 960,000 BTU/day x 30 = 28,000,000 BTU/month
  - 100,000 BTU/ft<sup>3</sup> of gas
  - 28,000,000 BTU = 288 units of gas 100 ft<sup>3</sup>
  - 100,000 BTU/ft<sup>3</sup> gas
  - according to the gas co. December, 1980 data, rate is \$.35/100,000 BTU = \$3.50 BTU
- Remember:
  - House takes 28,800,000 BTU (oil, gas) month
2. Calculate:
  - 288 ft<sup>3</sup> gas x \$.35 rate - \$100.00 month gas bill
3. Convert:
  - Resistance heating will require 20% less BTU (because it does not lose BTUs up the chimney like gas and oil.)
  - ∴, BTU required with electricity are 23,040/month
  - use:  $\frac{23,040,000}{* 3413} = 6757 \text{ kw} @ 3.64 \text{ kw} = \$243.04/\text{month elec. bill}$
  - \* 1 kw electricity = 3513 BTU
4. With ground water heat pump
  - $\frac{\$243.04/\text{month}}{2.5 \text{ cop for heat pump}} = \$97.00$

5. Conclusion: - homeowner saves \$3.00/month over gas bill
6. Realize: we save next to nothing. But examine the projected fuel costs between electricity and gas
7. Assume:
  - By 1985, electricity will have a 50% increase, bringing the heat pump bill to \$150/month
  - By 1985, gas will have a 100% increase, bringing the gas heat bill to \$200/month
 Save: note - difference of \$50.00
8. Assume: - oil bill will be \$200/month for heat. 1980
9. Recall: - heat pump bill is \$97.00
10. Realize:
  - heat pump already cost-effective over oil
 save: \$103
11. Assume:
  - oil prices 2 1/2 times 1980 prices in 1985. brings the oil bill to \$500
12. Recall:
  - heat pump bill (1985) \$150
 save: \$350

	from gas		from oil	
	1980	1985	1980	1985
5% conversion	\$ 933.3	\$5,555	\$ 41,864.35	\$ 142,257.5
10% conversion	\$1,866.6	\$11,110	\$ 83,728.7	\$ 284,515
25% conversion	\$4,666.5	\$27,775	\$209,321.75	\$ 711,285.5
50% conversion	\$9,333	\$55,550	\$418,643.50	\$1,422,575

Assumes: 6222 units use gas space heat  
 8129 units use oil space heat  
 1695 units use electric space heat

Source: Richmond CCEMP. "CCEMP After Two Years - 1980 Year End Report." (presented to the Common Council of the City of Richmond, Indiana) January 1981.

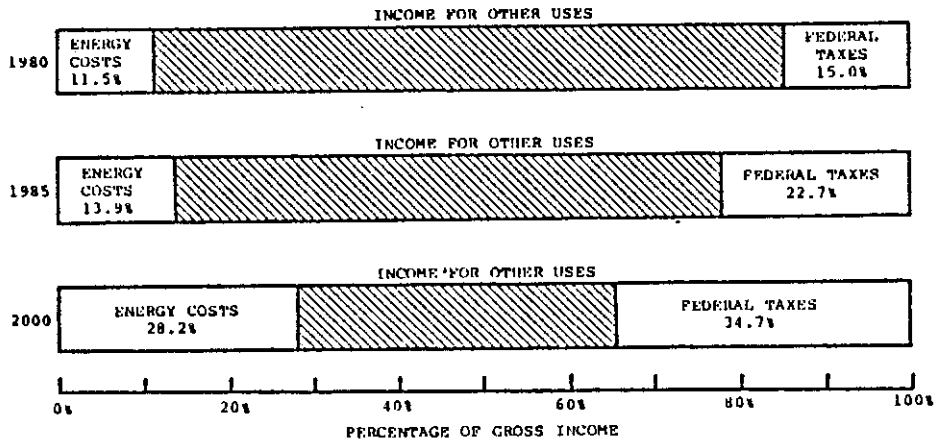
Figure 4: Estimated \$/BTU Savings

Limited explanation is given to indicate how any of these numbers were derived.

Janesville, WI

The Janesville CCEMP plan focuses on existing and new structures in the residential and municipal sectors only, emphasizing energy management and conservation. Janesville's Plan is composed of six tasks; Task IV includes an impact assessment which evaluates alternative programs. A subjective assessment such as that shown in Table 2 for the municipal sector, was conducted for various strategies categorized by plan objectives. These include: hiring of an energy coordinator; residential regulatory, incentive, and educational measures; and conservation strategies at the municipal level.

From their subjective assessment, the planning team calculated the possible energy and dollar savings which could result from the strategies outlined. For example, Table 3 shows the energy savings possible if past trends continue, and additional savings possible if the plan goals are met in the municipal sector. No detailed methodology is given on how the energy savings and program cost figures were derived.



- Based on gross income of \$16,000 per year in 1980 dollars (approximately the average income for a Dayton household) - increasing at same rate as inflation through 2000.
- Based on energy use in an average Dayton Single Family Detached home that uses utility gas to provide space heating, water heating, and cooking.
- Average gas use = 1,720 CCP per year  
 Average electric use = 5,860 kWh per year  
 Average gasoline use = 667 GAL in 1980; 545 GAL in 1985; 362 GAL in 2000; to provide 10,000 miles per year (reduced use due to improved efficiency of average car in 1985 & 2000).

Source: Dayton CCEMP. "City of Dayton Comprehensive Energy Plan - Appendix." February 13, 1981.

Figure 5: Energy Costs of an Average Dayton Household

TABLE 1  
Costs And Savings Of Energy Conservation Actions

COSTS AND SAVINGS OF ENERGY CONSERVATION ACTIONS  
FOR A POORLY INSULATED ONE-STORY DAYTON HOME  
(1044 Sq.Ft. of Heated Floor Space)

ANNUAL CONSUMPTION AND COST OF  
UTILITY NATURAL GAS BEFORE CONSERVATION ACTIONS

	<u>Annual Consumption</u> (CCF)	<u>Annual Cost</u> (Dollars)
Space Heating	2074	\$720
Water Heating	413	150
Cooking	<u>38</u>	<u>30</u>
TOTAL	2595	\$900

CONSERVATION ACTIONS - COSTS & PAYBACK PERIODS

	<u>Installation Costs</u> (Dollars)	<u>Payback Periods</u> (Years)
Ceiling Insulation	\$ 480	2.1
Exterior Wall Insulations	367	3.3
Basement Ceiling Insulation	209	3.3
Storm Windows, Storm Doors, & Weatherization	1,020	7.0
Weatherization (alone)	(200) not included in total	1.8
Water Heater Insulation	<u>20</u>	<u>0.9</u>
TOTAL	\$2,096	3.6 (all actions combined)

ANNUAL SAVINGS FROM CONSERVATION ACTIONS

	<u>Annual Consumption</u> <u>Savings</u> (CCF)	<u>Annual Cost</u> <u>Savings</u> (Dollars)
Ceiling Insulation	668	\$232
Exterior Wall Insulation	323	112
Basement Ceiling Insulation	184	64
Storm Windows, Storm Doors, & Weatherization	417	145
Weatherization (alone)	(272) not included in total	(95) not included in total
Water Heater Insulation	<u>65</u>	<u>23</u>
TOTAL	1657	\$576

OTHER CONSERVATION ACTIONS

	<u>Annual Consumption</u> <u>Savings</u> (CCF)	<u>Annual Cost</u> <u>Savings</u> (Dollars)
Thermostat Setback (after above actions)	59	\$ 21
Furnace Efficiency Improvement (from 60% to 70% efficiency, after above actions and thermostat setback)	60	21
TOTAL SAVINGS	<u>174</u>	<u>\$618</u>

Source: Dayton CCEMP. "City of Dayton Comprehensive Energy Plan - Appendix." February 18, 1981.

TABLE 2

Subjective Impact Assessment

OBJECTIVE	ACTION STRATEGY	CAN ENERGY SAVED & COST TO CITY BE QUANTIFIED		BENEFITS		COSTS	
		COST	SAVING	CITY	RESIDENT. SECTOR	CITY	RESIDENT. SECTOR
I-1. Conduct Energy audits of city owned buildings and cost/benefit analyses of possible energy conservation alternatives.  2. Implement those energy conservation techniques best suited to the individual city owned properties.	a. Participate in the Wisconsin Institutional Buildings Grants Program.	Yes	No	Increased energy efficiency in city owned buildings.	Less tax dollars spent on municipal energy use.	Monetary and staff time costs to conduct audits.	Support through taxes.
	b. Retain the services of a consultant to conduct the energy audits and cost/benefit analyses.	Yes	No	Increased energy efficiency in city owned buildings.	Less tax dollars spent on municipal energy use.	Monetary and staff time costs to conduct audits.	Support through taxes.
	a. Assign the responsibility for coordinating and implementing the adopted energy conservation programs to the energy coordinator or the appropriate division within municipal government.	Yes	No	Increased ability to implement CCEMP.	Less tax dollars spent on municipal energy use.	Monetary and staff time.	Support through taxes.
	b. Implement a program designed to increase the energy efficiency of the city of Janesville's street lighting system.	Yes	Yes	Reduced energy use.	Less tax dollars spent on municipal energy use.	-	-
II-1. Maintain an office within city government to coordinate public and private sector conservation programs and implement the strategies of the CCEMP.	a. Pursue federal funds and participate in federal programs which would provide assistance in maintaining local energy programs.	No	No	Continuation of the CCEMP.	Less tax dollars spent on municipal energy use.	Program monitoring grant writing.	Support of federal programs through tax dollars.
	b. The responsibility for implementing the CCEMP will be assigned to specific divisions and departments within municipal government or to the energy coordinator if so designated.	Yes	No	Increase ability to implement the CCEMP.	Less tax dollars spent on municipal energy use.	Monetary and staff time.	Support through tax dollars.

Source: Bradley J. Murphy. "Task IV - Identification and Evaluation of Alternative Energy Conservation Actions and Strategies." Janesville, Wisconsin, December 1980.

TABLE 3

## Projected Energy Use And Possible Savings: 1979-1985

BUILDING	1979	1980 Estimate		ENERGY COST 1980 - 1985					
		1980 \$	1979 \$	CURRENT DOLLARS			CONSTANT 1979 DOLLARS		
				At 1979 Use Levels	Plan Goal	6 Year Savings	At 1979 Use Levels	Plan Goal	6 Year Savings
<b>NATURAL GAS*</b>									
Municipal Building	14,032	12,438	9,595	158,832	95,299	63,533	84,005	50,400	33,605
Ice Arena	8,864	13,969	12,173	88,032	88,032	-	53,190	53,190	-
Public Library	18,040	11,331	9,874	180,578	90,289	90,289	107,888	53,944	53,944
<b>ELECTRICITY</b>									
Municipal Building	26,434	25,836	22,267	268,405	187,861	80,544	158,582	111,000	47,582
Ice Arena	36,996	40,859	41,548	356,994	356,994	-	221,968	221,968	-
Public Library	17,324	16,967	15,255	168,638	118,048	50,590	103,941	72,756	31,185
<b>TOTAL</b>	<b>121,690</b>	<b>121,400</b>	<b>110,712</b>	<b>1,221,479</b>	<b>936,523</b>	<b>284,956</b>	<b>729,574</b>	<b>563,258</b>	<b>166,316</b>

\* Adjusted for degree days.

Source: Eradley J. Murphy. "Task IV - Identification and Evaluation of Alternative Energy Conservation Actions and Strategies." Janesville, Wisconsin, December 1980.

New York, NY

The City of New York has produced a background report which examines the city energy profile as a basis for potential energy management directions. This is the first of three phases in the City's energy planning and management project. Phase II will select one economic sector and identify energy efficiency measures and alternative source possibilities that will reduce energy consumption and the associated costs. Phase III will develop an implementation plan to achieve the savings identified during Phase II in the most cost-effective way possible. The City then plans to replicate the procedure in other sectors (New York, 1981).

Through study of their energy consumption patterns, New York found that \$6.2 billion (or about 70%) of their energy expenditures, left the city in 1981. This figure is expected to grow due to New York's high dependence on oil as a basic fuel - 71% as compared to the national average of 44% (New York, 1981).

Efficiency measures identified in Phase 1 would cost an estimated \$3-\$4 billion. Such an investment could reduce the City energy bill by \$1.7 billion annually (see Table 4). Of this, \$1.0 billion (or about 60%) would be retained within the local economy, which in turn would generate \$2.5

billion in local sales. Data on energy savings potential is based on other published sources and studies. According to the study, the methodologies used will be available later in a separate technical appendix.

#### Carbondale, IL

In response to rising energy prices and the detrimental effect which they have on the local economy, Carbondale has initiated a Municipal Solar Utility (MSU) program referred to as the "The Other Utility". The model program, although developed for Carbondale, is intended to be easily transferred to any city. It is based on the idea that as energy prices rise faster than wages, a larger chunk will be taken out of household income. This in turn will mean less money to be recycled through the local economy, and more money being lost to the local economy to pay for energy imports. Retaining this money through conservation efforts, would create a stimulus to the local economy, producing jobs and increasing retail sales. Figure 6 compares a "Business as Usual" scenario where existing trends continue, to an "Alternative" scenario where conservation measures are implemented. This example provides an elementary approach to economic evaluation of the proposed measures. No explanation is given to determine how the multipliers and jobs were derived.

TABLE 4  
Energy Cost Savings Potential

	<u>Res.</u>	<u>Comm.</u>	<u>Public</u>	<u>Trans.</u>	<u>Indust.</u>	<u>TOTAL</u>
Oil						
fuel oil	235.4	72.1	22.2			329.7
gasoline			10.7	511.7		522.4
diesel			0.4	6.1		6.5
gasohol				.1		.1
OIL SUBTOTAL	<u>235.4</u>	<u>72.1</u>	<u>33.3</u>	<u>517.9</u>		<u>858.7</u>
Natural gas	82.3	19.1	11.9			113.3
Electricity	264.5	177.9	67.2	41.5		551.1
Steam	12.8	23.5	10.6			46.9
Coal			2.6			2.6
Industrial Fuels					<u>111.6</u>	<u>111.6</u>
TOTAL	595.0	292.6	125.6	559.4	111.6	1684.2
(% savings)	(22%)	(27%)	(28%)	(24%)	(10%)	(22%)

Source: New York City Office of Energy Conservation.  
"Energy Consumption in New York City: Phase I -  
Patterns and Opportunities." April 1981.

27,194	Approximate population of Carbondale.		
9,800	Approximate number of households (dwelling units).		
\$ 8,339,000	Amount of money spent on residential energy in 1979 (lighting, heating, hot water, etc.).		
3,751,000	Amount of money spent on commercial energy consumption last year. Households pay for commercial energy out		
	of the household budget when purchasing food, clothing, theater tickets, etc.	<u>The Alternative</u>	
11,842,000	Amount of money spent on gasoline.	2,000	Approximate amount of money per household to install conservation measures to cut residential energy consumption by 40 percent. This percentage reduction is lower than the present state of the art for this level of investment and is used to be conservative.
23,932,000	Total spent out of household income for residential, commercial and transportation energy.		
.2,442	Average amount spent by each household on energy in 1979.	19,600,000	Total amount of investment to conserve energy in the 9800 dwelling units. This money is spent locally to purchase conservation building materials and the labor to install them. This amount spent locally will stimulate the local economy and create additional economic growth due to economic multiplier effects.
5,797,000	Amount of money spent by Southern Illinois University at Carbondale on energy last year.	16,660,000	Above \$19,600,000 reduced by 15% federal tax credits.
1,271,000	Amount of money spent by Carbondale's industrial sector on energy in 1979.	less than 5 years	Payback time for conservation investment excluding energy price inflation and interest on borrowed money.
31,000,000	Total amount spent on energy imported into Carbondale in 1979.	882	Number of person-years of labor required to install the conservation measures. (45 person-years installation employment per million dollars invested).
26,350,000	Total amount of money flowing directly out of the community to pay for this energy. Recent studies show that no more than 10 percent to 15 percent of the money spent on energy remains in the local economy.	166	Number of permanent jobs created by retaining the saved \$3,335,600 within the community (166 jobs x \$20,000 per year = \$3,335,600).
	NOTE: These numbers are approximate and are included to indicate the magnitude of the economic impact of payments for imported energy.	3,335,600	Amount of money saved per year (in uninflated dollars or energy prices) in the Residential Sector of the community from 40% energy conservation target. Total annual savings will be smaller initially and will grow rapidly as conservation is implemented and the conservative 40% figure is surpassed.
	<u>Business as Usual</u>	\$ 13,342,400	Amount of new economic activity per year in Carbondale due to retaining \$3,335,600 in energy savings (with uninflated dollars and a 4.0 economic multiplier effect). Money saved by energy conservation becomes new discretionary income. That money is spent in the local economy rather than exported for energy payments. When I buy a haircut, my barber buys food, the grocer buys a new refrigerator, the appliance dealer buys a new suit, the clothing store manager buys dinner and a movie and the money goes round in a circle within the community. The local economy is strengthened, as a result.
\$ 2,393,000	Amount of additional money that left the community in 1980 if energy prices rose only 10%. This new expense decreased the amount of disposable income available within the community. This drain on the economy is directly equivalent to a business, with 159 employees earning an average of \$15,000 per year, closing shop permanently.		
2%	Assumed annual growth in city-wide energy consumption.		
10%	Assumed annual rate of energy price increases (NOTE: this is an <u>extremely</u> conservative assumption).		
239,320,000	Amount of money per year required to purchase residential, commercial and transportation energy in the year 2000. (A tenfold increase over 1979 cost).		
24,420	Cost to each household for energy in the year 2000.		

