# Planning for Energy Self-Reliance:
# A Case Study of the District of Columbia

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# A CASE STUDY OF THE DISTRICT OF COLUMBIA

Prepared for the U.S. Department of Energy Assistant Secretary for Intergovernmental and Institutional Relations Office of Consumer Affairs Contract No. EU-78-G-01-6466



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## Acknowledgments

## Other publications from the New Rules Project of the Institute for Local Self-Reliance:

**Meeting Minnesota's Renewable Energy Standard Using The Existing Transmission System**, by John Bailey, George Crocker, John Farrell, Michael Michaud, David Morris, November 2008

**Energy Self Reliant Sates: Homegrown Renewable Power**, by John Farrell and David Morris, November 2008

**Rural Power: Community-Scaled Renewable Energy and Rural Economic Development**, by John Farrell and David Morris, August 2008

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**The Policy Gap: Minnesota Energy Policy vs. Minnesota Climate Policy**, by John Farrell, John Bailey and David Morris, November 2007

**Big-Box Swindle: The True Cost of Mega-Retailers and the Fight for America's Independent Businesses,** by Stacy Mitchell, November 2007, Beacon Press

Since 1974, the Institute for Local Self-Reliance (ILSR) has worked with citizen groups, governments and private businesses to extract the maximum value from local resources.

A program of ILSR, the New Rules Project helps policy makers to design rules as if community matters.

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# FOREWORD

Under contract with the Department of Energy, Office of Consumer Affairs, the Institute for Local Self-Reliance undertook to analyze the feasibility of achieving energy self-reliance for the District of Columbia by maximizing conservation and renewable energy and minimizing the outflow of energy dollars.

In accomplishing this task, the staff was faced with a choice. There was the option of presenting only data. This is useful and our research on energy use and alternatives has been thorough and comprehensive. We need to know how much energy we use, and how we use it, and how much we can save, and how much we can generate in using solar energy. But the more we delved into the area, the more we became aware that the issues were less technological than they were sociological, economic, and political.

As a result, we have attempted to mix narrative and data, to discuss some important conceptual issues in municipal energy planning while presenting the basic data necessary to undertake that planning.

We've encountered our own personal frustration in reading reports whose conclusions had little methodological documentation. This was often compounded by the fact that the person who had directed the research had already moved on to another organization, state, or project. As we note throughout the paper, one's conclusions derive in large part from one's assumptions, we have described in detailed, often painstaking fashion the methodologies by which we arrived at our conclusions.

In preparing this study, we were provided with a considerable amount of support from many sectors. One always takes a risk by mentioning specific organizations, leaving others out in the process. The Consumers Utilities Board opened their technical advisory meetings to our staff. The Office of the Peoples Counsel also gave us access to their information. The Council of Governments, the Municipal Planning Office (now the Office of Planning and Economic Development), the Department of General Services, the Department of Finance and Revenue, and many other District government agencies gave us the type of help without which we could not have completed this study.

PEPCo and Washington Gas and Light were extremely cooperative in supplying basic energy-related data. In several instances, research members of existing agencies developed their own research projects on questions we asked. In at least one instance a private sector company undertook a survey on our behalf when we found that official government figures and our own informal findings were inconsistent with respect to heating-oil consumption.

The Office of Technology Assessment helped us through the maze of alternative technology, and the Department of Energy quickly responded to our need for a multiplier model to assess the impact of energy dollars on the District economy.

We hope that this document engenders debate and dialogue, for it is only through discussion that we can gain understanding, and only through understanding the complex issues related to energy that we can take advantage of a rare, almost unparalleled opportunity for the District of Columbia to become a model energy city.

The results and conclusions contained in this report are those of the ILSR staff, and they, in no way, reflect the opinions of the U.S. Department of Energy or of any other U.S. Government agency.

# INTRODUCTION

## Energy Self-Reliance for the District of Columbia

All the traditional assumptions concerning energy no longer pertain. Rate structures developed to encourage consumption during an era when energy costs were declining are being revised in the face of the new reality of rising energy costs. Energy conservation, once viewed as an insignificant gesture, antithetical to economic development, now holds great promise as an important contributor to the resolution of the energy crisis.

The oil embargo of 1973-74 gave way to the natural gas crisis of 1976-77, the coal strike of 1977-78, and the Iranian turmoil in 1978-79, bringing citizens to the realization, not only of the scarcity of the resource, but its vulnerable and tenuous distribution systems.

Large power plants, once encouraged because of their apparent economies of scale, are now viewed as potentially burdensome because of their environmental impact and the long lead times required before they become operational. Once, long lead times meant little, for utility companies could reliably count on an ever-burgeoning demand for their product. Now, demand is not keeping pace with earlier projections.

As the cost of power plants soars, consumers learn the advantages of conservation. The brownouts of the early 1970's have given way in many instances to the problems of excess capacity in the late 1970's.

The 400 percent increase in crude oil prices also brought solar energy into the marketplace. In many respects, the industry is still young, yet in a few short years the technological developments have proven so rapid that there is now a technological backlog awaiting commercialization. Low temperature flat plate collectors already share the marketplace with high temperature concentrator collectors used for air conditioning as well as heating, and newer systems generate both heat and electricity at high efficiencies.

Initially, solar storage systems contained only a few hours or days of energy. Now seasonal storage systems are in operation in the United States and Canada, as well as European countries. Surplus solar energy collected during the summer months can be stored for use during the winter heating season.

The concept of energy efficiency has been revived after 100 years of indifference. The most efficient power plants are those that generate both heat and electricity, that are near the point of consumption and can be built quickly to match changes in demand. The concept of community energy systems is now a topic of serious research.

The nature of energy utilities may be changing. Initially utilities were viewed as a mechanism for promoting energy consumption. Now public service commissions see a major objective of utilities being the reduction in the demand for energy. A steady state utility, or even one that shrinks in size, is now increasingly viewed as a positive development. The Public Utilities Regulatory Policies Act of 1978 requires the Federal Energy Regulatory Commission to compare the reliability of small power producers to that of more conventional centralized power plants. It requires utilities to encourage on-site generation of power by purchasing excess power and selling back-up power at reasonable rates, and by permitting small power producers to wheel their electricity across its grid system. In Washington, D.C., such an investigation would naturally lead to an in-depth analysis of neighborhood or block-scaled systems. Already industry and commercial establishments are uncoupling from large utility systems by using cogeneration systems which generate both heat and electricity. Producers of cogenerating units, such as Cummins Engine, see themselves as direct competitors to utilities, such as Consolidated Edison.