Source: Shawnee Solar Project. Municipal Solar Utility: A Model for Carbondale, Illinois. Chicago: Institute of Natural Resources, 1981.

Figure 6: Business as Usual vs. Alternative Energy Scenarios

Eugene, OR

Eugene enacted the strictest retrofit ordinance in the country to be met by all existing residential buildings by January 1985. The ordinance, however, allows for review by the City Council one year prior to implementation. Implementation may then be deferred until 1990 due to increased conservation action by the Bonneville Power Authority (BPA) and projections by BPA that electric deficits will not likely occur until 1990 rather than the earlier predicted date of 1985 (Randolph, 1982).

Eugene developed cost and savings data on the weatherization measures to be implemented through their retrofit ordinance. Since the first phase of their implementation process involves education programs, the data is expected to serve as an economic incentive for residents to voluntarily implement the suggested measures. Table 5 indicates those measures to be implemented under the ordinance and their respective costs and savings over a 20 year life of the measure. The data given is based on Eugene Water and Electric Board (EWEB) estimates of contractor cost for installation of the measures and potential energy savings of each measure. No methodology is given detailing the analysis done to determine the data.

TABLE 5

## Costs and Savings of Energy Efficiency Measures

## Assumptions:

- . 1,100 ft<sup>2</sup> "typical" pre-1974 single family dwelling
- . already has 3-3/4" rock wool insulation (R-11)
- . no floor insulation, water jacket insulation, caulking, or weatherstripping

	<u>Contractor Cost</u>	<u>Annual Energy Savings (thousands of BTU's)</u>	<u>Annual Cost Savings (1980 dollars)</u>		
			electricity	natural gas	oil
<b>I. COSTS AND ACCUMULATED SAVINGS</b>					
1. Attic Insulation from R-11 to R-30	\$ 265.00	3,193			
2. Floor Insulation to R-19 + Vapor Barrier	660.00	13,053			
3. Water Jacket (R-11 Insulation)	30.00	2,213			
4. Chaulking and Weatherstripping	<u>200.00</u>	<u>5,315</u>			
	\$1,155.00	24,239	\$105.00 (7,000 kwh)	\$130.00 (300 therms)	\$210.00 (230 gal.)
<b>II. TAX CREDITS</b>					
Federal Tax Credit	\$173.00				
State Tax Credit (\$125 limit)	<u>\$125.00</u>				
	\$298.00				
<b>III. NET COST (\$1,155-\$293) \$862.00</b>					
<b>IV. COMPOSITE PAYBACK TIMES</b>					
		Electricity with 7% annual rate increase:	6-1/2 years		
		Natural gas with 15% annual rate increase:	4 years		
		Oil with 20% annual rate increase:	3-1/4 years		

Source: Greg Page. "Summary of Staff Briefing Paper - Weatherization of Existing Residences." Eugene, Oregon, May 1, 1980.

Santa Clara Co., CA

Santa Clara County has passed a set of four energy ordinances requiring solar access and solar domestic hot water (DHW) systems in new development and certain conservation measures and solar DHW systems on existing residences at the time of resale (Randolph, 1982).

The County used a Solar Finance life cycle cost computer program (SOLEFIN) developed at the California Energy Commission to compare costs of solar and conventional DHW systems. This was done for new single family, retrofit single family, and new multifamily applications using both average and marginal fuel prices. In addition, pool heating cost comparisons were made. Basic assumptions shown in Table 6 were varied to determine the degree to which the variations might alter the results. The solar option was found to be the most cost effective in all instances on the basis of life cycle costs with the largest savings occurring when solar was compared to electric hot water heating (Doctor, 1979) (see Figure 7). No analysis was done to evaluate the effect of these programs on the local economy.

San Diego, CA

San Diego County began comprehensive energy planning primarily as an alternative to the proposed Sundesert nuclear powerplant to be located in their area. Their

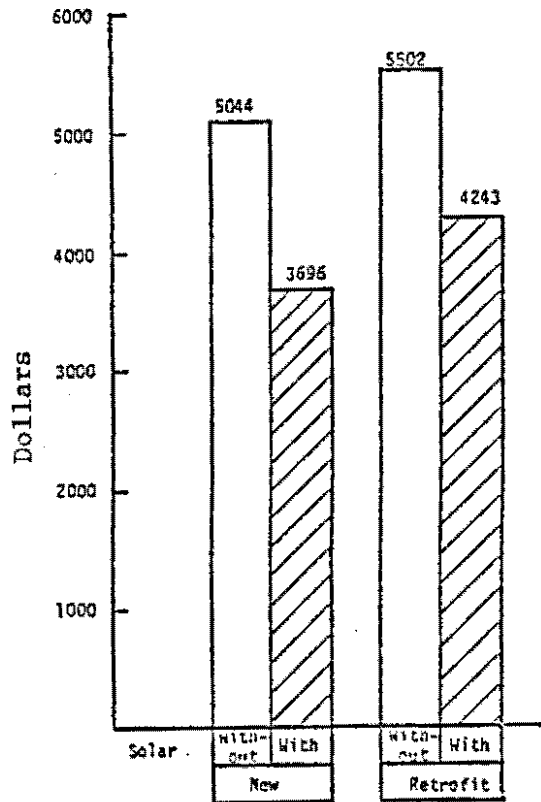
TABLE 6  
Basic Assumptions

	<u>New Single Family</u>	<u>Existing Single Family</u>	<u>New Multi-Family (per unit)</u>	<u>Pool<sup>a</sup></u>
Fuel Price Escalation Rate				
Natural Gas	15%	15%	15%	15%
Electricity	11%	11%	11%	11%
Energy Use without Solar				
Natural Gas (therms/year)	287	317	245	918
Electricity (kwh/year)	3976	4392	3394	----
Fraction of Fuel Displaced by Solar				
	0.7	0.7	0.7	0.82
Maintenance Cost and Frequency	1.5%, 3 yrs.	1.5%, 3 yrs.	1.5%, 3 yrs.	1.5%, 2 yrs.
Solar Equipment Installed Cost	\$2100	\$2500	\$ 750	\$3140
Conventional System Installed Cost	\$ 310	\$ 310	\$ 225	\$1300
Loan Terms				
Downpayment	10%	10%	20%	10%
Interest Rate	11.8%	11.8%	12%	12.5%
Loan Period (years)	30	30	25	10
Inflation Rate	8%	8%	8%	8%
Discount Rate	12%	12%	12%	12%

\* See Assumptions (Table I-A) in the average price sections for greater detail.

<sup>a</sup> Includes a pool cover which is used 50% of the time and is replaced every 2 years.  
Solar Collector area = 50% of pool area.

Source: Ronald D. Doctor, Office of. "Solar Energy Economics -  
For Santa Clara County." Santa Clara, July 2, 1979.



Source: Ronald D. Doctor, Office of. "Solar Energy Economics For Santa Clara County." Santa Clara, July 2, 1979.

Figure 7: Summary of Life Cycle Cost Comparisons (SF-DHW-Electric)

comprehensive effort led them to adopt the first solar energy mandate in the U.S. They first adopted an ordinance in December, 1978 mandating the use of solar domestic hot water (DHW) in new housing. Later in August, 1979 a solar access ordinance was adopted to ensure protection of the new solar systems from shading. Before the ordinance was adopted, a Solar Ordinance Feasibility Analysis (SOFA) was performed by the county energy office to examine the cost effectiveness of the proposed solar systems. Table 7 compares the cost of a natural gas system to a solar system. Table 8 compares electric systems with solar. The SOFA analysis concluded (Pulliman & Hedgecock, 1980, p.62):

- solar DHW would be cost effective over a 20 year operating life using 1978 dollar and utility rates. The comparison was more favorable with electric DHW systems than with gas;
- the added cost of a solar DHW system to a new home would be about \$1750 while it would displace 1.8 million therms of natural gas and 5.4 million kwh of electricity each year beginning 1980;
- the 55% total state and federal tax credit on the system would reduce overall system cost and provide a positive cash flow the first year; and,
- 400 jobs would be created within the county, between 1979 and 1995. This breaks out to 2039 labor years in solar manufacturing/installing fields and 4996 labor years in indirectly related services.

While no analysis was provided to show how these numbers were derived, it was said to be contained in a separate report.

The ordinances were written in compliance to SOEA recommendations. The recommendations provided guidelines for ordinance development and information necessary for adoption of the ordinances by illustrating the cost effectiveness of the ordinances (Pulliman & Hedgecock, 1980).

#### City of Boulder

Perhaps, the most successful member of the CCEMP group has been Boulder. The City Council has enacted a range of programs which involve: education, regulations, incentives, and energy production (Randolph, 1982). A local energy audit indicated that the residential sector of Boulder consumed an unusually high proportion of total energy use in Boulder- 35%; of that, 85% was for hot water and space heating. Boulder has subsequently placed greatest emphasis on residential energy programs.

Some study has been done by the City to determine the cost-effectiveness of retrofit measures. It was concluded that a \$3000 investment could reduce household gas consumption by about 75% with a 5 year payback period. A \$1000 investment could reduce household gas consumption by

TABLE 7

## Natural Gas vs. Solar

COST COMPONENT	STRUCTURE TYPE	
	<u>SINGLE FAMILY</u>	<u>MULTI FAMILY</u>
Natural Gas System		
Initial System Cost (with loan)	\$ 206	\$ 206
Energy Costs	2393	2393
Replacement Costs	<u>176</u>	<u>176</u>
Total	\$2775	\$2775
Solar System		
System Cost (with loan)	\$1513	\$1211
Back-up System Cost	(included with system)	
Maintenance Costs	463	374
Insurance Costs	0	0
Property Tax Costs	137	-241
Replacement Costs	196	196
Tax Interaction	93	79
Energy & Operating Costs	957	957
Tax Credits	966	770
Residual Value	<u>0</u>	<u>0</u>
Total	\$2407	\$1306
Cost Ratio*	1.2	1.5

\*Ratio of the total discounted costs of the conventional system to the total discounted costs of the solar technology.

Source: E.R. Pulliam and R.S. Hedgecock. "Local Leadership For Solar Energy," Solar Law Reporter, v.2 n.1, May/June 1980.

TABLE 8

## Electric vs. Solar

COST COMPONENT	STRUCTURE TYPE	
	<u>SINGLE FAMILY</u>	<u>MULTI FAMILY</u>
Electric System		
Initial System Cost (with loan)	\$ 195	\$ 195
Energy Costs	5395	5395
Replacement Costs	<u>165</u>	<u>165</u>
Total	\$5756	\$5756
Solar System		
System Cost (with loan)	\$1513	\$1211
Back-up System Cost	(included with system)	
Maintenance Costs	463	374
Insurance Costs	0	0
Property Tax Costs	137	-241
Replacement Costs	187	137
Tax Interaction	93	79
Energy & Operating Costs	1957	1957
Tax Credits	966	770
Residual Value	<u>0</u>	<u>0</u>
Total	\$3293	\$2697
Cost Ratio*	1.3	2.1

\*Ratio of the total discounted costs of the conventional system to the total discounted costs of the solar technology.

Source: E.E. Pulliam and R.A. Hedgecock. "Local Leadership For Solar Energy," Solar Law Reporter, v.2 n.1, May/June 1980.

50% with a payback period of 3 years (Boulder, 1980). The Boulder plan did not include the analytical basis for this data. As part of Boulder's continuing energy planning, feasibility studies have been conducted on four potential energy production projects. One option, a 3 mega-watt hydro project was found to be feasible and further action is being taken to implement the project (Randolph, 1982).

### Portland, OR

The Portland Energy Conservation Project, directed by the City of Portland, began in July 1975. Sponsored by the U.S. Department of Housing and Urban Development, the project's purpose was to (Portland, 1979):

- collect data on Portland energy use,
- develop programs for saving energy in Portland, and
- develop conservation planning methods that could be used by other cities.

The project represents one of the "first large-scale, systematic efforts to address the full range of community energy choices and has served as a point of departure for many other similar efforts elsewhere" (Meshenberg, 1982 p.40).

Basic cost and savings data was provided for conservation programs proposed by the project. Economic impacts were also considered in evaluating the various

choices. Figure 8 represents the amount of job losses attributable to increasing energy prices through 1995, and the potential effects that a 34% energy conservation savings would have on local jobs. Much of the preliminary study for these estimates was done by the Bonneville Power Administration (BPA). Assumptions stated by the Portland study include:

- the average household spends 9% of after-tax income for energy;
- a doubling in energy prices would reduce the after-tax income by an additional 7% (households would reduce energy consumption by 10%);
- at least half of all Portland jobs are dependent on consumer expenditures (others are related to government and institutional spending); a 7% reduction in consumer expenditures could produce 3 1/2% unemployment; and,
- most of the increased dollars spent for energy would be funneled out of Oregon; the unemployment could, therefore, be long term unless the increased energy revenues are recycled in the local economy.

#### Springfield, IL

The Illinois Institute of Natural Resources used the City of Springfield as the focus of a hypothetical residential energy conservation program. The loan program funded by a municipal bond would provide 10" of ceiling insulation (R-30) in 17,000 dwelling units in Springfield. The program analysis contained in the Institute's report resulted in the following effects. The program would (Illinois INR, 1981, Executive Summary):


**IMPACT OF ENERGY PRICE RISES ON JOBS IN 1995**

	With No Conservation	With 34% Savings from Conservation
Local jobs lost due to reduced consumer expenditures when energy costs double in "real" dollars.	23,522 jobs lost	5,550 jobs lost
Local jobs created due to expenditures on conservation measures to produce 34% savings. <sup>1</sup> (28 billion Btu's of electricity and 82 billion Btu's of gas and petroleum saved.)	—	3,274 jobs created
Local jobs created by the construction of thermal power plants to produce electrical energy equivalent to that saved by 34% conservation <sup>2</sup> (28 billion Btu's)	1,167 jobs created	—
Local jobs created by the import of natural gas and petroleum supplies equivalent to that saved by 34% conservation (82 billion Btu's)	Insignificant	—
<b>Total Job Losses</b>	<b>22,355 jobs lost</b>	<b>2,276 jobs lost</b>

<sup>1</sup> Based on ratio between cost of conservation in the residential and commercial sectors and the jobs created by that expenditure. See Bonneville Power Administration Electric Energy Conservation Study, Skidmore, Owings & Merrill, July 1976, page 306. The total cost of installing conservation measures in the residential and commercial sectors in the Portland SMSA would be \$570 million by 1995. This expenditure would produce 1,940 jobs per year or one job per 23.6 billion Btu's saved. Jobs created due to conservation in the combined industrial, commercial, and residential sectors were estimated by applying the one job per 23.6 billion Btu's saved to the combined Btu savings in all three sectors. Cost estimates for conservation measures in the industrial sector were not available.

<sup>2</sup> Based on estimate of jobs created by building thermal power plants, in Bonneville Power Administration Electric Energy Conservation Study, page 306.

Source: Portland, City of. Energy Conservation Choices for the City of Portland - Volume 3: Summary of Conservation Choices. Washington D.C.: U.S. Government Printing Office, September 1979.

Figure 8: Impacts of Energy Price Rises on Jobs in 1995

- save up to 30% of the energy required to space heat homes involved in the program,
- save the equivalent of 100,000 barrels of oil per year, or enough energy to space heat almost 8000 well-insulated Springfield homes,
- over the 25 year life of the bonds , save Springfield residents more than \$200 million in avoided energy costs (1981 dollars),
- repay the initial conservation investment in less than 4 years,
- provide Springfield residents with an additional \$3.0 million per year (1981 dollars), after repaying their initial conservation investment, to spend on additional goods and services, and
- enable participating Springfield residents to repay the loans directly out of the energy cost savings attributable to the conservation measure.

Energy Savings. According to work done by University of Illinois: Small Homes Council - Building Research Council and by Energy Extension Service of INR, installing 10 inches of insulation in an average 600 square foot uninsulated attic would yield energy savings of 33.6 million BTU per year -- roughly 30 percent of the energy used to space heat such a home (Illinois INR, 1981).

Dollar Savings. The cumulative energy savings between 1981 and 2005 was determined to be worth more than \$200 million (constant 1981 dollars). This dollar savings was based on the price projections derived by Dr. Al Casella in a report entitled: Springfield Energy Project: Preliminary Energy Audit of the City of Springfield. According to Casella's

projections, the prices of residential fuels would increase at the following rates for the period 1980-2000 (Illinois INR, 1981, p.45).

Natural Gas	10% p.a. from \$3.15/10(6) BTU in 1980
Propane	7% p.a. from \$11.29/10(6) BTU in 1980
Electricity	6% p.a. from \$10.23/10(6) BTU in 1980

Dollar Costs. Savings must be compared with program costs to establish the program's feasibility. It was estimated that it would cost approximately \$550, including labor, to insulate a single 600 sq ft attic with 10 inches of fiberglass insulation, assuming that there is access to the attic (Illinois, 1981). This \$550 cost per unit multiplied by the 17,500 dwellings equals a total cost of \$9.6 million, excluding administration costs.

Economic Benefits. At current energy prices the annual energy dollar savings were estimated to be roughly \$2.15 million per year. Taking into consideration the projected energy price increases, the payback period would be about 3.9 years (Illinois INR, 1981). After repayment of the loan and considering energy price increases, energy savings were predicted to be worth about \$3.1 million per year. The program would lead to an increase in the disposable income of the local residents equivalent to the cost of energy saved and an additional economic benefit resulting from the \$5.3 million spent on labor to install the insulation. This

translates into 200 person years of employment or an average of 40 jobs over a five year period. Finally, the remaining \$4.3 million which would be spent for materials is another local expenditure made to local merchants for supplies (Illinois INR, 1981).

The above study provides a good explanation of program costs and savings. However, little explanation is given for the economic benefits which are suggested in the report. Assumptions are made with no reference to their origin.

#### 2.4 GROUP 3 - ANALYSIS OF EFFECTS ON THE LOCAL ECONOMY

This final group of case studies goes beyond program costs and savings to evaluate effects of community energy plans and programs on the local economy. These communities provide the methodologies used to determine broader economic effects. Each considers different economic effects and provides various means for deriving the effects.

##### Bridgeport, CT

The Greater Bridgeport Regional Planning Agency (GBRPA) performed a Systemic Options Assessment as a means of evaluating energy strategies outlined in their CCEMP Plan. Using a procedure prescribed by Argonne National Laboratory (ANL), this assessment identifies and evaluates several impacts associated with the energy strategies of the GBRPA.

For the purposes of this study, only the economic impacts will be discussed here.

Economic impacts were divided into three categories for this assessment: energy dollars saved, implementation costs, and employment and income impacts. A summary of the results is shown in Table 9. Although the results are noteworthy, it is the methodology used to obtain the results, which is of prime interest here. The following explains how these results were achieved.

Energy Dollars Saved. The energy strategies would include conservation of energy and use of renewable sources, resulting in a future decrease in the amount of fuel consumed. Dollar savings were derived by multiplying the estimated reduction in fuel by its unit cost. The expected reduction in energy consumption for the program implementation period of five years was divided by five (20 years for solar-related measures) to derive annual savings estimates. Annual savings were then multiplied by fuel price estimates (shown in Table 10), which are based on several different sources.

Implementation Costs. Total implementation costs were taken from the Regional Strategies Report. These costs were assumed valid and adjusted for inflation in the following manner (GBRPA, 1982, p.36):

- Assume annual inflation rate of 8%

TABLE 9  
Summary of Economic Impacts

Strategy	First Year Economic Impacts				
	Benefit/Cost Ratio	Employment		Disposable Income	Multiplier Effect
		Direct Labor	Indirect Labor		
*Bridgeport land-fill gas recovery	0.35	1	7	\$ 102,720	\$ 451,970
*Bunnells Pond hydroelectric generation	0.18	7	1	102,720	451,970
*Boston Ave. Industrial Park cogeneration	0.89	74	22	1,232,640	5,423,620
*Passive solar*	1.73	1	3	51,360	225,980
*Solar hot water*	0.84	3	2	64,200	282,480
*Photovoltaics*	3.82	2	13	192,600	847,440
*Industrial solar process heat*	NA	NA	NA	NA	NA
*Residential					
-no cost	NA	NA	NA	NA	NA
-low/mod.cost	1.22	14	16	385,200	1,694,880
-high cost	0.21	256	105	4,635,240	20,395,060
*Transportation					
-fleet efficiency	0.88	22	46	873,120	3,841,730
-VMT reduction	0.07	31	31	796,080	3,502,750
*Industrial					
-small firms	0.28	23	10	423,720	1,864,370
-large firms	0.03	61	25	1,104,240	4,858,660
-Comprehensive Business Energy Service	691.70	1	108	1,399,560	6,158,060
*Commercial					
-private sector	0.23	31	12	552,120	2,429,330
-municipal sector	0.08	29	12	526,440	2,316,340
Total	0.51	556	413	\$12,441,960	\$54,744,640

\* To be phased in over a 20-year period.

Source: Greater Bridgeport Regional Planning Agency.  
"Systemic Options Assessment." June 1982.

TABLE 10  
Resource Energy Fuel Prices

	Electrical Utility \$/Brl	Home Heating Oil \$/Gal	Natural Gas \$/MCF	Gasoline \$/Gal
1980	\$30.00*	\$1.036*	\$3.07*	\$1.330*
1981	34.00*	1.243*	3.73*	1.350*
1982	30.00*	1.229*	4.59**	1.360*
1983	30.00**	1.229**	5.55**	1.360**
1984	32.70**	1.340**	6.38**	1.458**
1985	35.97**	1.474**	7.34**	1.575**

\* Based on available data sources:

- o Electrical Utility: United Illuminating Company Report to the Siting Council, March 1982 and testimony for coal conversion proposal.
- o Home Heating Oil: State of Connecticut Office of Policy and Management, Energy Division #2 Heating Oil Mointoring Report, Nov. 1980 - June 1982.
- o Natural Gas: Southern Connecticut Gas Company Connecticut Energy Corporation 1981 Annual Report
- o Gasoline: Greater Bridgeport Regional Planning Agency Regional Energy Strategies Report Comprehensive Community Energy Management Program, Volume III, January 31, 1981.

\*\* Projected fuel prices based on best estimates of price increases:

- o Electrical Utility: United Illuminating Company Testimony for coal conversion proposal Residual oil prices are expected to increase: 1983 = 0%; 1984 = 9%; 1985 = 10%
- o Home Heating Oil: Assumed same annual price increase as for residual oil
- o Natural Gas: Energy User News, Vol. 17, No. 21 EUN's energy users price increase survey: 1982 = 23%; 1983 = 21%; 1984 = 15%; 1985 = 15%
- o Gasoline: Assumed an inflation rate of 8%

Source: Greater Bridgeport Regional Planning Agency.  
"Systemic Options Assessment." June 1982.

- First year costs = total costs / 5
- Second year through fifth year = first year cost x 1.08
- Total costs = first year costs + second year costs +  
.... + fifth year costs

Employment and Income Impacts. The GBRPA energy strategies include three types of measures. First - low, medium, and high cost conservation measures in the residential, transportation, industrial, and commercial sectors. Second, an integrated community energy system consisting of the development of alternative energy sources. Finally, renewable energy options which are all solar related. For each measure, the direct labor impact, indirect labor impact, and induced impact on disposable income, was derived from the total investment in the measures. What seems to be an overstated multiplier of 4.4 was then applied to disposable income. The following assumptions and methodology are based on information provided in other sources and were used by GRBPA to derive the impacts summarized in Table 9 (GBRPA, 1982, pp.36-37).

Assumptions:

- Total on-site labor is estimated at 18.7 labor years per million dollars of investment
- Induced labor for the manufacture and purchase of material is estimated at 10.6 labor years per million dollars of investment
- 41% of investment is for salary and wages

- 59% of investment is for material and products
- 40 hours per week, 52 weeks per year
- \$8.23 per hour average wage rate
- 25% tax bracket
- Income Multiplier equals 4.4

Methodology:

- Direct labor = total investment x .41 x 18.7 / 1,000,000
- Indirect labor = total investment x .59 x 10.6 / 1,000,000
- Indirect labor = shift from energy consumption x 20 - 1,000,000 (shift in energy dollars)
- Average annual income = 40 hr x 52 wk x 8.23
- Disposable income = Average annual income x (1-.25)
- Income multiplier = 1 / (1-MPC)
- MPC = total personal consumption - total personal income

Sources:

Regional Energy Strategies Report, Greater Bridgeport Regional Planning Agency, January 1982.

Survey of Current Business, U.S. Department of Commerce, January 1982.

Macroeconomics John Lindauer, 1971.

Bridgeport Labor Market Review, Connecticut Labor Department Employment Securities Division, May 1982.

Bridgeport offers no explanation of how they arrived at their assumptions other than referring to sources which are

not properly footnoted. Data such as the multiplier and labor per million dollars of investment are key variables which seem to have been pulled from one of the four listed sources. Such a lack of explanation and documentation greatly reduces the validity of the analysis.

### Boulder County, CO

Boulder County is concerned with the growing number of dollars which leave its local economy to pay for energy imports. Stemming from this concern, an Energy Assessment was prepared by the County Department of Community Action Programs to determine the economic impacts of local energy consumption. By examining energy consumption patterns, the Department discovered that \$217 million were spent in 1981 for energy imports. Of that, \$195 million left the local economy. This economic drain was translated into 6,400 potential jobs being lost to the local economy.

To determine the economic impacts involved, the Assessment first examined past energy consumption. The total bill for the County was then computed by simply multiplying energy consumption by the unit cost of energy.

Next, the Assessment determined the fate of the County's energy expenditures. Most of the local energy dollars left the economy to pay distributors of fuel. To determine what this economic drain was, the study first

calculated energy dollars retained. To do this, the following procedure was used (Boulder County DCAP, 1981, p.30):

- Number of employees working for power suppliers was multiplied by an average personal income, yielding \$10,190,000 of wages earned by utility employees (assume wages are spent locally).
- It was assumed that all of the property taxes paid by utilities stayed in the local economy (\$2,001,253 was the amount on record at the County Treasurer's Office).
- For gasoline expenditures, the wholesale portion of the retail price is exported and markup over the wholesale price remains to pay wages, insurance, mortgage, etc. Using this assumption, it was calculated that \$5,845,000 or 10% of the total gasoline purchases remained in the County.

The Assessment went on to determine what this dollar loss meant in terms of jobs. To do this, assumptions were based on a study done for the Council on Economic Priorities, which indicated average household expenditures for various goods and services support 50 jobs for each \$1 million spent. Next it was assumed that a mix of electricity, oil, and natural gas supports 18 jobs for every \$1 million spent (Buchsbaum and Benson, 1979). Based on these assumptions, it was estimated that the retention of each \$1 million energy dollars through reductions in consumption would result in a net gain of 32 jobs. The \$200 million drain from the economy due to energy costs thus represents a loss of an estimated 6400 jobs.

The calculation for dollars retained in the local economy seems reasonable and arrives at a rough estimate. However, the estimate for loss of jobs, is of questionable validity since it has assumptions picked from a national study having no particular relevance to the Boulder County economy.

#### Philadelphia, PA

Economics is given as the major reason for the development of the Philadelphia CCEMP Plan. Concerned with growing energy expenditures of which only "20 cents on the dollar remain in the economy" (Daspit, 1981, p.1), Philadelphia proceeded to develop their Action Plan.

It was not possible for Philadelphia's CCEMP project team to quantify the economic effects of all the formulated program strategies. However, a study was done to quantify the benefits of a program to make Philadelphia's housing stock more energy-efficient over the next 10 years. This study was performed for Philadelphia by the Wharton Econometric Forecasting Association (WEFA). It was an attempt at modeling the effects of conservation policy on the local economy. The following describes the assumptions behind the analysis which produced the results shown in Figure 9 .

	<u>Employment (Man-years)</u>	<u>Personal Disposable Income</u>	<u>Net Savings From Cons.</u>	<u>Total Discretion- ary Income**</u>	<u>Gross City Product</u>
1981	10	.1	.4	.6	.3
1982	349	4.5	1.3	5.8	10.8
1983	918	11.6	3.4	15.0	30.8
1984	1,263	15.9	5.9	21.8	45.5
1985	1,233	15.5	8.9	24.3	46.2
1986	1,282	16.4	13.4	29.8	47.4
1987	1,558	20.2	22.3	42.5	56.8
1988	1,785	23.3	31.1	54.5	66.1
1989	1,865	24.5	40.1	64.6	70.1
<u>1990</u>	<u>2,083</u>	<u>27.9</u>	<u>49.0</u>	<u>77.0</u>	<u>77.1</u>
10 yr.	12,346	159.8	175.9	335.7	451.1

\*Sums may not check because of rounding.

\*\*Personal disposable income plus net savings from conservation.

Source: Court Dasplit. "Philadelphia's Energy Future: A Recommended Action Plan." City of Philadelphia, October 1981.

Figure 9: Economic Impacts - Policy Compared to WEFA Baseline, 1981-1990

WEFA simulated three scenarios which present a range of possible energy futures for Philadelphia. The first scenario, WEFA Baseline, assumes an amount of conservation expected from existing energy programs and price increases. The next scenario, Low Baseline, assumes a higher level of consumption than that of the WEFA Baseline scenario. This represents the perception of CCEMP staff that there was a decreasing degree of voluntary conservation in response to high energy prices occurring in the city. The final scenario is the Policy Scenario, which shows the level of energy savings achievable, assuming that target levels of conservation improvements of the programs recommended by the CCEMP report are reached.

Economic Effects. The model used by WEFA applies three effects to the scenarios which are expected to occur as a result of the energy conservation program. First, there will be an increase in contract construction. The model measures the expected employment increase by dividing total wages by forecast wage rates for that particular industry. Next, there will be a change in discretionary income. Those people who invest in conservation will eventually have more money for non-energy expenditures. This change can be measured the same as a change in disposable income (personal income less taxes) and is expected to have the same effect

on the economy. Finally, the model considers those effects resulting from reduced revenue of local energy suppliers. "The variation from the baseline in retail oil sales is also a direct input into the model" (WEFA, 1981, p.47).

Assumptions. The data necessary to simulate these effects was collected and calculated by both the CCEMP staff and WEFA. The following describes how the data was derived. The CCEMP staff was responsible for the assumptions in the model concerning housing stock. They estimated that 80% of row and semidetached housing stock of Philadelphia would be affected by conservation measures. The other 20% was excluded to allow for derelict buildings which would not be included, and because the benefits would mostly affect owner occupied units.

CCEMP staff was also responsible for determining the mix of conservation measures. After considerable analysis in this area, the staff specified nine conservation measures and the penetration factor expected for each; the results are shown in Figure 10 .