It is during this period of ferment and change that Washington, D.C. is undertaking its first energy plan.

The purpose of this report is to analyze the current energy picture of the District of Columbia, and the potential for energy self-reliance. It is meant to present a conceptual framework for viewing the energy crisis from a municipal perspective, and to describe possible strategies for maximizing conservation and the use of indigenous energy resources.

This report conceives of the District of Columbia as a nation. Although it has no formal trade borders its balance of payments is of increasing interest to both local planners and residents. Payments for energy have an adverse impact on the D.C.'s balance of payments. The District imports almost all of its energy (except for the few dozen buildings which generate a portion of their energy through solar devices). The city, including the United States government operations within the District, imported over $600 million in energy in 1977. Excluding the federal government, over $480 million was exported to pay for energy that year.

Only a small portion of these payments found their way back to the local economy in any form, either wages, or taxes, or dividend payments. After tracing these money flows, we conclude that, in 1977, only 13 cents of the energy dollar returned to the city. Of this, only 3 cents went directly to D.C. residents in wages and salaries. Nine cents went to the D.C. government as taxes.

The District reduced energy consumption by 17% between 1972 and 1977. This was greater than the 8-10% population decline during this same period. Almost 100% of this decline is accounted for by fuel oil conservation, primarily in the commercial sector. The twin causes appear to be conservation measures and the shift, as a result of pollution standards, from #6 to #2 heating oil. In 1977 the total energy consumption was 93.8 trillion BTU's (145 trillion BTU's if primary energy used in generating electricity is considered). This energy was consumed in the following functions:

| | | |
|---|---|---|
| Transportation | 17.0 | |
| Space-heating | 43.5 | (52.2)* |
| Water-heating | 8.5 | ( 9.4)* |
| Space-Cooling | 3.4 | (11.5)* |
| Lighting | 6.9 | (23.0)* |
| Appliance | 1.2 | (4.0)* |
| Process | 11.6 | (26.5)* |
| Not Accounted For | 1.2 | |

Much greater conservation efforts are possible. We conclude that between 1977 and 1990 the District, including the federal government, could reduce end-use consumption by one third, from 93.8 trillion BTU's to 62.1 trillion BTU's, even as it adds tens of million square feet of new office space and residential units. This does not represent the technically possible maximum conservation but rather that conservation which is economically feasible. Such conservation could be achieved with less than a 7 year payback on the original investment.

We argue in this report for a societal perspective on energy planning. Investments in energy conservation generate money savings which then "multiply" through the local economy. Energy conservation and solar energy businesses tend to be small, and therefore more locally based. They tend also to be more labor intensive, in the installation stage of the operation, than many industrial jobs. The peculiar nature of the D.C. economy, however, with its high proportion of service and office jobs, means that relatively little of the products used in conservation and solar (e.g. storm windows, caulking, solar collectors) are manufactured within the boundaries of the city, so there is relatively little benefit to the local economy in these expenditures. In addition, since the D.C. economy consists of the most labor intensive sectors, as District residents invest in conservation and/or solar they will divert investments and consumption in these other sectors, thereby slightly decreasing the amount of total employment in the city.

However, once the conservation measures are enacted, there is a positive flow of dollar savings. This increases to discretionary income of the individual, which can become part of the gross sales volume of a given economy. The money from the purchase cycles and recycles through the economy to the wholesaler, supplier, manufacturer, to his supplier, and so on. The recycling can occur six, eight, or even ten times. This is called the turnover rate. The actual value of each transaction diminishes so that the sales multiplier for the District of Columbia is 2.42. This is the calculated value derived through the use of the Department of-Energy RIMS model. Thus if residential space heating were reduced by 30% the savings generated to the individual would be $20 million. The gross sales in the local economy would increase by almost $50 million.

The report stresses the need for the city to actively encourage and even compel, conservation, for the general welfare of the city. There are many mechanisms already in operation in various parts of the nation which are described in the report, and which can be adapted to the needs of D.C.

Yet conservation is only the first step, albeit a critically important one, in the process of achieving energy self-reliance. Conservation affects the demand side of the picture. But to achieve true self-reliance, we must explore the supply side as well.

Experience from around the country indicates that it is difficult to permanently motivate people around the issue of conservation. This is partially true because conservation appears to be a negative impulse. Although it need not mean changing one's lifestyle, or decreasing one's standard of living, conservation still means reducing consumption. It must be part of any public education effort to stress that conservation does not mean doing without, but doing better.

Moreover the effects of conservation are muted by energy price increases. As our consumption decreases, the price we pay per unit increases. For example, the District of Columbia, including the U.S. government, reduced energy consumption by 17% between 1972 and 1977, yet paid 79% more for energy in the latter year.

How much energy can the city of Washington generate within it boundaries? The two most significant sources of such energy are solid waste and direct solar energy. Although most of the solid waste stream is imported, and therefore not truly a locally generated resource, the continuing need for these materials means that they will be available for some time in the future. Solar technologies are presently economical in the narrow sense from the individual's perspective, for there are only 4,000 D.C. residents who have electric hot water systems'. These systems are candidates for solar given the high relative cost of electricity in comparison to natural gas.

As discussed in the report, however, the economics may alter when viewed from the perspective of a city planner. For example, if the city were to help finance solar systems that cost $100 million, but which displaced only $60 million of natural gas over their lifetime, it would be seen as a poor investment from the vantage point of an individual homeowner.

However, if we assume that 20 cents on the natural gas dollar returns to the city, while 60 cents of the solar dollar stays in the city (through the purchase from local firms of locally produced solar technologies) and if we furthermore accept the 2.5 to 1 multiplier, the economic picture changes. The $60 million that would he paid for natural gas returns $12 million to the city, for an impact on 'gross sales of $30 million. The solar investment of $100 million returns $60 million to the city, for a total gross sales of $150 million, more attractive investment for the city.

If these economics prove accurate, the role of the city will be to develop mechanisms, both financial and legislative, that will blend the self-interest of local residents with that of the city as a whole.

In planning for energy self-reliance, we estimated the total energy that could be generated from solar technologies outfitted on all existing and new rooftops. The technologies we reviewed are those currently in operation, and in the marketplace. Such an analysis was not performed on the basis of economics, partially because of changing energy prices and changing prices for hardware, partially because, to repeat, economics in significant part depends on one's perspective. The analysis was done to provide an outside estimate on the amount of energy that could be generated by direct solar energy falling on rooftops within the city We did not assume the use of sides of buildings, nor of streets, nor open space areas, all places where solar systems have proven viable.