Finally, the CCEMP staff was responsible for making assumptions about the financing available. CCEMP developed a list of funding sources, terms of the loans and amount available from each. To estimate the conservation investment, they assumed that all of the financing available

<u>Measure</u>	<u>Penetration Factor<sup>a</sup></u>	<u>Target No. of Installations</u>	<u>Billion BTU's Saved<sup>b</sup></u>	<u>Percent Contribution to Total</u>
1. Clock thermostat	.54	188,600	1037	7.0
2. Storm windows/doors	.45	157,100	4100	27.5
3. Attic/roof insulation	.45	157,100	2592	17.4
4. Wall insulation	.17	59,400	1414	9.5
5. Moveable window insulation	.285	99,500	1015	6.8
6. Solar wall	.015	5,200	78	0.5
7. Solar domestic hot water	.075	26,200	555	3.7
8. Vent dampers (gas heat)	.45	157,140	1760	17.9
9. Burner modification (oil heat)	.27	93,300	933	9.6

a. The total of 436,500 row and semidetached buildings in Philadelphia was discounted by 20 percent to allow for abandonment and for deteriorated structures which are unlikely to be improved. The penetration factors shown were applied to the resulting universe of 349,200 buildings. Penetration factors are the product of the estimated proportion of structures to which the measure is applicable (15 to 90 percent) and its estimated consumer appeal (10 to 90 percent).

b. At 66 percent seasonal efficiency. The WEFA analysis actually assumed average efficiencies increasing over the decade from .63 to .7 (gas) and from .53 to .65 (oil).

Source: Court Dasplit. "Philadelphia's Energy Future: A Recommended Action Plan." City of Philadelphia, October 1981.

Figure 10: Economic Impacts - Target Penetration Levels

would be used under the Policy Scenario plus a fraction more which would be the result of price induced conservation financed by personal savings. The amount of resulting conservation levels achieved by 1990 under the Policy Scenario is over 97% of the target penetration. Under the WEFA Baseline it is 58%, and under the Low Baseline it is 19%.

WEFA derived the fuel price forecasts which are applied to the scenarios. The effect of fuel price changes on energy consumption levels will have a major impact on the analysis. The fuel price forecasts as derived by WEFA, required technical analysis which can not be adequately expanded on here.

Philadelphia, with the aid of consultants, was able to produce many reports leading to their Final Action Plan. Much of the analysis done required the use of sophisticated econometric computer models which are explained in the reports, but require knowledge in this area to understand and interpret. Such indepth analysis may produce more accurate data, but is very expensive and may not always be necessary for program implementation.

#### Los Angeles, CA

The CCEMP Energy/LA Action Plan is the result of several extensive studies carried out by Energy/LA Project

Staff and outside consultants. The Plan stemmed from the City of Los Angeles desire for better energy management after having faced energy shortages in the 1970's. The Plan goal is for an additional 21% reduction in energy use through: 1) more efficient use of existing, conventional energy supplies, and 2) development of local energy sources. Several energy efficiency measures are proposed and evaluated in the Plan. One half of the energy reduction goal is expected to be achieved by making existing homes and workplaces more efficient. Another quarter of the goal is attributed to the use of alternative energy sources. The final quarter of the goal is expected from the combined effect of transportation measures, and increased efficiency in new construction.

The Plan projects that the implementation of energy efficiency measures will result in a reduction in LA energy bills by \$790 million in the year 1990 alone, at an annual cost of \$301 million, creating a net savings of \$489 million (Los Angeles, 1981, p. 35). Such an energy and subsequent dollar savings is projected to create 9,500 jobs during the 1982-90 implementation stages, and 14,031 jobs afterwards. This Plan is expected to allow Los Angeles to meet 1990 energy needs more cheaply and provide significant job and air quality benefits. The following is an examination of

how the Energy/LA Project Staff calculated potential jobs, and energy and dollar savings resulting from the energy efficient measures described in the Plan.

Energy Savings. Estimates of net 1990 energy savings are shown in Figure 11 by fuel type and the sectors in which proposed energy efficient measures are to be implemented. Within the residential sector, for example, energy efficiency measures are directed toward 1) new dwellings, 2) retrofit of existing dwelling, and 3) the use of solar in heating swimming pools, conversion of electric hot water heaters to solar, and a city ordinance mandating solar water heaters in all new homes (when feasible) built after 1982. There are also energy savings resulting from alternative sources of energy (see Figure 12). The energy savings resulting from the specific elements of the plan were derived through a number of staff and consultant technical studies.

Unit Cost of Energy Efficiency Measures. A cost comparison between the expected 1990 energy efficiency measures and electricity generation and natural gas prices is shown in Figure 13 . A comparison such as this provides a measure of cost effectiveness which can be very useful in deciding which route to take. The methodology used to derive the unit cost is provided in the following formulas (Los Angeles, 1981, p.101):

SECTOR	ELECTRICITY			NATURAL GAS			FUEL OIL, GASOLINE OR DIESEL			Total Action Plan Net Savings (TBTU)
	Action Plan Gross Savings (Primary TBTU)	DWP Projected Savings (Primary TBTU)	Action Plan Net Savings (Primary TBTU)	Action Plan Gross Savings (TBTU)	SoCal Gas Projected Savings (TBTU)	Action Plan Net Savings (TBTU)	Action Plan Gross Savings (TBTU)	Other Program Savings (TBTU)	Action Plan Net Savings (TBTU)	
Residential*										
New	1,104	.062†	1,042	1,467	.066	1,401	N/A	N/A	N/A	2,443
Retrofit	3,404	.021†	3,383	19,601	1,221	18,380	N/A	N/A	N/A	21,763
Solar	.407	.059††	.348	5,928	2,964	2,964	N/A	N/A	N/A	3,312
Commercial										
New	7,842	0†††	7,842	0	0	0	N/A	N/A	N/A	7,842
Retrofit**	23,597	12,016	11,581	8,105	3,984	4,121	.393	0	.393	16,095
Industrial										
Retrofit**	6,183	1,508	4,675	2,462	2,056	.406	1,739	0	1,739	6,820
Public Retrofit**	2,484	1,265	1,219	1,042	.453	.589	.069	0	.069	1,877
Transportation††††	N/A	N/A	N/A	N/A	N/A	N/A	27,740	13,870	13,870	13,870
<b>TOTAL</b>	<b>45,021</b>	<b>14,931</b>	<b>30,090</b>	<b>38,605</b>	<b>10,744</b>	<b>27,861</b>	<b>29,941</b>	<b>13,870</b>	<b>16,071</b>	<b>74,022</b>

\*DWP residential savings are 456 GWh between 1982 and 1990 (inclusive) but are the result of different programs than those in the Action Plan. Since DWP programs do not overlap those of the Action Plan, these savings cannot properly be subtracted from the Action Plan gross savings.

\*\*Action Plan gross savings for this sector are the Mello Bill 1985 goals of 33% and 15% reductions from 1979 consumption for the commercial (and public) and industrial sectors, respectively.

†Electricity savings due to SoCal Gas programs.

††Estimated savings from the DWP solar water heater program.

†††Savings included in commercial retrofit.

††††See programs listed in Okazaki, "Implementation Plan for Transportation Energy Management," Energy/LA, November, 1980.

Source: Los Angeles, City of. "Energy/LA Action." July 1981.

Figure 11: Calculation of the Net 1990 Energy Savings

SOURCE	CAPACITY (MW)	CAPACITY* FACTOR (%)	ANNUAL ELECTRICITY PRODUCTION (10 <sup>6</sup> KWH)	COMMENTS
Cogeneration	300	80%	2103.27	Natural gas fuel assumed to be used for heat load only.
Waste	39	70	238.88	Two 19.5 MW units
Wind	10	35	30.66	
Fuel Cells	1	85	7.45	Natural gas fuel subtracted from Action Plan gas savings
Photovoltaic	10	23	20.00	Dispersed arrays
Total	360	N/A	2400.26	N/A

\*A capacity factor represents the ratio of energy produced to the energy which would be produced if operation was at 100% of rated capacity for every hour of the year.

Source: Los Angeles, City of. "Energy/LA Action Plan."  
July 1981.

Figure 12: Capacity and Energy Production from Alternative Sources of Electricity

- Annual investment = capital recovery factor x investment
- Capital recovery factor =  $d / 1 - (1+d)(n)$ , where "d" is the discount rate and "n" is the finance period (assumed here to be equal to the measure's lifetime). A real discount rate of 5% was used. The discount rate of 5% is based on an interest rate of 18% and an expected inflation rate of 13%.
- The cost of an energy efficiency measure, per unit of energy is: cost of efficiency = annual investment / annual energy savings or,
- Cost of efficiency = capital recovery factor x investment/annual energy savings

For the transportation sector, cost per gallon is derived by converting the projected transportation savings from BTU's to gallons. This figure is then divided into the annual program cost, yielding a cost in dollars per gallon.

Job Creation. Energy measures can create jobs in two ways: first, through direct spending on energy measures, and second, through the increase in income which occurs when energy is saved. "Gross capital jobs" indicated in Figure 14 is the employment generated by spending on a particular energy measure. To calculate the "gross capital jobs", the dollar amount to be spent on each measure is multiplied by an employment generation factor, or by the number of jobs created per million dollars of spending. The employment generation factor for each measure was derived from an input-output model performed for Los Angeles by the Regional Economics Group (1980). This factor indicates the number of

Sector/ Measure	Lifetime of Measure	Capital Recovery Factor	Capital Cost (10 <sup>6</sup> 1980 \$)	Capital Cost Allocated to Electricity* Savings (10 <sup>6</sup> 1980 \$)	Capital Cost Allocated to Gas Savings (10 <sup>6</sup> 1980 \$)	Elec- tricity Saved in 1990 (10 <sup>6</sup> kWh)	Gas Saved in 1990 (TBTU)	Cost of Measure (\$/KWH in 1980 \$)	Price of IPP Elec- tricity in 1990 (\$/KWH in 1980 \$)	Cost of Measure in 1980 \$	Price of SoCal Gas in 1990 (\$/ Therm in 1980 \$)
Residential											
New	30	.0651	\$113.9	\$23.8	\$ 90.1	104	1.40	\$.0149	\$.0438	\$.422	\$.632
Retrofit	10	.1295	390.0**	97.0	293.0	340	19.54	.0393	.0438	.211	.632
Solar	20	.0803	139.3 +1.3†	5.0	134.3	35	2.96	.0128	.0438	.405	.632
Commercial											
New	30	.0651	0	N/A	N/A	786	0	0	.0438	N/A	.676
Retrofit	12	.1129	357.0	166.8	173.6	1160	4.12	.0162	.0438	.476	.676
Industrial											
Retrofit	10	.1295	18.2	7.8	10.4	468	.41	.0022	.0438	.331	.779
Public											
Retrofit	12	.1129	1.0	.4	.6	122	.59	.0004	.0438	.105	.676
All Measures Combined	N/A	N/A	\$1020.7	\$300.8	\$702.0	3015	29.02	\$.0117	\$.0438	\$.278	\$.676

\*Electricity savings computed on a delivered basis.  
\*\*This amount is higher than the one given in Figure 16, because for this figure all retrofit measures were assumed to be contractor-installed, rather than partially owner-installed.  
†Annual operation and maintenance expense.

Source: Los Angeles, City of. "Energy/LA Action Plan. July 1981.

Figure 13: Unit Cost of Energy Efficiency

jobs created per million dollars of spending. From the "gross capital jobs" is subtracted the number of jobs which would be created if the money to be spent on the measure was spent on the ordinary basket of consumer goods resulting in the "net capital jobs". The employment generation factor for consumer spending used here is 21.50 person years per million dollars spent.

Operation and maintenance jobs are also calculated net of the job impact of ordinary consumer spending. Respending of money saved on energy expenditures does not require an adjustment for ordinary consumer spending.

Finally, it was noted by Energy/LA Project Staff that no jobs are displaced in the utility industry as a result of energy efficiency measures.

Due to efforts by the Project Staff, and outside consultants, extensive studies have been done to determine the effects of energy programs. The results shown in the Action Plan provide significant evidence of the economic benefits of energy programs. The Energy/LA Action Plan was adopted in December 1982; it represents the most comprehensive approach taken by any of the CCEMP communities. The American Planning Association awarded the Energy/LA Action Plan with its Outstanding Planning Program Honor Award in recognition of this "comprehensive plan to guide public policy" (Planning, May 1983, p. 19).

SECTOR AND MEASURE	CAPITAL COST* (1977 \$) 10 <sup>6</sup>	EMPLOYMENT GENERATIONS FACTOR (PERSON-YEARS/1977\$)	GROSS CAPITAL JOBS (1982-90) (PERSON-YEARS)	NET CAPITAL JOBS (1982-90) (PERSON-YEARS)	ANNUAL OPERATION AND MAINTENANCE COST (1977\$)	ANNUAL OPERATION AND MAINTENANCE JOBS (PERSON-YEARS)	ANNUAL RESPONDING (NET** DOLLAR ENERGY SAVINGS (10 <sup>6</sup> 1977\$))	ANNUAL RESPONDING JOBS (PERSON-YEARS)	ANNUAL RESPONDING PLUS OPERATION AND MAINTENANCE JOBS (PERSON-YEARS)
RESIDENTIAL									
NEW	\$ 89.6	52.87	4,737	2,803	0	0	\$ 10.2	220	220
RETROFIT	241.1	55.40	13,357	8,152	0	0	110.5	2,385	2,385
SOLAR	109.6	48.84			2.6	54	14.1	304	358
COMMERCIAL									
NEW	0	---	0	0	0	0	41.1	888	888
RETROFIT	254.8	37.57	9,571	4,070	0	0	65.5	1,845	1,845
INDUSTRIAL									
RETROFIT	9.6	55.50	533	326	***	***	38.9	840	840
PUBLIC	.8	37.57	30	13	0	0	10.0	216	216
TRANSPORTATION	11.6	48.58	564	314	.4†	20	149.6	3,230	3,250
TOTAL	\$717.1	N/A	28,792	15,678	3.0	74	\$459.2	9,928	10,002
ALTERNATIVES									
COGENERATION	\$143.2	55.50	7,945	4,854	\$57.3	1,983	131.8	1,608	3,591
WASTE	63.6	55.50	3,531	2,157	.1	50	14.9	322	372
WIND	10.6	63.82	676	447	--	--	1.9	42	42
FUEL CELL	.3	41.09	14	7	.6††	8	-.6	-13	-5
PHOTOVOLTAIC	4.0	59.58	241	154	.1	4	1.2	25	29
TOTAL	\$221.7	N/A	12,407	7,619	\$61.1	2,045	\$149.8	1,984	4,029
GRAND TOTAL	\$938.8	N/A	41,199	23,297	\$64.1	2,119	\$609.0	11,912	14,031

\* Does not include finance cost.  
\*\* Net of operation and maintenance cost.  
\*\*\* Included in capital cost.  
† Labor only (estimated).  
†† Includes fuel cost.

Source: Los Angeles, City of. "Energy/IA Action Plan." July 1981.

Figure 14: Job Impact of Energy/IA Action Plan on Los Angeles County in 1990

## Chapter III

### DISCUSSION OF CASE STUDIES

The Chapter II, case studies were presented to examine the degree of economic analysis which has been included in energy plan and program development. Table 11 provides summary information on each of the communities discussed in the case studies; it should be referred to throughout the following discussion. It indicates the type of energy planning effort which each community has undergone, the degree of economic analysis provided, and what implementation has occurred. This Chapter is a discussion of the conclusions which can be drawn from the information provided in the case studies. The discussion focuses on three questions which address the extent of economic analysis performed by communities; the influence of economic analysis on plan or program implementation; and the projected effects of plans and programs on the local economy.

Economic analysis in energy planning, as stated in Chapter I, includes both program cost effectiveness and effects on the local economy, or economy effects. The cost effectiveness of an energy plan or program can be determined through one of the following techniques: payback, cash

TABLE 11

## Summary Information On Case Studies

	Type Of Energy Planning Effort			Degree Of Econ. Analysis		Implem.	
	Specific Program	Comp. Plan	Studies	Cost Effect.	Economy Effects	Adopt	Program Implem.
St. Paul, MN		X		E	O	X	X
Austin, TX		X		E	O	X	X
Davis, CA	X			O	O		X
Ann Arbor, MI		X		E	O	X	X
Oceanside, CA	X			E	O		X
Ashland, OR	X			O	O		X
Palo Alto, CA	X			E	E		X
Greenville, NC*		X		E	E	X	
Knoxville, TN*		X		E	E	X	
Seattle, WA*		X		O	E	X	X
Richmond, IN*		X		O	O	X	
Dayton, OH*		X		O	O	X	
Janesville, WI*		X		E	O	X	
New York, NY			X	E	E	2	
Carbondale, IL	X			O	O		X
Eugene, OR	X			O	O	X	X
Santa Clara, CA	X			O	O		X
San Diego, CA	X			O	O		X
Boulder, CO*		X		O	O	X	X
Portland, OR		X		O	O	X	X
Springfield, IL			X	O	O	-	
Eridgeport, CT*		X		O	O	X <sup>2</sup>	
Boulder Co., CO			X	O	O	-	
Philadelphia, PA*		X		O	O	X	
Los Angeles, CA*		X		O	O	X	X

\* CCEMP Community

O No Data Given

E Data Provided, No Quantitative Analysis Given

O Data Provided With Limited Or Questionable Analysis

● Detailed Data And Analysis Provided

<sup>1</sup> Feasibility Study Done On Production Program Only<sup>2</sup> Conducting Further Study

flow, life cycle cost, or benefit/cost analysis. Economy effects include: direct on-site jobs, increases in local sales, increases in local income, and multiplier effects. These two components of economic analysis must be clear before the following discussion can be understood. Each of these will be discussed further in Chapter IV.