Assuming that annual storage is available, we estimate that one third to one half of D.C.'s total energy needs, including those of the federal government and the transportation sector,could be met by direct solar energy plus solid waste conversion after conservation efforts take place. Over 75% of the total required energy could be gained from these sources if the transportation sector is excluded. Solar energy represents approximately 90% of the total available energy; solid waste would generate about 10%.

Energy self-reliance can be an important motivating theme for the city of Washington. The transformation of its buildings and residences into producers of energy - not merely consumers - is an exciting, powerful, and realistic concept.

In moving toward energy self-reliance, the District will be faced with the disadvantages common to older cities. The District is basically an already-built environment. New innovations in energy efficient building design will not contribute significantly to the District's energy profile for another generation, because the housing stock turns over so slowly. Seventy percent of the District's residents are renters; and the motivation for landlords to convert to energy conservation or solar is much lower than that of individual homeowners, since energy costs are simply passed on to tenants. The density of D.C. is among the highest of any city in the United States and this reduces the effectiveness of solar energy, which requires a great deal of space in order to provide for a substantial portion of the energy needs of an area.

However, although the disadvantages are real, so, too, are the advantages. Because of the predominance of rowhouses in the District of Columbia, the city's dwellings tend to use less energy per unit than do the more dispersed suburban communities or sprawling newer cities. The city's building height limitation means that although population density is high, Washington's downtown areas and apartment buildings are not so immense that they would be unsuitable for using solar energy. Other positive facts about the District's energy-use patterns are these: a majority of District residents currently use public transportation to go to and from work; and the District has little energy-intensive, heavy industry to add to its energy needs.

Washington, D.C. has other important advantages. In allocating federal energy monies, Washington, D.C. is treated as both a state and a city. Thus, the District will be receiving, during 1979, a very substantial amount of energy-related funding including several million dollars for low-income conservation programs, and several hundred thousand for the creation of an energy extension service. These funds can provide leverage and the basis for sound, serious energy programming.

The city of Washington also has unusual authority over most facets of the energy picture. It is a major direct consumer. Twelve percent of the total energy consumed in 1977 was used by the District government. It also has the authority to decide how energy-efficient our buildings and appliances will be, how energy-efficient the design of the overall city will be. D.C. is like a state in its relationship to the Public Service Commission. The city council can define the public interest in overseeing the creation of rate structures and accounting procedures that encourage its goals.

Such goals would best be established through the active participation of the residents of the District. No matter how well-intentioned the conservation program, in the final analysis its success depends to a large degree upon the educated response of the small business and residential sector. No matter how well-designed a building may be, the way we maintain and operate it can vary actual consumption by as much as 100%. In fact, given the potential for viable community energy systems, energy planning might best be accomplished on the neighborhood level. This report suggests that the many functions of an energy office could best be fulfilled through relying on existing service delivery mechanisms and city institutions.

The best argument for developing an awareness of, and demonstration of, community-based energy systems, is that they can build self-confidence and a renewed sense of citizenship and participation. Not only would the process familiarize citizens with one of the more important issues of our times, but it can prove to be an important educational and experiential base for their work in other planning areas. Too often, neighborhoods still become involved in planning efforts only after the fact, in response to a city initiative or plans of a private developer. Most of these decisions relate to zoning and land-use planning, which often cause neighborhoods to react in a defensive manner.

Energy planning could, from the beginning, be a partnership between city and neighborhood. Both could have the common purpose of inexpensive and environmentally benign energy sources.

In the process, the concepts mastered can be transferred to other planning and policy efforts. The concepts of off-peak and peak energy, reducing the export of money from the District, of the individual's actions and their impact on total system costs, of the trade-off between reliability and cost, of economies of scale in energy generation and storage, of the different definitions of "efficiency" and "economics"; these are all concepts that can he transferred to almost any planning process. Transportation planning, air pollution planning, medical facility planning, rely on similar concepts.

By initiating neighborhood-based energy planning, the city will be educating its citizens to deal with a host of planning issues. During this planning process, the people of Washington would not only evaluate the technical aspects of energy systems and their economics, but must also develop a set of ethical criteria upon which to base their evaluations. What is the objective of an energy system? Clearly it must be reliable and economical - but there may he other equally important values.

For example, what value do we place on the issue of scale?

What value do we place on the issue of equity? How do we treat the most needy in our energy plans? What value do we place on the environment? On flexibility in the face of changing realities?

Once the technical issues are mastered, these will become the focus of our pending public debate-on energy systems.

The planning process can use existing institutions of learning. The school system can use its buildings as the basis for experimentation and learning, its faculty as technical experts and its children as a workforce. These changes in curriculum will not undermine the process of learning but rather enhance it. The ancient aphorism of vocational education is "I hear and I forget; I see and I remember; I do and I understand". Certainly trigonometry can be learned as well while sizing a solar collector as by doing problems in the abstract from a textbook. Vocational training schools can teach the art of using a lathe while constructing solar collectors, or storm windows, as they can by making ornaments as gifts.

The libraries, as the storehouses of knowledge in our communities, can be the demonstration sites for energy conservation and solar, and the basis for providing information on new technologies, legislation and other items. Our Advisory Neighborhood Commissions can be the basis for data-gathering on consumption habits. Our small business can provide the training and expertise.

Friendly competition among our neighborhoods or single-member districts may be a way to encourage self-reliance. The winners could receive cash awards to be used for the operation of programs or projects in their community. The process can stimulate and reward ingenuity, and can provide the serious data base upon which future planning can be done.

Washington, D.C. is the nation's capital. Over 20 million people visit the District each year. What better demonstration can there be of the seriousness of our commitment to conservation and solar energy than to encourage the District to become a model energy city. Visitors interested in conservation can see not only demonstration systems, but they can visit city hall and learn about the complex process of enacting legislation; they can visit the financial institutions to explore the feasibility of innovative financing mechanisms that integrate the needs of the market place with the needs of the larger community, and they can visit the neighborhoods to learn how citizens can involve themselves in both the planning, and implementation, of energy self-reliance.

# CHAPTER 1

## Energy Use, and the Energy Balance of Payments of the District of Columbia

**Total Energy Consumption:**
Since 1972, the District has reduced its energy consumption. This reduction, however, did not lead to reduced payments for energy. The total cost of energy in current dollars in the District rose from 1972 to 1977 by 79%, while the amount consumed declined by 17%.* (This translates into a significant per capita decline even when the 8-10% population decrease in the District during this period is considered.)