DO COMMUNITY ENERGY PLANNING EFFORTS IN THE U.S. REFLECT INDEPTH ANALYSES OF EFFECTS ON THE LOCAL ECONOMY?

Effects on the local economy are alluded to throughout the case studies, yet very few communities actually provide any quantitative analysis to verify their statements. For example, of the twenty-five studied only two communities, Los Angeles and Philadelphia, provided detailed economic analysis including study of both program cost effectiveness and economy effects. Los Angeles provided the most comprehensive approach to energy planning which included indepth economic analysis conducted on a wide range of programs. Employment effects were determined for Los Angeles by a consulting firm with the use of an input-output model. The analysis conducted by Philadelphia was also detailed, considering economy effects such as employment and income. Philadelphia also hired a consulting firm, which used an econometric model to determine economy effects. Philadelphia's effort appeared not to be as comprehensive

as Los Angeles' in that it only considered energy programs which affected the residential sector.

Five other communities (Bridgeport, Boulder County, Springfield, Portland, and Carbondale) also addressed economy effects; however, their analysis lacked documentation and explanation, creating uncertainty of the results. Finally, there were five communities (Palo Alto, Greenville, Knoxville, Seattle, and New York) which addressed economy effects but provided no analysis to back up their data. A total of only twelve communities addressed economy effects; however, most did so in a superficial manner.

Cost effectiveness of program proposals or options was addressed by twenty-two of the twenty-five communities. Only three communities: Ashland, Davis, and Boulder County did not provide any data on program cost effectiveness. Of the twenty-two communities, only four provided indepth analysis within their reports; they are: Santa Clara, San Diego, Philadelphia, and Los Angeles. There were nine others which provided analysis but it was somewhat weakened by the lack of documentation. Some of these communities, however, indicated that more indepth analysis was provided in separate technical reports. Finally, there were nine others which addressed program cost effectiveness but

provided no analysis within the available reports. Based on the available information provided by this investigation, it can be concluded that while most communities have addressed program or plan cost effectiveness to some degree, most energy planning efforts in the U.S. have not reflected indepth analysis of the effects of energy plans and programs on the local economy.

In-depth economic analysis such as that done by Los Angeles and Philadelphia may not always be necessary. Use of input-output and econometric models to analyse economy effects is very costly and time consuming, making it impractical for most smaller communities with limited resources. Alternatives must be made available to those communities who wish to examine the economy effects of their energy plans and programs without the expense and time which was allocated in the Los Angeles and Philadelphia CCEMP projects. The framework presented in Chapter IV might provide this alternative to communities.

DOES ECONOMIC ANALYSIS FACILITATE IMPLEMENTATION OF ENERGY PLANS AND PROGRAMS?

Implementation of energy programs is often dependent on a cost effectiveness study which demonstrates the potential benefits of a plan or program to the locality. While such a study is important, it alone cannot guarantee plan or

program implementation. A study of twenty-two community energy planning experiences conducted by Randolph, supported a notion of Corbett and Hayden (1980), that there are three key roles present in nearly all communities which have had success with implementation, including: "an articulate and committed elected official who pushed for program enactment; a planner or planning consultant who prepared supportive technical information (mostly cost effectiveness information), and a local energy constituency which provided community education and vocal support at the public hearings" (Randolph, 1982, p. 22). Such evidence points to the need for the other roles suggested above to be filled if program implementation is to occur.

Of the twenty-five communities studied here, twenty-two were successful in either plan adoption or program implementation or both. The other three: New York, Springfield, and Boulder County were only conducting studies and therefore were not striving for implementation at the time. Only those twenty-two communities which achieved implementation will be discussed in this section.

There is a distinction between program implementation and plan adoption. Of the twenty-two communities included here, fifteen achieved plan or program adoption. Adoption of a plan or program signifies community approval of the

concepts created in an energy plan or program. It also often establishes energy planning as a community goal which is usually added to the local comprehensive plan along with objectives and plans for further action. Plan or program adoption is only significant to the extent that specific programs or measures contained in the plan or program are later implemented. Only eight of the fifteen communities which have achieved adoption have moved toward program implementation. Many of the remaining seven, must still overcome certain political and funding obstacles to implementation. While program implementation creates more significant results, adoption must still be considered an important achievement in the political process toward action. The seven other communities which experienced program implementation did so without formal plan or program adoption.

All but two of the twenty-two communities achieving some implementation, Ashland and Davis, addressed cost effectiveness. It is possible that Ashland and Davis may have considered cost effectiveness but did not include it in the reports which were available. Further study would be necessary to determine this. Nine of the twenty remaining communities which addressed cost effectiveness did not include any analysis to verify the data presented. In many

cases the data was found to be useful in the implementation process, however, the technical analysis was simply not included in the reports which were reviewed.

Nine of the twenty-two communities which experienced implementation addressed economy effects. Of these, five (Palo Alto, Seattle, Carbondale, Portland and Los Angeles) were successful in program implementation and four (Greenville, Knoxville, Bridgeport and Philadelphia) achieved only plan or program adoption. The remaining thirteen communities did not address economy effects, yet were still successful in implementation. Four of those communities which addressed economy effects (Palo Alto, Greenville, Knoxville and Seattle) did so without providing any analysis to verify their data. Once again the analysis may be provided in a separate technical report; however, further study would be necessary to verify this possibility.

There is little conclusive evidence provided in the case studies which would support a claim that analysis of economy effects facilitates implementation. However, economic analysis as stated in the question posed in this section, includes both cost effectiveness and economy effects. It would therefore be reasonable to draw some conclusions about the effect of cost effectiveness analysis on implementation.

Economic analysis in the form of cost effectiveness studies was found to facilitate implementation in two previously mentioned studies (Corbett and Hayden, 1980; Randolph, 1982). The cases presented here serve to further illustrate the relationships between implementation and cost effectiveness studies. The information provided in this study can only lead to assumptions about the usefulness of cost effectiveness studies in program implementation.

Cost effectiveness studies seem to occur in most cases where there is to be a public expenditure, so as to prove the program's worthiness. Such studies may therefore be considered a "given" as they are often required before public expenditures for programs can be made. Studies of economy effects might provide an added selling point; however, further study would be necessary to determine the real effect of information on economy effects on program implementation. Economic analysis in the form of economy effects may be most useful when a program requires a large initial public expenditure with longer paybacks. If immediate benefits to the local economy can be shown in the form of jobs, the program might be more easily implemented.

TO WHAT EXTENT DO ECONOMIC ANALYSES CONDUCTED IN THOSE COMMUNITIES STUDIED SUPPORT THE CLAIM THAT COMMUNITY ENERGY PROGRAMS BENEFIT THE LOCAL ECONOMY?

Community energy programs are expected to benefit localities due to the effect of import substitution. Energy programs will reduce energy consumption; thereby, reducing energy imports and leakages of local dollars. The number of subsequent jobs created and the amount of increase in local income are questions to be addressed when examining the effect of energy programs on the local economy. Twelve of the 25 communities addressed economy effects. Five of these: Palo Alto, Greenville, Knoxville, Seattle, and New York, provided no analysis and very limited data within the reports which were examined. Another five: Carbondale, Portland, Springfield, Boulder County, and Bridgeport provided limited analysis which was based on other studies with little documentation or explanation. Each of these 5 concluded that there would be substantial employment and income benefits resulting from the proposed energy program. The only two studies among the five which provide reliable information on economy effects are Los Angeles and Philadelphia. Both of these communities relied on economic models for determining economy effects. The Los Angeles study indicated that implementation of energy efficiency

measures proposed in their Energy/LA Action Plan would reduce Los Angeles' energy bills by \$790 million in the year 1990 alone, at an annual cost of \$301 million, creating a net savings of \$489 million. This energy and dollar savings was projected to create 9,500 jobs during the 1982-90 implementation stages, and 14,031 jobs afterwards (see page 63). Philadelphia projected an increase in total discretionary income equal to \$336 million over the ten year implementation period. Total employment projected for the ten year implementation period equaled 12,346 (see Table 9). Both of these communities conducted sophisticated economic analysis to examine the effects of their energy programs on the local economy. Their results, although only projected estimates, provide some basis to support the often made claim that energy programs do benefit the local economy.

The degree of impact which these economy effects will have on a locality depends on several factors. The amount of dollars retained will of course depend on the energy savings which is achieved. Use of outside dollars, such as federal or state grant money, to implement a program will also result in greater economy effects. A program which is paid for entirely from within the community will have smaller effects; however, there will still be a stimulus to the local economy due to the effects of import substitution.

The projections given above are all that the case studies provided to support the claim that community energy programs benefit the local economy. While the benefits seem reasonable from an economic standpoint, no study has been done to determine actual effects on the local economy after program implementation. Further study in this area might be possible now that some energy programs have been in existence for several years.

## Chapter IV

### A FRAMEWORK FOR ECONOMIC EVALUATION IN ENERGY PLANNING

#### 4.1 INTRODUCTION

A general framework for performing an economic analysis of community energy plans and programs is developed in this Chapter. The framework is presented in phases or steps which can be followed depending on time, resources and personnel available to the community. Phase 1 examines energy economic audit data to determine the effect which present energy consumption levels have on the money available to the local economy. Program cost effectiveness is determined in Phase 2. Phase 3 examines the effect of energy programs on the local economy. A summary table of the equations presented in this Chapter is given in Appendix A. While the framework does not provide a highly technical approach to economic analysis; it is a reasonable means for a local government to quickly perform an economic analysis on their energy plans and programs.

#### 4.2 PHASE 1 - ENERGY ECONOMIC AUDIT DATA

This phase examines community energy consumption and relates it to energy dollars spent and how much of this leaves the local economy. Figure 15 illustrates the input necessary for Phase 1 analysis beginning with a community energy profile and the progression of steps which follows, including the total energy bill for a community and the percentage of energy dollars retained in or lost from a local economy.

The first step for many communities which approach community energy planning is to assess the local energy situation. The conventional approach is through a community energy audit. The audit determines the level of energy consumption (demand) by sector, and sources of energy supply by fuel type. The results will often demonstrate the need for action, and show where that action should be targeted. It also provides a baseline against which to compare future energy consumption. Energy programs can then be proposed which will best suit the specific needs of the local community.

There exist two energy audit methodologies which are commonly used by communities. The first is a simplistic approach provided in County Energy Plan Guidebook written by Okagaki and Benson (1979). This method is dependent on data

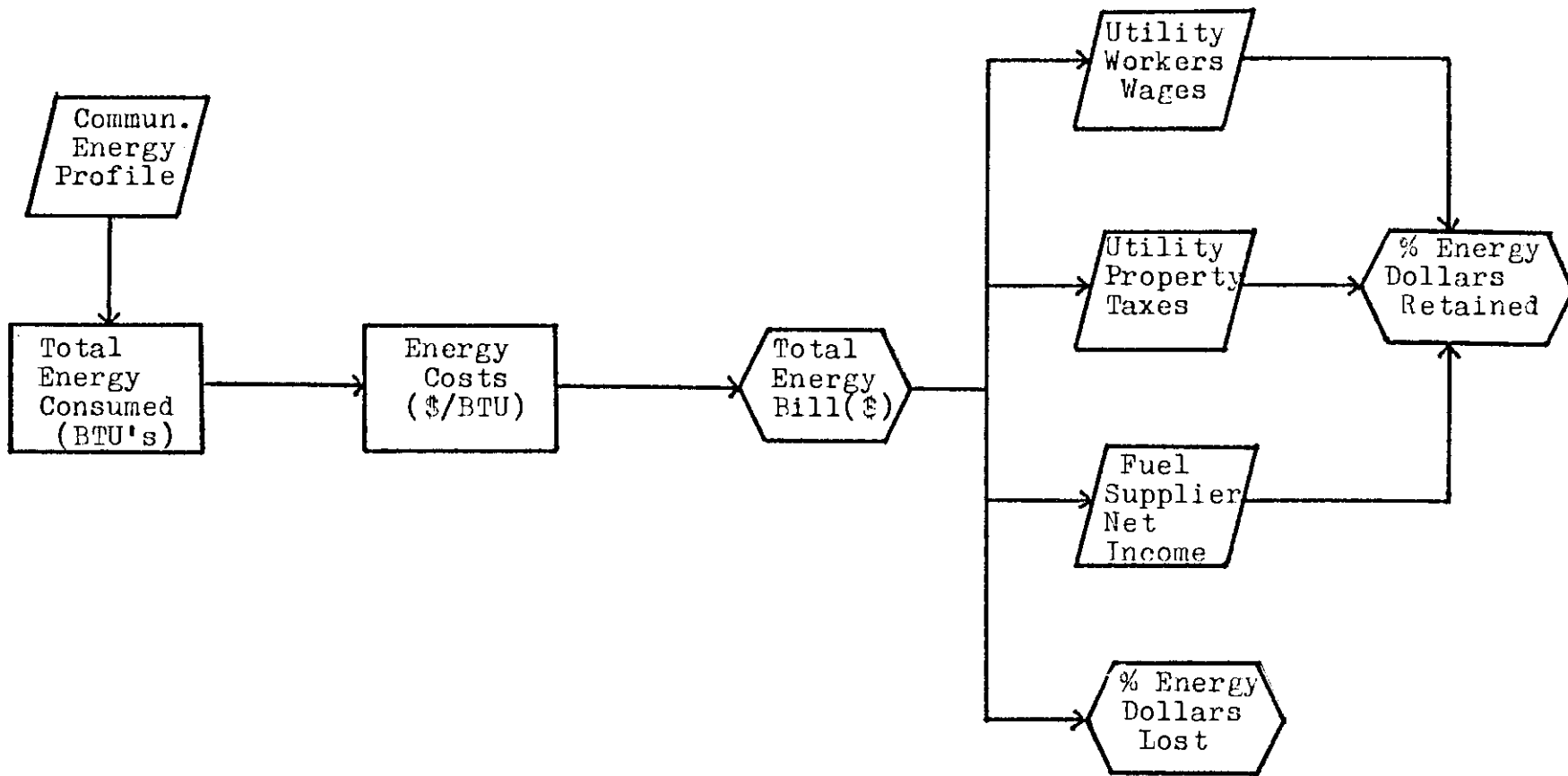


Figure 15: Phase 1 - Flowchart

aggregated at the state level and secondary census information which inherently contain inaccuracies when applied at the local level. A more comprehensive approach is found in the Hittman Methodology which was developed by Hittman Associates for CCEMP. It requires a significantly larger amount of time and money. The Hittman Methodology, or variations of it, was used by the CCEMP communities. There are lessons to be learned from the 2-3 year experiences of these 16 communities which were awarded grants by the U.S. Department of Energy to develop comprehensive energy management plans (Moore et al., 1981, p. 236):

"Spending a large amount of time and money on conducting a highly detailed, built-up audit may result in information that is too detailed for overview and general education purposes. In addition, communities found that the data gathered was not in a form useful for analysis of specific energy management actions."

"The implication is that for communities desiring to address a broad set of energy concerns, a general profile of energy use in various community sectors can provide sufficient information for setting policy and energy management objectives. Such a profile may be derived from utility records and from sampling for nonreported fuels, such as fuel oil. If needed, more detailed estimates of fuel consumption by end uses can be developed later."

The CCEMP experiences lead to the conclusion that community energy audits should be based primarily on information from utilities and fuel suppliers with perhaps some sample surveys being conducted to fill in the gaps.

The Dayton CCEMP experience provides a good example of the use of surveys to determine the community energy profile (Dayton, 1981). Once the energy profile for a community is determined, the steps outlined in the next two sections can then be included in the analysis.