The District has been relatively stable with respect to energy use since 1972. Consumption decreased for all energy sources except electricity during the period of greatest price increases, 1972-75; consumption increased, as illustrated by Charts I and II, Total Energy Consumption and Annual Average Change in Consumption, but below its historic rates during the period of more moderate price increases from 1975-1977.

### Chart I: Total Energy Consumption**[1]

**(trillion BTUs)**

| Energy Source | 1972 | 1975 | 1977 |
|---|---|---|---|
| Electricity [a] | 19.5 | 19.8 | 21.4 |
| Natural Gas [b] | 28.4 | 24.8 | 25.6 |
| Fuel Oil [c] | 45.8 | 33.1 | 24.2 |
| Gasoline [d] | 16.7 | 16.2 | 17.0 |
| Coal [e] | 5.3 | 3.9 | 5.6 |
| Total | 115.7 | 97.8 | 93.8 |

* In 1972 in constant dollars this translates to a 35 percent increase. Current dollars were deflated by the rate of inflation of the general consumer price index for D.C. in the years 1972-77 of 7.65 percent.

**Throughout this paper the British Thermal Unit (BTU) is used as a common measurement. To explore its relationship to typical kinds of activities, see Explanatory Notes on BTU's page 60.

[1]In this and the other tables and charts in this section end use energy, not primary energy, was used. We felt that it gives a more accurate picture of the energy required by the city. However, in Appendix L , page 267 we have altered these tables to include the primary energy usage in generating electricity, with a system efficiency of 30%.

Almost all of the energy reduction from 1972 to 1977 was the result of a dramatic reduction in fuel oil consumption, from 45.8 trillion BTU's to 24.2 trillion BTU's. The figures appear exaggerated, but there has been a significant switch from the use of #6 to #2 fuel oil to conform to anti-pollution requirements, and a side-effect has been a reduction in fuel consumption. (For a more complete treatment of the issue of fuel oil consumption, please refer to Appendix D.) In addition, conservation efforts have taken place in the commercial sector. The Apartment and Office Building Association (AOBA) reports that there has been a reduction of approximately 20% in energy use by its members since 1972, a time when there were no escalator clauses to cover rising fuel costs.

### Chart I: Total Energy Consumption

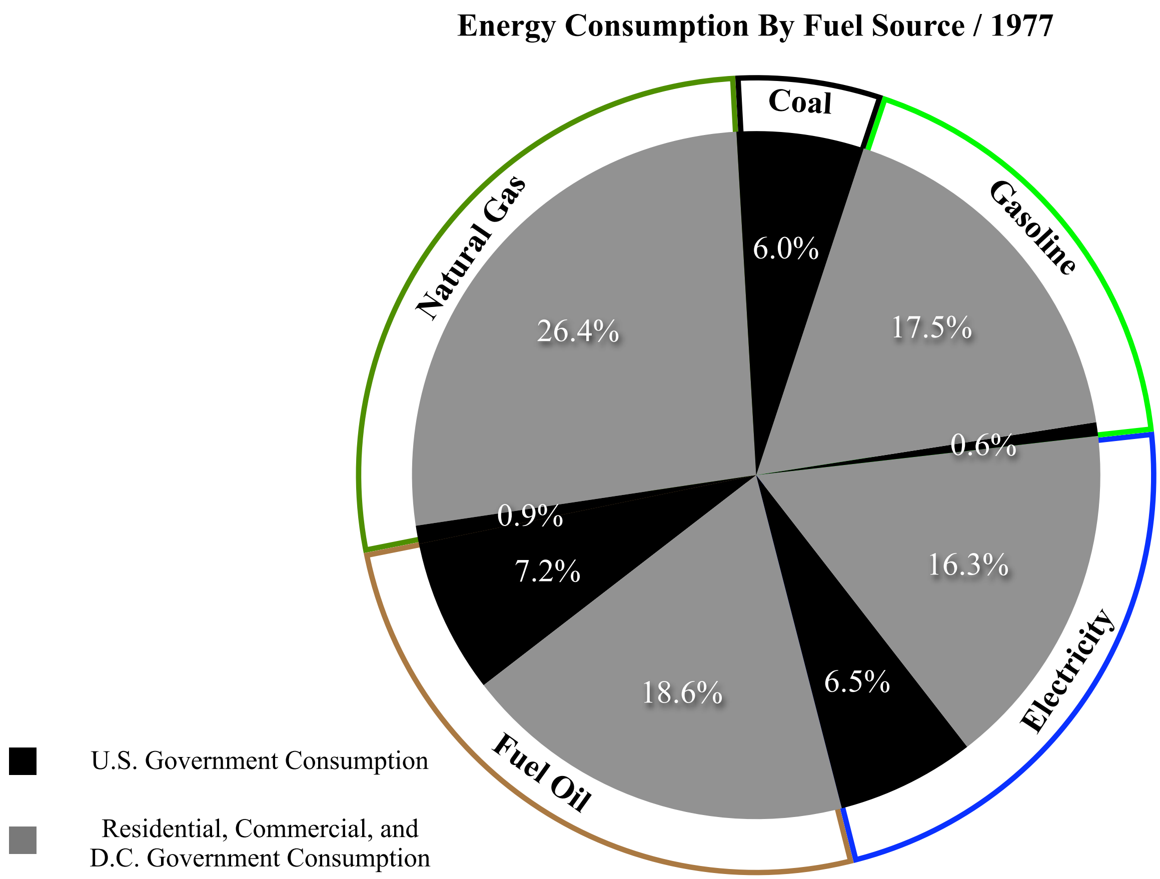
| Energy Source | 1972 | 1975 | 1977 |
|---|---|---|---|
| Electricity (KWH x $10^6$) | 5713.4 | 5801.3 | 6270.1 |
| Natural Gas (Therms x $10^6$) | 284.0 | 248.0 | 256.0 |
| Fuel Oil (gallons x $10^6$) | 315.4 | 227.9 | 166.7 |
| Gasoline (gallons x $10^6$) | 139.2 | 135.0 | 141.7 |
| Coal (tons x $10^6$) | 0.22 | 0.16 | 0.23 |

### Chart II: Annual Average Change in Consumption

**(trillion BTUs)**

| Energy Source | 1972-77 | 1972-75 | 1975-77 |
|---|---|---|---|
| Electricity [a] | 1.88% | 0.51% | 3.96% |
| Natural Gas [b] | -2.05% | -4.42% | 1.60% |
| Fuel Oil [c] | -11.98% | -10.26% | -14.49% |
| Gasoline [d] | 0.36% | -1.01% | 2.44% |
| Coal [e] | -.1.11% | -9.72% | 19.83% |
| | **-3.55%** | **-4.93%** | **-2.07%** |

a. KWH=3,413 BTU's (Based on end-use consumption, not primary energy use)
b. Therm=100,000 BTU's
c. Gallon=145.190 BTU's
d. Gallon=120,000 BTU's
e. Bituminous coal, ton=24,580,000 BTU's




**End Use: Who Uses What:**

Washington, D.C., is the nation's capital. Its energy use is dominated by government. The United States Government, which leases or owns 90 million square feet of office space in the city (more than twice the amount of commercial office space) uses 25% of the total energy, excluding gasoline. The majority of its heating needs are met through its own power plants, using coal as its primary fuel. Chart III, Energy Use by Sector by Fuel Source, illustrates this point.

The District Government, and the United States Government operations within the District, together consume 33% of the total energy, excluding gasoline. Together, they account for 37% of the total electricity consumed. The residential sector uses about 57% of total energy when gasoline is excluded.

Single-family homes use 15.2 trillion BTU's, or approximately the same amount as multi-family dwellings, which use 17.2 trillion BTU's. About 34% of the total population of the District lives in single-family homes, occupying about 57% of the total gross square feet of residential space. The commercial/industrial/institutional sector is a catchall category. It includes everything from office buildings to banks to industry. The Institute for Local Self-Reliance is continuing research in this sector to estimate floor-area. The largest components of the institutional sector appear to be universities, churches, and hotels. (See page 25 for further breakdown.)

The office building sector uses about 26% of total energy in this category. Chart IV, End Use Consumption by Sector by Fuel Source, and Chart V, Energy Consumption by Function and Sector, show the spectrum.

As illustrated, most families use natural gas for cooking, space-heating, and water-heating. Almost 60% of space-heating in the residential sector is done with natural gas. Thirty-nine percent use fuel oil. Over 70% of District residents use natural gas for hot-water heating, with most of the remainder using fuel oil. The average residential unit uses between 31 and 38 million BTU's for hot-water heating, when it uses natural gas as the heating source. Space-heating requirements range from 102 million for a single-family detached home using natural gas, to 50 million for an average apartment unit. Cooking requires about 8 million BTU's per year for a natural gas stove. An illustration of this use is found in Chart VI, Average Fuel Use By Residential Unit By Function.

In the commercial/industrial/institutional sector, an almost equal amount of fuel oil and natural gas is used for space-heating. About half the water-heating for the commercial/industrial/institutional sector is done with natural gas.

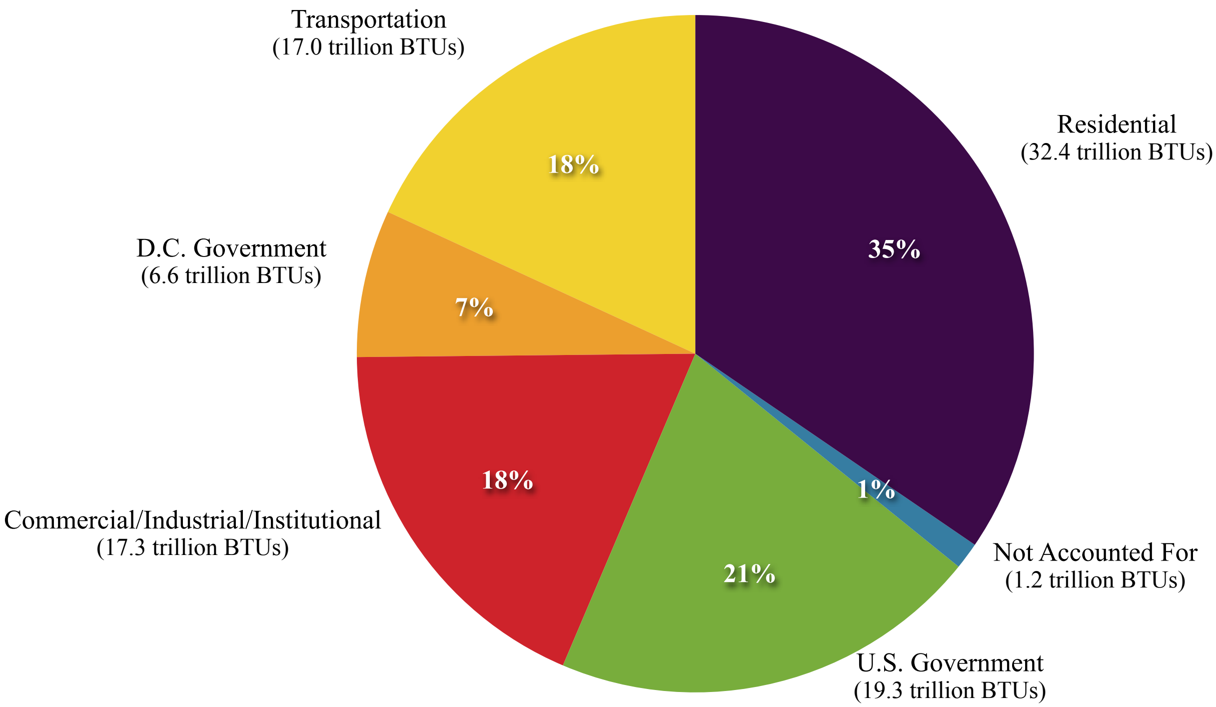
Washington, D.C. residents own as many appliances as residents of other American cities. An average home has more than two television sets. Almost 40% have two television sets, one black and white and the one color. The average residence for individually-metered electric customers is cooled by more than one air conditioner. One in five are central air-conditioning systems. About 25% of the population uses portable electric heaters.