#### 4.2.1 Total Energy Bill

The sum of expenditures for all fuel types in all sectors will equal the total energy bill. Ideally the calculation should be done to include past, present, and future energy costs. Each should be expressed in constant dollars using consumer price indices for energy as shown in Table 12 . To do this, the dollars for the year of analysis are divided by that year's price index and multiplied by the price index for the year for which the dollars are to be based, e.g. \$100 in 1982 is equivalent to \$56.1 in 1975 dollars ( $100/287.1 * 161.2 = \$56.1$ ). Constant dollars serve to negate the effect of inflation on prices, providing a better comparison of energy costs for various years.

Past, present, and future energy prices must be obtained to determine the total energy bill for a community. Past and present electric and natural gas prices can usually be obtained from the local utility company. Past and present oil prices can be obtained from local fuel

TABLE 12  
 Consumer Price Indexes of Fuels and Utilities: 1965 to 1982

[1967=100. Represents all urban consumers. A therm=100,000 Btu's. Annual averages for cities combined. See text, p. 452. See also *Historical Statistics, Colonial Times to 1970*, series E 203-211]

ITEM	1965	1970	1974	1975	1976	1977	1978	1979	1980	1981	1982, May
Consumer price index, all items.....	84.5	116.3	147.7	161.2	170.5	181.5	195.4	217.4	246.8	272.4	287.1
Fuels and other utilities.....	88.3	107.6	150.2	167.8	182.7	202.2	216.0	239.3	278.6	319.2	345.4
Gas (piped) and electricity.....	99.4	107.3	145.8	169.6	189.0	213.4	232.6	257.8	301.8	345.9	389.6
Utility (piped) gas.....	99.6	108.5	143.9	172.5	201.2	239.3	263.1	305.3	383.9	414.9	493.4
Gasoline, regular and premium.....	94.9	105.8	159.9	170.8	177.9	188.2	196.3	265.6	369.1	410.9	370.4
Electricity (composite).....	99.1	106.2	147.5	167.0	177.6	189.3	203.4	219.1	253.4	291.5	314.9
Fuel oil, coal, and bottled gas.....	94.6	116.1	214.6	235.3	250.8	283.4	298.3	403.1	556.0	675.9	644.6
Fuel oil No. 2.....	94.4	109.3	213.0	230.6	247.2	280.2	296.9	416.8	579.7	709.2	670.6
Telephone services, residential.....	100.8	102.5	121.4	125.3	128.6	131.3	132.8	132.4	135.7	147.7	161.6
Water and sewer service, residential.....	94.4	120.4	154.8	169.9	188.7	209.1	232.8	243.3	259.8	290.9	323.5

Source of tables 770 and 771: U.S. Bureau of Labor Statistics, *Monthly Labor Review*.

Source: U.S. Bureau of Labor Statistics, *Monthly Labor Review*.

suppliers. Future price projections will vary by locality for electricity, they should therefore also be obtained from the local utility. Natural gas and oil price projections can, however, be based on national data since they are more sensitive to national occurrences rather than local conditions. The Department of Energy is a good source for price projections.

Assuming energy prices can be determined for any year to be studied through the above mentioned sources, they should be expressed in constant present value dollars and used in the following equation to determine the total energy bill (TE) for the community:

$$TE = \sum_j \sum_k E_{jk} * P_j$$

where, E => energy consumption (in BTU's)

P => price of energy (constant \$/BTU)

j => fuel type

k => consumption sector

The total energy bill (TE) is calculated using the above formula for each year to be studied, and then is expressed in constant dollars using the method described above. To do this, the total energy consumption (E) in fuel type (j), consumption sector (k) is multiplied by the dollar price (P) per BTU of fuel type (j). The energy bill for all sectors and all fuel types is then summed to equal the total energy

bill (TE) for study year one which is then expressed in constant dollars. This type of calculation will also provide a breakdown of energy costs by sector and by fuel type which can be examined to determine where the greatest expenditures occur.

Calculating energy costs can serve many purposes. Comparing past and present costs will indicate the increase which has occurred in local energy expenditures. In many cases consumption will have decreased in the past few years; even so, costs will have increased, causing an overall increase in the community energy bill. Present energy costs will provide a base year from which to plan for future goals. Future costs will indicate the expected costs if existing trends were to continue. They will also serve as an indicator of possible savings in further calculations.

Finally, there is an important new meaning which occurs when energy usage is expressed in familiar dollar terms. Citizens and government officials are known to be more responsive to figures which indicate "millions of dollars spent" as opposed to "BTU'S of energy used." When expressed in dollars, energy usage and possible savings suddenly become a more crucial matter, necessitating immediate action.

#### 4.2.2 Percent Energy Dollars Lost From (or Retained in) the Local Economy

It was assumed by most communities, that on the average, 20% of the total money spent by a locality on energy, will be retained or recycled through the economy. The other 80% will go to pay fuel distributors, resulting in a major loss to the local economy. This substantial dollar drain, will increase with rising energy prices, necessitating a need for immediate action.

To estimate this dollar drain on the local economy, the number of local utility workers are multiplied by the average income of a utility worker. This equals the total wages earned, which are assumed to be spent locally. Added to this, is the amount paid in property taxes by the utility which is also assumed to be spent locally. Finally, dollars retained through gasoline expenditures is also added to the above. This is determined by subtracting the wholesale price paid by local distributors from the retail price, the result is the total markup which is assumed to be retained locally. The total of the above equals energy dollars retained which can be subtracted from the total energy bill to give dollars lost which can be expressed as a percentage of the total. The following provides a summary of the procedure necessary to determine energy dollars retained in or lost from the local economy (Boulder, 1981).

1. Multiply: #of utility employees x average personal income = Total Wages Earned (assume wages are spent locally)
2. Determine: Amount paid by utilities in property taxes (assume taxes are spent locally)
3. Determine for gasoline: Retail Price - Wholesale Price = Total Markup (assume Total Markup is retained locally in the form of wages, insurance, mortgage, etc.)
4. Total: 1 + 2 + 3 (above) = Total Energy \$ Retained Locally
5. TE (above) - Total Energy \$ Retained = Total Energy \$ Lost, or
6. ( $\$ \text{ Retained (or Lost) / TE}$ ) x 100 = % Retained or Lost

#### 4.3 PHASE 2 - PROGRAM COST EFFECTIVENESS

This phase examines programs to compare their direct implementation costs against their expected energy and dollar savings (benefits). Such an analysis will determine the cost effectiveness of a particular program, which is perhaps the most important measure of a program's feasibility and ability to be implemented. Figure 16 illustrates the procedure necessary to conduct the analysis included in this phase.

Considered in this phase are specific energy programs and energy projects. Energy programs which save energy through conservation measures can involve regulation, financing, tax incentives, and outreach programs.

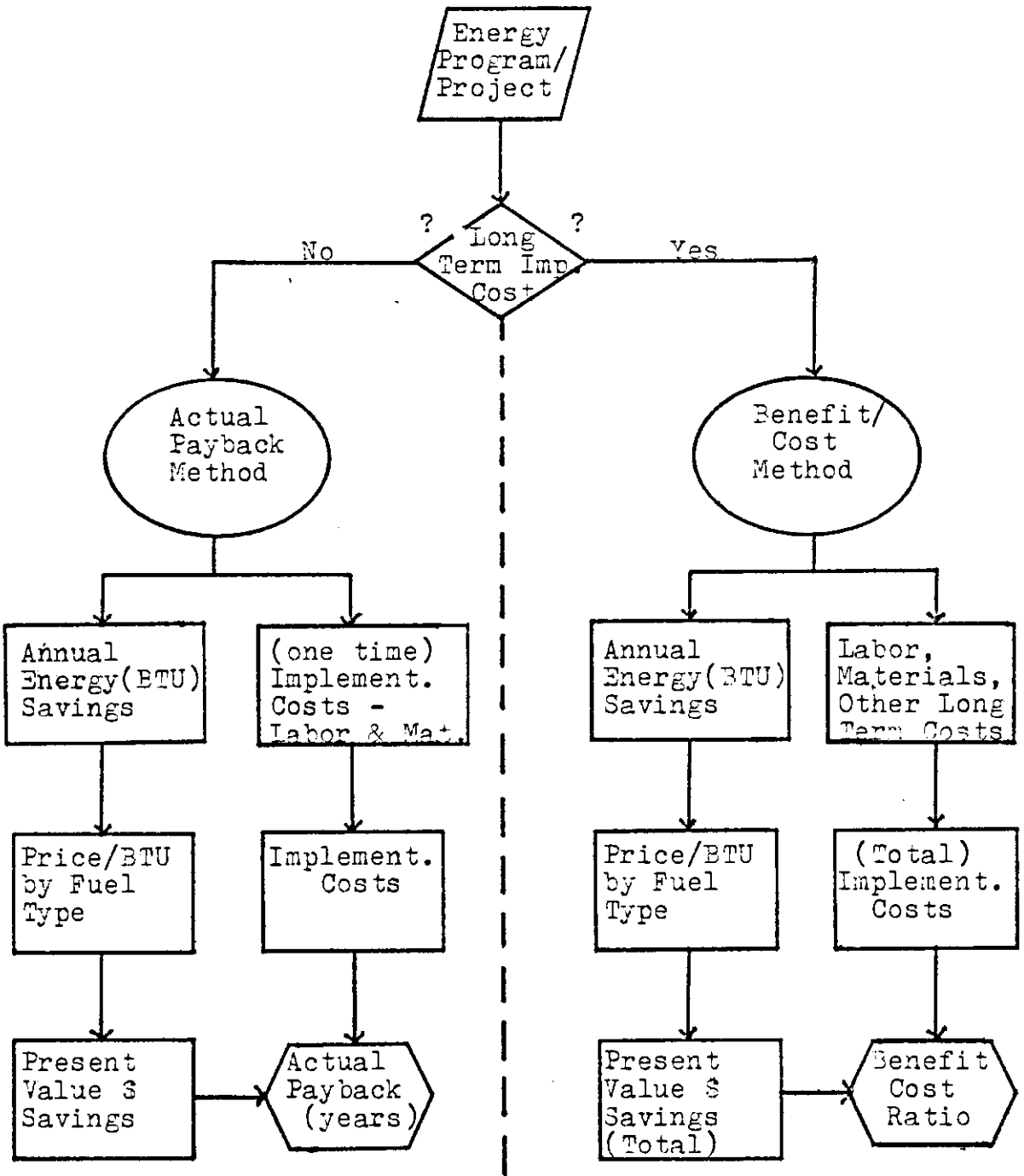


Figure 16: Phase 2 - Flowchart

Regulations include improved building codes, retrofit conservation standards, solar access ordinances, mandating of solar domestic hot water heaters, and other programs which require a specific action be taken by the citizen. Financing programs are often available through municipal solar utilities or the local utility company. These programs can provide low or zero interest\* loans for weatherization, installation of solar devices, and other energy conserving measures. Incentives may take the form of a property or income tax credit such as that offered by the federal government and many state governments, allowing a deduction from income tax for a percentage of the cost of a solar system or weatherization. Finally, outreach programs include a variety of possibilities such as educational workshops, energy audits, or installation of weatherization devices in low income homes. The analysis for such programs will differ depending on the type of program and whether it will include simply initial labor and materials costs or if additional costs such as administrative costs must also be considered over the implementation period. Local energy projects producing energy from local sources will also save energy, due to the subsequent reduction in community energy imports.

#### 4.3.1 Potential Energy Savings

Implementation of specific energy conservation or production programs will reduce the amount of energy previously consumed and imported. Energy savings attributable to specific conservation programs will depend upon the type of program and local conditions. Considering this, it is best for savings estimates to be derived locally. A local contractor can estimate potential savings for weatherization programs through heat loss reduction estimates. Savings attributable to solar DHW are usually based on the percent contribution which the solar system will make to the overall household hot water energy demand. When transportation programs are considered such as carpooling, energy savings can be estimated by determining the reduction in miles travelled and multiplying it by average miles per gallon of gasoline to arrive at gallons of gasoline saved.

Energy production projects usually require an engineering feasibility study to evaluate the project. This is most commonly performed by a consultant. Included in this will be technical studies which will show the amount of energy which can be produced by a particular project.

#### 4.3.2 Potential Dollar Savings

The amount of money saved as a result of potential energy savings from program implementation is the potential dollar savings (PVB). This represents program benefits in more meaningful dollar terms. To calculate dollar savings (B), energy savings (ES) are multiplied by projected energy prices (P) for each respective future year (t) and fuel type (j) to be considered. Dollar savings (B) are then expressed in present value dollars to facilitate comparisons with other present day investments. Total present value dollar savings (PVB) are then equal to the sum of dollar savings for all fuel types for all years.

$$PVB = \sum_{tj} PVB_{tj}$$

$$PVB_{tj} = B_{tj} / (1+i)^t$$

$$B_{tj} = P_{tj} * ES_{tj}$$

where, PVB => total present value dollar savings

B => dollar savings

P => price of energy (\$/BTU)

ES => energy savings (BTU's)

t => future year

j => fuel type

i => discount rate

Dollar savings can also be calculated in the same manner for energy projects, where the energy produced will be the energy savings as expressed in the equations above.

#### 4.3.3 Program Costs

The costs associated with implementing or installing specific energy conservation programs or energy production projects are addressed in this section. Specific programs which require only initial labor and materials cost to implement, such as a retrofit regulation, can be best estimated by a local contractor for solar devices or conservation measures or the local U.S. Department of Energy weatherization organizations for conservation measures. Administrative costs associated with some energy conservation programs can be best estimated in-house. For example, Seattle's proposed retrofit ordinance required high administrative costs to pay for the inspections necessary for implementation and enforcement. Such costs will tend to affect the whole community over the implementation period. Santa Clara County, however, implemented a solar hot water heater ordinance which required no administrative costs to the county government. The costs of the ordinance could therefore be estimated based on initial labor and materials costs to the individual household. Costs associated with

energy production projects will be expressed in dollars per unit of energy produced. This figure will be determined through the technical part of the feasibility study performed on the project.

Present value costs for a specific program with no administrative costs will simply be the initial investment cost (IC). The present value costs (PVC) of programs and projects which will accrue costs beyond the initial investment are determined in the following equation:

$$PVC = IC + \frac{C_1}{(1+i)^1} + \frac{C_2}{(1+i)^2} + \dots + \frac{C_t}{(1+i)^t}$$

where, PVC => present value costs

IC => initial investment

$C_t$  => costs in year t

t => future year

i => discount rate

#### 4.3.4 Cost Effectiveness

Given dollar savings and costs, energy programs and projects can be evaluated in terms of their cost effectiveness. There are four common ways to do this: payback analysis, cash flow analysis, life cycle cost analysis, and benefit/cost analysis. Payback analysis can

be calculated based on crude payback (initial cost/first year savings), or more accurately based on actual payback. Actual payback considers fuel price escalations which drive up energy prices, and discounts the future savings to present value dollars. Annual cash flow analysis considers all factors which affect system cost effectiveness. Each of these factors such as operation and maintenance costs, tax deductible interest payments, loan payments, tax rebates, down payments, property taxes, insurance costs, and others are listed year-by-year to derive a total net cash flow for each year (Leckie et al., 1981) such as is shown in Table 13 . Life cycle cost analysis compares the costs of one alternative (such as a solar water heater) to another (such as an electric water heater) over the life of the system. This type of analysis was conducted by Santa Clara County (see Figure 7). Benefit/cost analysis is simply the ratio between the present value benefits and costs of a system. Only two of the above methods, actual payback and benefit/cost analysis, are illustrated in the following sections. These two were chosen because they can be easily derived based on data which has been earlier determined in this phase of economic analysis. Also, examples of the other two methods have been provided above and in Chapter II.

#### 4.3.4.1 Actual Payback

Actual payback analysis is a simple, straight-forward means of determining the cost effectiveness of programs which will not accrue any additional costs beyond the initial investment of labor and materials such as weatherization programs. This analysis, however, provides misleading results when applied to more complex programs in that it only considers benefits up to a break even point, resulting in an unrealistically long payback period which is often easily dismissed by our mobile society. This type of analysis should therefore be supplemented in most cases by one of the other more detailed analysis methods mentioned above for more accurate results. To determine actual payback (AP), the initial investment costs (IC) are divided by the first year dollar savings as expressed earlier ( $\sum_j P(o,j) \times ES(o,j)$ ) to arrive at crude payback. Crude payback is then modified by applying the discount or interest rate (i) and fuel price escalation rate (r). This can be done with the equation below; or simply, crude payback can be applied to Figure 17 (Leckie et al., 1981, p.207) along with the difference between fuel price escalation rate (r) and interest rate (i) to arrive at actual payback in a reasonably accurate manner.

$$AP = \log \frac{\left[ 1 + \frac{IC}{\sum_j P_{oj} * ES_{oj}} \right] * (R-1)}{\log R}$$

where,  $R \Rightarrow 1+r/1+i$

$i \Rightarrow$  discount rate

$r \Rightarrow$  escalation rate of fuel prices

$IC \Rightarrow$  initial cost

$\sum_j P_{oj} * ES_{oj} \Rightarrow$  first year savings

$P_{oj} \Rightarrow$  price of fuel type (j) in the first year (o)

$ES_{oj} \Rightarrow$  energy savings for fuel type (j) in the first year (o)

#### 4.3.4.2 Benefit-Cost Ratio

Benefit/cost analysis is used here to determine the cost effectiveness of energy programs and projects which require added costs, such as administrative, beyond the initial implementation costs of labor and materials. The benefit/cost ratio gives an initial indication of the cost effectiveness of a program upon which implementation decisions are often based. A benefit/cost ratio is derived by simply dividing present value dollar savings (PVB) by present value costs (PVC), each of which was determined earlier in Phase 2 analysis.

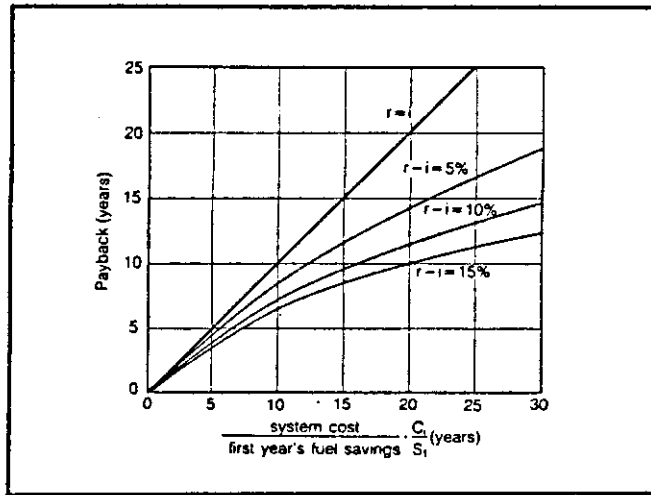
TABLE 13

## Annual Cash Flow Analysis

Year	Fuel Savings	Loan Payment	Loan Interest	Tax Savings	O&M	Tax Credit	Down Payment	Net Cash Benefit
1	+200	-248	240	+84	-25	+1000	-500	516
2	240	248	239	84	30	—	—	46
3	288	248	238	83	36	—	—	87
4	346	248	237	83	43	—	—	138
5	414	248	235	82	52	—	—	198
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.

Notes: A. \$2,500 system cost; 20% down, 30-year, 12% loan; 35% tax bracket; \$200 first year savings, escalating at 20%, 40% federal tax credit.

Source: Leckie, Jim et al. More Other Homes and Garbage.  
San Francisco: Sierra Club Books, 1981.



Source: Jim Leckie, et al. More Other Homes and Garbage.  
San Francisco: Sierra Club Books, 1981.

Figure 17: Actual Payback

$\frac{PVB}{PVC}$

where,  $PVB = \sum_{tj} PVB_{tj}$

$$PVC = IC + \frac{C_1}{(1+i)^1} + \frac{C_2}{(1+i)^2} + \dots + \frac{C_t}{(1+i)^t}$$

#### 4.4 PHASE 3 - EFFECTS ON THE LOCAL ECONOMY

This phase goes beyond program cost effectiveness, as shown in Phase 2, to examine the effect energy programs have on the local economy. Economy effects are considered here because energy programs often result in a significant dollar savings to the locality in terms of decreased energy imports. Import substitution can promote the local economy by decreasing the amount of dollars which leave the locality to pay for imports (see Figure 3). This can often lead to local economic growth as there will be more locally spent money. The same effect occurs when there is increased export activity resulting in more money for the locality. Energy programs which may not have an immediate payback will often create other immediate benefits such as those caused by import substitution. To adequately assess energy program feasibility these effects should also be considered.

Figure 18 indicates the procedure necessary for Phase 3 analysis and the progression of effects. Employment is used as an indicator in this analysis because of data

availability and the need for a common unit to express all economy effects. The following sections will include a discussion of direct and indirect employment created, effect on local energy suppliers, and other minor economic effects. Each effect will be dependent on the type of program, its intensity, and local economic conditions. Example calculations are provided in Appendix B to further illustrate the procedure outlined in these sections. This phase provides only a general analysis which will have to be modified for the local situation.

#### 4.4.1 Direct Employment

Direct, on-site employment will be created with the implementation of most energy conservation programs and production projects. For example, workers required to install a solar DHW system are considered direct employment. To estimate direct employment, program implementation costs are examined to determine the breakdown of costs. Costs attributable to labor (LC) are multiplied by the percent of total labor cost which is attributed to various wage sectors  $PC(k)$ . This can then be divided by local estimated wages  $W(k)$  for the labor sector affected. This will give number of jobs created in that employment sector  $J(k)$ . The sum of all employment sectors affected will be total direct jobs (DJ).

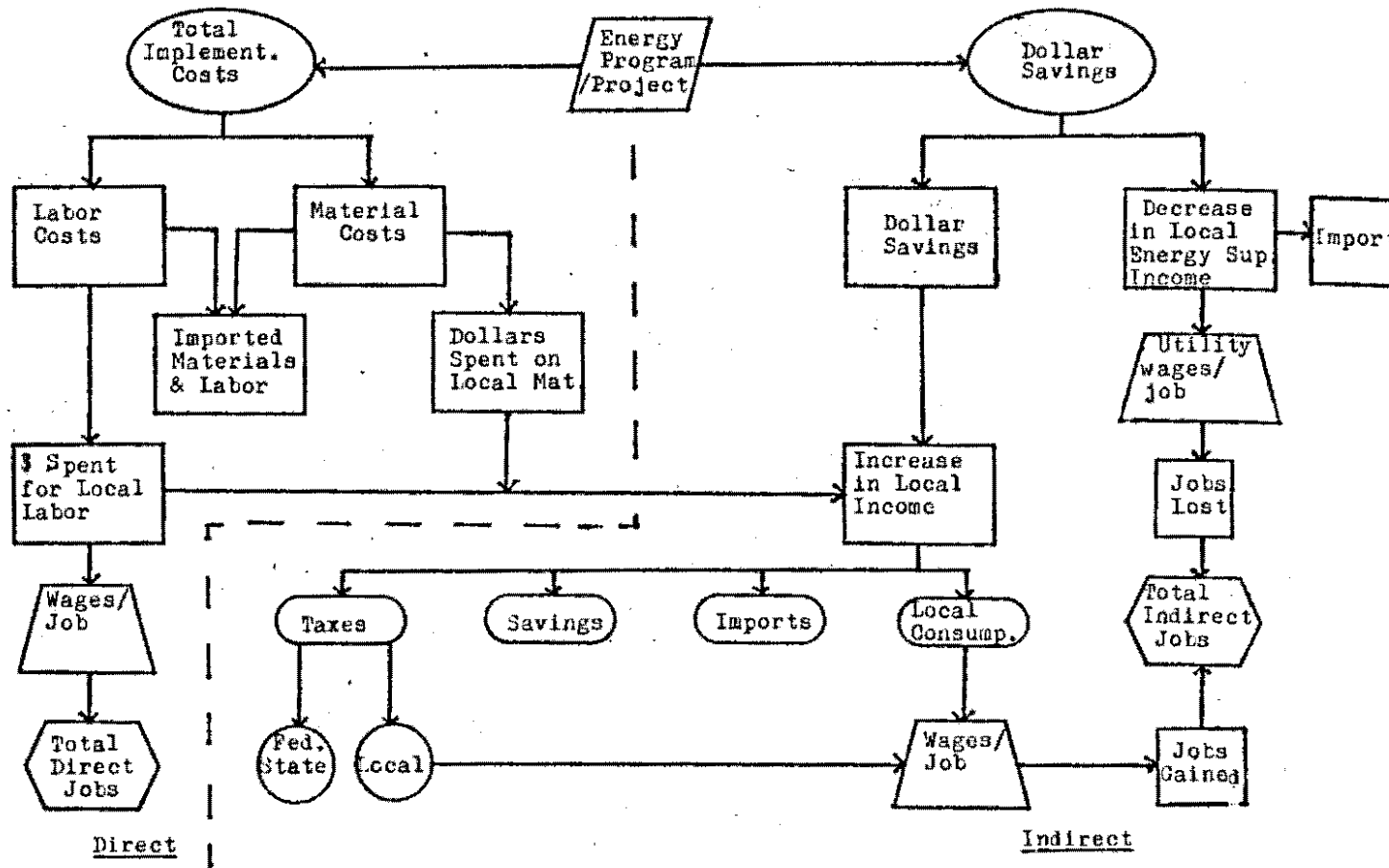


Figure 18: Phase 3 - Flowchart

$$DJ = \sum J_k$$

$$J_k = (LC_k / W_k) / t$$

$$LC_k = LC * PC_k$$

where,  $J_k$  => direct jobs created in sector k

LC => total labor cost

$LC_k$  => labor cost in sector k

$W_k$  => wages for sector k

$PC_k$  => % of total labor cost for sector k

k => employment sector

t => implementation period

When energy production projects are considered there will likely be some importing of specialized trade workers. This will decrease total direct jobs and their indirect effects since wages, in part, will be spent outside of the local economy. Considering this for all programs, the use of local workers will reap the maximum benefits.

#### 4.4.2 Indirect Employment

Indirect employment will result when direct local expenditures are made; thereby, creating expenditures somewhere else in the economy. For example, workers hired to install a solar DHW system will receive wages as a direct result of the energy program. Some of these wages will directly leak out of the locality in the form of taxes and

savings. Remaining wages will then be dispersed through the local economy to pay for such items as: food, housing, personal goods and services, transportation, medical, recreation, education, and local taxes. An increase in indirect housing expenditures may then create further indirect expenditures in the local lumber yard. This effect will continue on for infinity.

The proximity of a community to other communities and its ability to produce goods and services locally will determine the extent of the multiplier effect. Totally isolated, self-reliant communities would require no imports; thereby, enabling them to retain all expenditures. Such a condition would of course not occur if the community was examining ways to reduce energy imports. On a more realistic scale, communities which are a suburb of a larger city will likely lose nearly all indirect expenditures to the surrounding area. Finally, there is the community which may be isolated to a certain degree from other large cities and therefore require only a percentage of its goods and services to be imported. This more typical community will experience a multiplier effect but it will be considerably smaller than that which would be derived by one of the commonly used economic impact models, the export base model. The export base method produces a multiplier which is

misleading due to its use of an average multiplier for the whole economy rather than multipliers which are industry specific. A study done by Garrison (November, 1972, p. 337) on the multiplier effect on small rural areas, reinforces this concept:

"The multiplier analysis applied to the five counties in which new industry located during the period 1958-63 suggests that, in addition to the new plant payroll and employment, there was a modest multiplier effect on personal income in the local consumption sector of the rural economy. However, the multiplier effect on employment was rather small. Only 98 new jobs in trade, finance, services, and other local consumption of nonbasic activities were attributed to the new plants, which had a combined local employment of 1,177."

Economic effects are commonly analysed through one of three economic models: input-output, econometric, and export base. The input-output model provides a large degree of sector detail, giving necessary results and more. Use of it will, however, depend primarily on availability of resources since it is quite expensive and time consuming to develop. Los Angeles used an input-output model for their economic analysis. Econometric models can also provide detailed economic impact analysis. They are, however, quite difficult to apply at the local level due to data requirements which tend to increase required time and expense. Philadelphia used an econometric model for their economic analysis (Winger, 1977).

The export base model has many problems including its use of only two sectors, export and local. This results in an often overstated average multiplier which may not accurately apply to all sectors. Despite its problems, the export base model has been used for many years as a determinant of local economic growth. It is easily understood and can be implemented quite cheaply compared to the input-output and econometric models. The export base model concept will be used for this section of Phase 3 analysis.

An accounting approach will be used here to examine indirect employment effects. It is similar to export base in that it acknowledges injections and leakages which effect the local economy. It is used over the export base method because it creates more accurate multipliers which are industry specific. The many assumptions involved, however, lessen the degree of accuracy achieved by this accounting approach. For this reason, any existing econometric and input-output model for a community should be used to arrive at the most accurate results. Once developed, these models can be applied to various local economic situations at a lesser cost. Export base is also not used here due to its inability to consider injections such as dollars spent on materials and program dollar savings. These injections are

questionable due to the theory that this money would have been spent locally despite energy program implementation. A case can be made, however, for these injections when the money invested is obtained from outside sources, such as a federal or state grant.

The accounting approach derives the increase in local income due to energy programs and then tracks this dollar amount through the local economy to estimate how much money remains in the locality. Indirect jobs are then derived from this dollar figure. Figure 18 will be helpful for interpreting the flow of money which occurs in this approach. The following is a discussion of injections and leakages to the local economy occurring as a result of implementation of energy programs and the subsequent indirect jobs created.

Injections. There are basically three factors creating an increase in local income, they are: direct wages, dollars spent on materials, and program dollar savings. Direct jobs as discussed earlier will provide an injection into the local economy in the form of wages earned. This can be thought of as the figure earlier determined to be cost of labor (LC).

Implementation costs will include cost of materials (MC), this amount should be available from the implementation costs determined earlier in Phase 2. A

breakdown of materials used and costs of each should be examined to determine what materials can be bought locally and what will be imported. A rough estimate of material costs which are bought locally (MC) will then be a direct injection to local income.

Dollar savings (PVB) were derived in Phase 2 and can be used here as a direct injection into local income. The total amount of these injections divided by the implementation period (t) will be the annual increase in local income (I) as shown in the following equation:

$$I = (LC + MC + PVB)/t$$

where, I => increase in local income

LC => cost of labor

MC => cost of materials

PVB => present value dollar savings

t => implementation period

It might be argued that an increase in income is only attributable to dollar savings. To a certain degree this will be true for locally funded programs. Those programs which are funded by outside sources, however, will cause an increase in income which can be attributed to all of the above injections.

Leakages. An increase in local income can be thought of as a household budget, to determine how much money is spent in various sectors of the economy. To do this, census data referring to the locality or region should be used. From this we can determine the percentage which is lost to federal and state taxes (T). This is multiplied by income (I) to give the dollar amount lost to federal and state taxes  $I(T)$ . Savings (S) are also considered a leakage because of the uncertainty of where savings are distributed in the form of investments. They can be derived in the same manner as taxes, ie: multiply the percentage saved (S) by income (I) to give income lost to savings  $I(S)$ . Subtracting both of these leakages from income, we are left with income available for household consumption or disposable income  $I(H)$  as shown in the following equations:

$$I_H = I - I_T - I_S$$

$$I_T = I * T$$

$$I_S = I * S$$

where,  $I_H$  => disposable income

$I$  => increase in local income

$I_T$  => income paid for taxes

$I_S$  => income in savings

$T$  => % of income, lost to federal and state taxes

$S$  => % of income, saved

Disposable income  $I(H)$  can now be multiplied by personal consumption rates for each sector  $LPC(K)$ , or the percent of expenditures which are retained locally in the remaining sectors of the economy: food, housing, personal goods and services, transportation, medical, recreation, education, and local taxes. This will give income retained locally for each sector  $I(k)$ . Personal consumption rates will vary significantly by community since they are based on local availability of goods and services. For housing, transportation, medical, recreation, and education, estimates will be based primarily on assumptions about the locality. For example, in looking at transportation, if the community has several car dealers, mechanics, and gas stations, we can assume that most of this money will be retained. If, however, the community supplies only gasoline, the percentage lost will be based on the percent of expenditures occurring in other components of transportation. Census and employment data on the locality may be helpful in determining the degree of local economic activity occurring in each sector. Some assumptions will have to be made for smaller communities which do not have such data disaggregated for them. Local taxes in most cases will be totally retained. Dollars retained through

expenditures on food, and personal goods and services will depend on the retail attractiveness of the area. This can be estimated with the use of a gravity model.