### Chart III: Energy Use by Sector By Fuel Source [1]

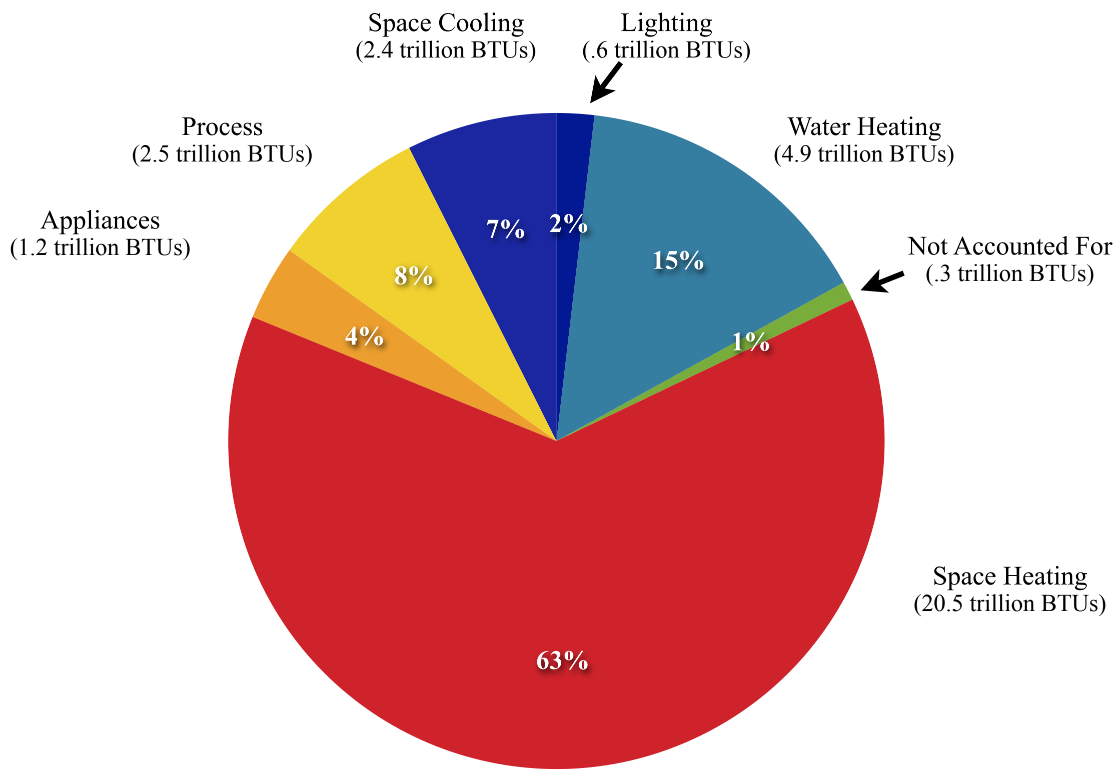
**($10^{12}$ BTU)**

| | Electricity | | Natural Gas | | Fuel Oil | | Coal | | NA | Total | % Total D.C. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | BTU | % | BTU | % | BTU | % | BTU | % | | BTU | |
| Residential | 4.8 | 23.0 | 18.2 | 70.8 | 9.4 | 40.2 | | | | 32.4 | 42.2 |
| Com/Ind/Inst | 8.2 | 39.2 | 5.4 | 21.0 | 3.7 | 15.8 | | | | 17.3 | 22.5 |
| U.S. Government | 6.1 | 29.2 | 0.8 | 3.1 | 6.8 | 29.1 | 5.6 | 100 | | 19.3 | 25.1 |
| D.C. Government | 1.8 | 8.6 | 1.3 | 5.1 | 3.5 | 15.0 | | | | 6.6 | 8.6 |
| Not Accounted For | | | | | | | | | 1.2 | 1.2 | 1.6 |
| TOTAL | 20.9 | | 25.7 | | 23.4 | | 5.6 | | 1.2 | 76.8 | 100 |
| % Total D.C. | 27.2 | | 33.5 | | 30.5 | | 7.2 | | 1.6 | | |