Gravity models are based on Newton's Law of Gravity, where the attraction between two bodies is based on the mass of each and the distance between the two as shown in the following formula (Dickey, 1975 p. 200):

$$F_{12} = G \frac{M_1 M_2}{d_{12}^2}$$

where,  $F_{12}$  => the gravitational force between bodies 1 and 2

$M_1$  => the mass of body 1

$M_2$  => the mass of body 2

$d_{12}$  => distance between bodies 1 and 2

$G$  => constant

This has been related to shopping travel and dollars spent outside the community for retail as is described in the following example (Dickey, 1975 p. 200):

M(1) might represent the "mass" of trips available at, say, a residential area; M(2) the 'mass' or attractiveness of a shopping area; d(12) the distance between the two areas; and E(12) the number of trips between the two areas. This interpretation would imply through the gravity model that the greater the size or attractiveness of the two areas (masses) and the less the distance between them, the more would be the number of interarea trips. This was found to resemble many real world situations."

Using this model, the degree of retail trade occurring in the locality and outside of the locality can be determined. Dollars remaining in each sector after imports are considered  $I(k)$  can be divided by annual wages for that sector  $W(k)$  to determine indirect jobs created in each sector  $JC(k)$ . These can be totalled to equal total indirect jobs created (JC) as is done in the following equations:

$$JC = \sum JC_k$$

$$JC_k = I_k / W_k$$

$$I_k = I_H * LPC_k$$

where,  $JC_k$  => jobs created in sector k

$I_k$  => income retained in sector k

$W_k$  => wages paid in sector k

$I_H$  => disposable income

$LPC_k$  => personal consumption rates in sector k (% retained locally)

k => consumption sector

#### 4.4.3 Effect on Local Energy Suppliers

The potential decrease in jobs to the local energy suppliers must also be considered. Since less energy will be used as a result of energy programs, conventional energy supply businesses will be expected to decline to some degree. It is proposed that this decline will produce a

"downward multiplier effect which is expected to be relatively small, however, because of the minor fraction of energy expenditures which stay in the locality" (Daspit, 1981 p. 36). Conclusions about this effect were reached in another study (Los Angeles, 1981 p. 105):

"No jobs are displaced in the utility industry when energy is conserved (or produced). This is because employment in the industry is relatively insensitive to the amount of energy sold, due to the capital intensive nature of utility industry production and necessity of retaining operation personnel in reserve even when plants and equipment are idle. For this reason, no job displacement has been subtracted from the 'responding jobs' created"

It can be assumed through these examples that although there may be an effect it is likely to be negligible. To estimate the effect, despite its proposed insignificance, dollar savings PVB determined earlier, are divided by average local utility wages (W) to determine jobs lost (IJ). This should result in a rough estimate which can be subtracted from indirect jobs created to equal net indirect jobs:

$$JL = (PVB / W) / t$$

where, PVB => present dollar savings

W => average wage for utility workers

t => implementation period

$$IJ = JC - JL$$

where, JC => jobs created

JL => jobs lost

#### 4.4.4 Minor Economic Effects

There will be minor economic effects which result from energy plan or program implementation. These effects can not be easily quantified and should only be considered qualitatively. These effects will include: opportunity costs, cyclical sensitivity, population growth, and others. Opportunity costs occur when money is tied up in an investment thereby eliminating the "opportunity" to invest elsewhere. The degree of sensitivity which a community has to national economic conditions is measured as cyclical sensitivity. It is possible that by reducing energy consumption and becoming less dependent on energy imports, a locality will not be as affected by (sensitive to) national energy shortages and prices. Population growth in a community which has decreased its reliance on energy imports may increase the multiplier effects especially if new industry moves into a community because of lower energy costs. There are likely to be many other factors effecting the local economy, but most will be insignificant asides. Once program feasibility is decided they may only serve to reinforce program implementation.

## Chapter V

### SUMMARY AND CONCLUSION

This thesis supports the hypothesis stated in the introduction: "community energy planning efforts in the U.S. do not reflect indepth analysis of effects on the local economy." Community energy plans and programs of twenty-five communities examined in this thesis included in nearly all cases, the study of program cost effectiveness. However, most plans and programs lacked any analysis performed to determine the effects on the local economy.

The case studies were divided into three groups based on the degree of economic analysis which had been conducted by the community on their energy plan or program. The first group provided no economic analysis at all or what was provided was very limited, referring only to program cost effectiveness with no analysis to substantiate the data provided. The second group, by the most part included data and some analysis of program cost effectiveness. Some communities in this group also included effects on the local economy; however, with the exception of Carbondale, Portland, and Springfield, no analysis was provided to substantiate the data. This group on the whole provided more extensive data and analysis than group one; however,

none of these communities provided detailed economic analysis of both program cost effectiveness and effects on the local economy. The third group contains two communities, Philadelphia and Los Angeles which performed detailed economic analysis on their energy plans and respective programs. The other two communities included in this group, Bridgeport and Boulder, provide economic analysis; however, it is considered to be questionable due to the manner in which it was developed. Each case study was written to include any information which addressed the questions discussed in Chapter III.

Chapter III examined the relationships between economic analysis and community energy plans and programs through a discussion of the following three questions:

1. Do community energy planning efforts in the U.S. reflect indepth analyses of effects on the local economy?
2. Does economic analysis facilitate implementation of energy plans and programs?
3. To what extent do economic analyses conducted in those communities studied support the claim that community energy programs benefit the local economy?

The first question is a restatement of the hypothesis, and as stated above, evidence provided in the case studies indicated that indepth analysis of effects on the local economy, did not occur in most cases. Only twelve of the twenty-five communities examined economy effects and five of

these only provided data with no analysis. Five others provided analysis but it was limited with questionable documentation. Only two, Los Angeles and Philadelphia provided indepth analysis of economy effects. The present lack of analysis on economy effects was considered to exist partly because of misconceptions about the degree and type of analysis necessary and limited resources available to perform such an analysis.

Economic analysis alone cannot always guarantee program implementation, as was discovered in a study done by Corbett and Hayden (1980) and later supported by another study done by Randolph (1982). These studies concluded that there are three key roles present in nearly all communities which have had success with implementation, including: a committed elected official, technical support personnel (to provide mostly cost effectiveness studies), and a local energy constituency. Economic analysis was present in the form of program cost effectiveness in all of the twenty-two communities which were successful in program implementation. Nine of these communities supplied data within their reports; however, no analysis was included to verify the data. In such instances it might be assumed that the data was nevertheless valid since it was often used to implement the program. The studies mentioned above (Corbett and

Hayden, and Randolph) clearly indicated the need for cost effectiveness studies in order to achieve implementation. Further study beyond the scope of this thesis, however, would be necessary to determine how influential program cost effectiveness is in the decision for program implementation in these particular cases. It can only be assumed here that a community is not likely to implement a program involving public expenditures of money, when the program is not thought to be beneficial at least in terms of program cost effectiveness.

There is not enough evidence presented here to determine whether analysis of economy effects is always helpful in program implementation. A lack of economy effects data may not inhibit implementation when the above stated roles are filled; however, provision of it may further serve to influence a hesitant community.

The benefits to the local economy referred to in the third question were projected to be substantial in the two communities (Los Angeles and Philadelphia) which performed detailed economic analysis. Further monitoring of communities during and beyond program implementation would provide the evidence necessary to further validate this point. The economic benefits often referred to by communities are in most cases only assumptions, which

although reasonable, require data to substantiate the claims if they are to be considered viable. Chapter IV provides a means for addressing the economic benefits alluded to by some communities, and overlooked by others.

The framework which was developed in Chapter IV is a major focal point of the thesis. The framework was developed in phases which are progressive and can be followed to the extent that resources are available. Phase 1 examines energy audit data relating it to dollars spent by a community on energy and how much of that is retained in or lost from the locality. Phase 2 is the first part of economic analysis, it considers program cost effectiveness which often determines program feasibility. Phase 3, the second part of economic analysis, examines the effects of energy plans and programs on the local economy. Economy effects as they are referred to in this phase, are expressed as jobs gained or lost by the locality as a result of plan or program implementation.

To conclude, the framework is a simplistic, yet reasonably accurate means for performing economic analysis on energy programs. By avoiding the complexities of other economic models, this approach allows the potential for communities to perform the analysis in house, and still attain an adequate degree of accuracy due to the development

of industry specific multipliers. The extent to which the analysis of economy effects will influence implementation, however, remains uncertain without more extensive study. The degree of influence will likely depend on the individual situation and the need for justification of program implementation.

## Appendix A

### SUMMARY TABLE OF EQUATIONS

#### Phase 1 - ENERGY ECONOMIC AUDIT DATA

Total Energy Bill (TE) => Sum of products of energy consumption and energy price over all sectors and fuel types

$$TE = \sum_j \sum_k E_{jk} * P_j$$

where, E => energy consumption (in BTU's)

P => price of energy (constant \$/BTU)

j => fuel type

k => consumption sector

#### Phase 2 - PROGRAM COST EFFECTIVENESS

Potential Dollar Savings => Sum of products of energy savings and energy prices over all sectors and fuel types, expressed in present value dollars

$$PVB = \sum_{tj} PVB_{tj}$$

$$PVB_{tj} = B_{tj} / (1+i)^t$$

$$B_{tj} = P_{tj} * ES_{tj}$$

where, PVB => total present value dollar savings

B => dollar savings

P => price of energy (\$/BTU)

ES => energy savings (BTU's)

t => future year

j => fuel type

i => discount rate

Program Costs => Initial cost plus discounted cost for each future year

$$PVC = IC + \frac{C_1}{(1+i)^1} + \frac{C_2}{(1+i)^2} + \dots + \frac{C_t}{(1+i)^t}$$

where, PVC => present value costs

IC => initial investment

$C_t$  => costs in year t

t => future year

i => discount rate

Actual Payback (AP) => Initial investment cost divided by first year dollar savings discounted for interest and fuel price escalation rates

$$AP = \log \frac{\left[ 1 + \frac{IC}{\left( \sum_j P_{oj} * ES_{oj} \right) * (R-1)} \right]}{\log R}$$

where, R =>  $1+r/1+i$

i => discount rate

r => escalation rate of fuel prices

IC => initial cost

$\sum_j P_{oj} * ES_{oj}$  => first year savings

$P_{oj}$  => price of fuel type (j) in the first year (o)

$ES_{oj}$  => energy savings for fuel type (j) in the first year (o)

Benefit/Cost => Present value dollar savings divided by present value dollar cost

$\frac{PVB}{PVC}$

where,  $PVB = \sum_{tj} PVB_{tj}$

$$PVC = IC + \frac{C_1}{(1+i)^1} + \frac{C_2}{(1+i)^2} + \dots + \frac{C_t}{(1+i)^t}$$

Phase 3 - EFFECTS ON THE LOCAL ECONOMY

Total Direct Employment (DJ) => Dollar cost for on-site labor divided by wages for each labor sector

$$DJ = \sum J_k$$

$$J_k = (LC_k / W_k) / t$$

$$LC_k = LC * PC_k$$

where,  $J_k$  => direct jobs created in sector k

LC => total labor cost

$LC_k$  => labor cost in sector k

$W_k$  => wages for sector k

$PC_k$  => % of total labor cost for sector k

k => employment sector

t => implementation period

Total Indirect Employment (IJ) => Net jobs from indirect jobs created  
and from indirect jobs lost.

$$IJ = JC - JL$$

where, JC => jobs created  
JL => jobs lost

Jobs Created => Indirect jobs resulting from an increase in local  
expenditures.

$$JC = \sum JC_k$$

$$JC_k = I_k / W_k$$

$$I_k = I_H * LPC_k$$

where,  $JC_k$  => jobs created in sector k

$I_k$  => income retained in sector k

$W_k$  => wages paid in sector k

$I_H$  => disposable income

$LPC_k$  => personal consumption rates in  
sector k (% retained locally)

k => consumption sector

Leakages => Dollars lost from the locality

$$I_H = I - I_T - I_S$$

$$I_T = I * T$$

$$I_S = I * S$$

where,  $I_H$  => disposable income

I => increase in local income

$I_T$  => income paid for taxes

$I_S$  => income in savings

T => % of income, lost to federal and state taxes

S => % of income, saved

Injections => Total dollar increase in local  
income due to energy programs

$$I = (LC + MC + PVB)/t$$

where, I => increase in local income

LC => cost of labor

MC => cost of materials

PVB => present value dollar savings

t => implementation period

Jobs Lost => Jobs lost through fewer sales by local energy  
suppliers

$$JL = (PVB / W) / t$$

where, PVB => present dollar savings

W => average wage for utility workers

t => implementation period



Total Indirect Employment (IJ)

$$IJ = JC - JL \quad . . . \Rightarrow IJ = 59 \text{ emp} - 15 \text{ emp} \\ = 44 \text{ emp}$$

where, JC => jobs created  
 JL => jobs lost

$$JC = JC_k \quad . . . \Rightarrow JC = JC_1 + JC_2 + JC_3 + JC_4 + JC_5 \\ = 16 + 21 + 5 + 12 + 5 \\ = 59 \text{ emp}$$

$$JC_k = I_k / W_k \quad . . . \Rightarrow JC_1 = \$390,000 / \$25,000/\text{yr}/\text{emp} \\ = 16$$

$$. . . \Rightarrow JC_2 = \$260,000 / \$12,500/\text{yr}/\text{emp} \\ = 21$$

$$. . . \Rightarrow JC_3 = \$104,000 / \$20,800/\text{yr}/\text{emp} \\ = 5$$

$$. . . \Rightarrow JC_4 = \$156,000 / \$12,500/\text{yr}/\text{emp} \\ = 12$$

$$. . . \Rightarrow JC_5 = \$78,000 / \$17,000/\text{yr}/\text{emp} \\ = 5$$

$$I_k = I_H * LPC_k \quad . . . \Rightarrow I_1 = \$2,600,000 * .15 \\ = \$390,000$$

$$. . . \Rightarrow I_2 = \$2,600,000 * .10 \\ = \$260,000$$

$$. . . \Rightarrow I_3 = \$2,600,000 * .04 \\ = \$104,000$$

$$. . . \Rightarrow I_4 = \$2,600,000 * .06 \\ = \$156,000$$

$$. . . \Rightarrow I_5 = \$2,600,000 * .03 \\ = \$78,000$$

where, I<sub>k</sub> => income per sector  
 k=1 => housing  
 k=2 => food  
 k=3 => transportation  
 k=4 => clothing, personal care  
 k=5 => medical care  
 k=6 => public utility

$$I_H = I - I_T - I_S \quad . . . \Rightarrow I_H = \$4M/yr - \$1M/yr - \$.4M/yr \\ = \$2,600,000/yr$$

$$I_T = I * T \quad . . . \Rightarrow I_T = \$4,000,000 * .25 \\ = \$1,000,000$$

$$I_S = I * S \quad . . . \Rightarrow I_S = \$4,000,000 * .10 \\ = \$400,000$$

$$I = (LC + MC + PVB)/t \quad . . . \Rightarrow \\ I = (\$6.5M + \$5.5M + \$8M)/5yr \\ = \$4,000,000$$

where,  $I_H \Rightarrow$  annual income for household expenditures

Assume:  $T = .25$  (% of income, lost to federal and state taxes)

$S = .10$  (% of income, saved)

Personal Consumption Rates (retained locally):

$$LPC_1 = .15$$

$$LPC_2 = .10$$

$$LPC_3 = .04$$

$$LPC_4 = .06$$

$$LPC_5 = .03$$

Assume:  $W_1 = \$25,000/yr/emp$  (\$12/hr)

$W_2 = \$12,500/yr/emp$  (\$ 6/hr)

$W_3 = \$20,800/yr/emp$  (\$10/hr)

$W_4 = \$12,500/yr/emp$  (\$ 6/hr)

$W_5 = \$17,000/yr/emp$  (\$ 8/hr)

$W_6 = \$20,800/yr/emp$  (\$10/hr)

$$JL = PVB / W_6 / t \quad . . . \Rightarrow JL = (\$1.6M / \$20,800/yr/emp) / 5yr \\ = 15 \text{ employees}$$

Assume: Only 20% of PVB would have been retained locally,  
(i.e.  $PVB = 8,000,000 * .20 = 1,600,000$ ) due to existing  
leakage of local energy dollars to outside suppliers

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