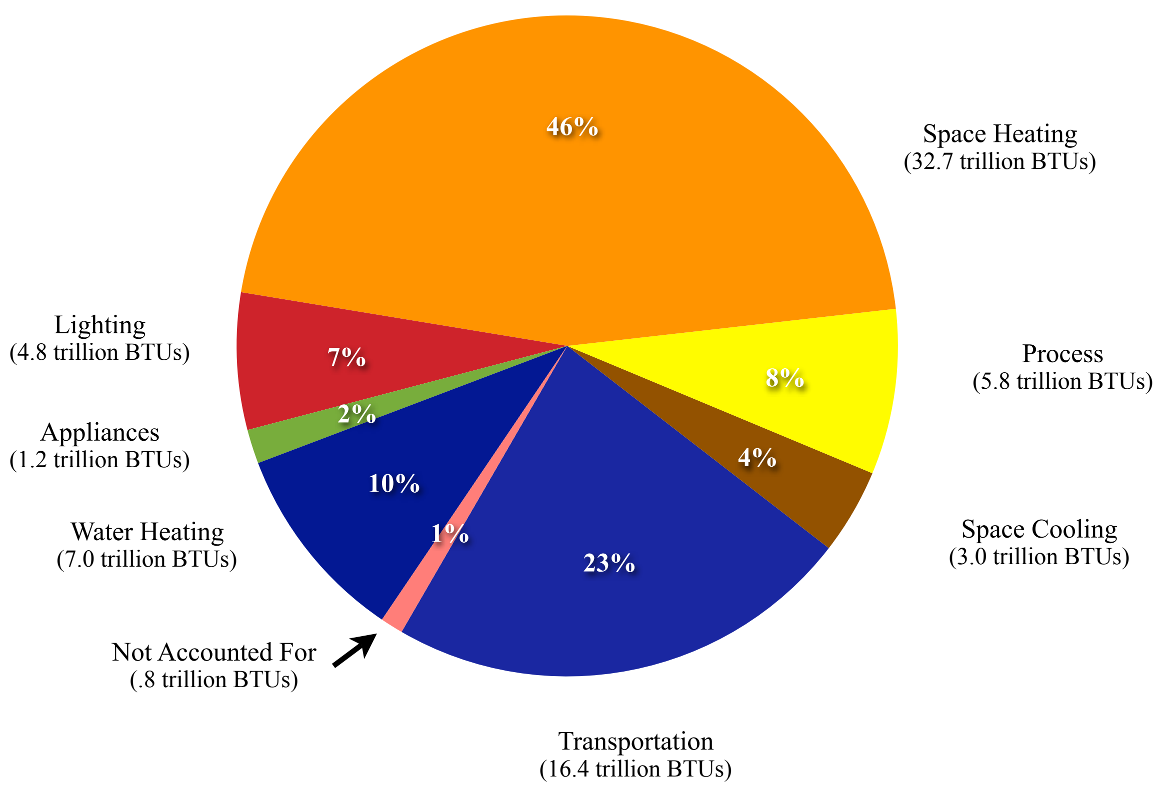
### Energy Consumption by Sector / 1977



**Residential End-use Consumption / 1977**
**(Excluding Transportation)**




**End-Use Consumption / 1977**
**(excluding U.S. Government)**



## Chart IV: End-Use Consumption By Sector and Fuel Source

**Fuel Source**
**($10^{12}$ BTUs)**

| End-Use Category | Electricity[a] | Natural Gas | Distillate Oil | Residual Oil | Coal[c] | N.A.[d] | Total | Res + C/I/I |
|---|---|---|---|---|---|---|---|---|
| Space Heating | | | | | | | | |
| Residential | 0.2 | 12.4 | 5.5 | 2.4 | | | 20.5 | 64 |
| Com/Ind/Ins | 1.5 | 5.6 | 2.3 | 2.8 | | | 12.2 | 51 |
| Water Heating | | | | | | | | |
| Residential | 0.1 | 3.5 | 1.3 | | | | 4.9 | 15 |
| Com/Ind/Ins | 0.2 | 1 | 0.9 | | | | 2.1 | 9 |
| Space Cooling | | | | | | | | |
| Residential | 2.2 | 0.2 | | | | | 2.4 | 8 |
| Com/Ind/Ins | 0.6 | | | | | | 0.6 | 3 |
| Lighting | | | | | | | | |
| Residential | 0.6 | | | | | | 0.6 | 2 |
| Com/Ind/Ins | 4.2 | | | | | | 4.2 | 18 |
| Appliance[e] | | | | | | | | |
| Residential | 1.2 | | | | | | 1.2 | 4 |
| Com/Ind/Ins | | | | | | | | |
| Process | | | | | | | | |
| Residential | 0.5 | 2 | | | | | 2.5 | 8 |
| Com/Ind/Ins | 3.5 | 0.1 | 1 | 0.1 | | | 4.7 | 20 |
| Not Accounted For | | | | | | 0.8 | 0.8 | 1 |
| Totals | | | | | | | | |
| Sub-total | 14.8 | 24.8 | 11 | 5.3 | | 0.8 | 56.7 | |
| Residential | 4.8 | 18.1 | 6.8 | 2.4 | | | 32.1 | |
| Com/Ind/Ins | 10 | 6.7 | 4.2 | 2.9 | | | 23.8 | |
| NA | | | | | | 0.8 | 8 | |
| % All D.C. | 26 | 44 | 19 | 9 | | 1 | | 100 |
| Residential | 8 | 32 | 12 | 4 | | | | 57 |
| Com/Ind/Ins | 18 | 12 | 7 | 5 | | | | 42 |
| Not Accounted For | | | | | | 1 | | 1 |

a) Electricity consumption at point of use. b) Group-metered apartments (GMA) and master-metered apartments (MMA) are included c) U.S. Government consumes approximately 100% of coal-fueled energy d) Not Accounted For e) For breakdown of the residential components of lighting, appliance, and process by building type see Appendix A.

## Chart V: Energy Consumption by Function and Sector[1] District of Columbia, 1977 (includes U.S. Government).

| Residential | $10^{12}$ BTU | % |
|---|---|---|
| Space Heating | 20.5 | 64 |
| Water Heating | 4.9 | 15 |
| Space Cooling | 2.4 | 8 |
| Process Use2 | 4.3 | 13 |
| Total | 32.1 | 100 |
| | | |
| **Commercial/Industrial/Institutional** | **$10^{12}$ BTU** | **%** |
| Space Heating | 24.2 | 56 |
| Water Heating | 3.4 | 8 |
| Space Cooling | 1.0 | 2 |
| Process Use | 14.6 | 34 |
| Total | 43.2 | 100 |
| | | |
| Residential + Comm/Ind/Inst - | $76.8 \times 10^{12}$ BTUs | |

[1]See footnote 1, page 7.
[2]Includes lighting and appliances

## Chart VI: Average Fuel Use by Residential Unit by Function (Therms/year)

| | Space Heating | Water Heating | Cooking | Total |
|---|---|---|---|---|
| Townhouse | 700 | 336 | 72-84 | 1,120 |
| Single family (Detached) | 1,020 | 384 | 84 | 1,492 |
| Apartment | 500 | 316 | 83 | 900 |

WGL Statistical Information
Source: Mr. Ron Boone, Washington Gas Light Company

The total energy used for appliances, however, excluding water-heaters but including air conditioners, represents less than 12% of the total residential use. However, it represents more than 80% of the electricity used in the residential sector, except in all-electric homes. (For further information, see Chart VIII,Appendix A,entitled Residential Appliance Saturation (Residential Individually-Metered Customers).

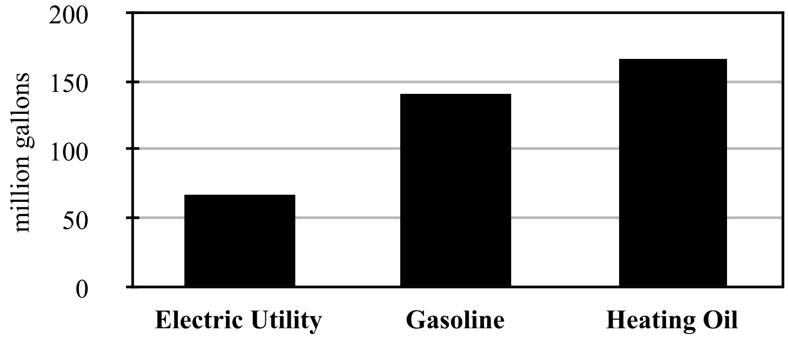
In the commercial/industrial/institutional sectors, space heating consumes about 50% of the total energy, while in the residential sector over 63% of total energy is used for space heating. Three percent of the energy in the residential sector is used for lighting (but almost 25% of the total electric requirements), whereas in the commercial office building sector about 20% of the total is used for lighting, which constitutes 60% of total electric consumption.

**Transportation:**

The transportation sector in the District, when the U.S. government's energy consumption is included uses 18% of total energy, or 17.0 trillion BTUs.[1] Excluding the U.S. Government, it represents 23% of total energy. Gasoline sales to D.C. residents accounted for 38% of petroleum utilization in the District of Columbia, as shown in Transportation Table T-1. The amount of gasoline consumed by different sectors of the D.C. economy is shown in Transportation Table T-2. Work-related transportation consumes about 21% of total transportation energy.[2] Seventy-seven percent of District residents worked within the District of Columbia, and 49% of work-related trips by District residents travelling within the District were done by public transit.[3] Estimated mileage of D.C. registered vehicles is shown in Transportation Table T3.

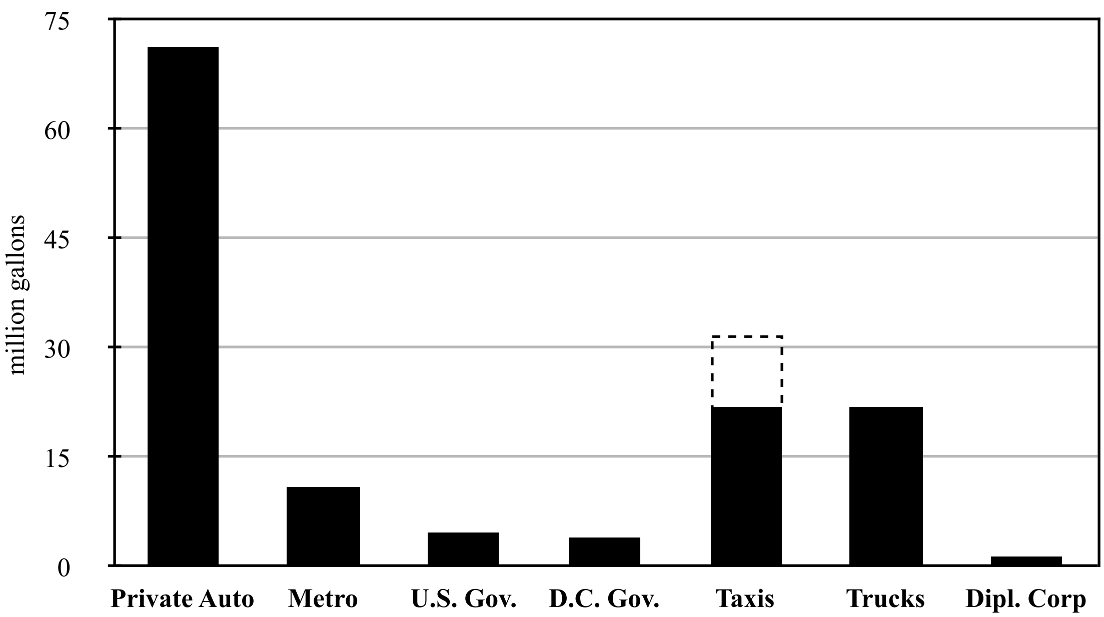
Metrorail electricity consumed approximately 50 million kilowatt hours, or 174 billion BTU's for transportation within the District of Columbia.[5] Metrorail bus consumed 1.8 trillion BTU's for area-wide transportation.[6] Truck traffic represented about 10.6% of the total miles travelled in Washington , D.C. in 1976.[7]

**Table T1: Petroleum Utilization in the District of Columbia, Listed by Purpose, 1977**

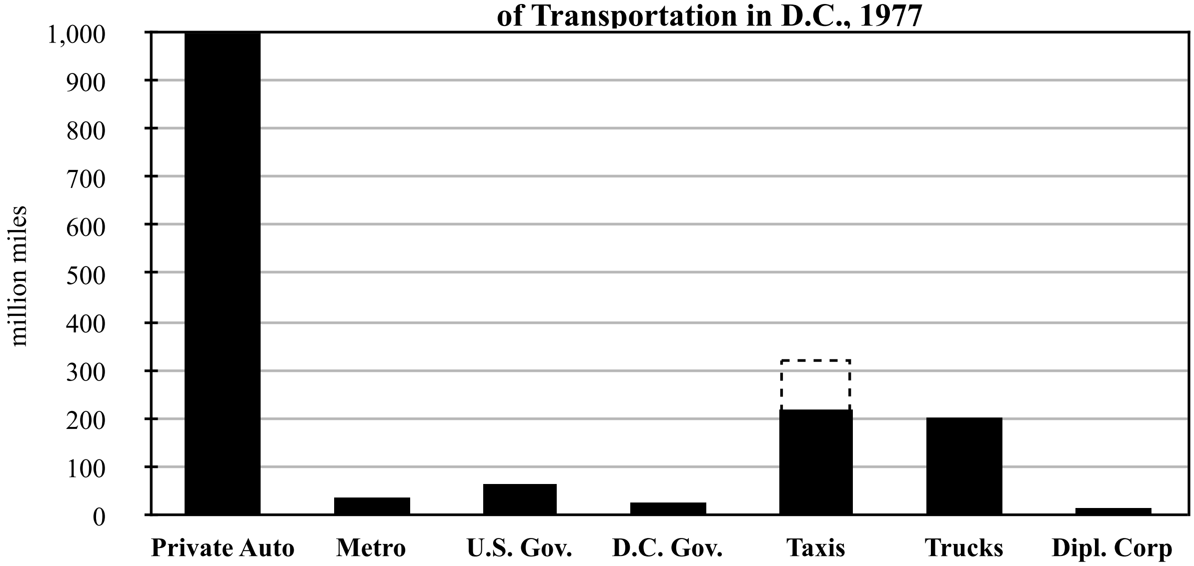



The pattern which emerges from an analysis of the District's energy picture is that the primary user is the residential sector; the primary fuel is natural gas; and that the primary cost is for electricity. The major area for conservation is in space heating, but there appear to be substantial opportunities for conservation in all areas. Given the variety of consumption patterns by sector (e.g., lighting in the office buildings versus appliance use in the residential sector), strategies may be tailored to the specific needs of that sector.

**Table T2: Gasoline Consumption in the District of Columbia, 1977**



## Table T3: Miles Traveled by Sector and Mode of Transportation in D.C., 1977




**Energy and Dollars: The District's Energy Balance of Payments:**

The lion's share of dollars which are paid for energy by District residents and the local government leaves the city. If the city is compared to a nation, the export of energy dollars can be viewed as a balance-of-payments problem.

Of the $602 million spent for energy in 1977 by the District, including energy expenditures by the U.S. Government's operations in the District, $78 million, or 13%, returned in wages, taxes, or other direct benefits. (See Chart VII - District of Columbia Energy Related/ Dollar Flows.) Excluding the U.S. Government, the District spent $416 million in 1977 for energy. Approximately $54 million was retained, of which only $16 million, or 30%, went to wages and salaries

## Chart VII: District of Columbia Energy-Related/Dollar Flows

**(including U.S. Government)[8]**

| | Electricity | Gas | Fuel Oil | Gasoline | Coal[b] | Total |
|---|---|---|---|---|---|---|
| Amount Spent | $288,958,000 | $77,852,914 | $66,692,380 | $90,129,000 | $9,903,794 | $533,536,088 |
| D.C. Wages[a] | $6,506,101 | $3,539,803 | $463,621 | $7,401,268 | $1,786,824 | $19,697,617 |
| D.C. Employee Income Tax | $219,705 | $150,639 | $20,014 | $202,875 | $81,972 | $675,205 |
| Dividends[c] | $1,471,057 | $379,447 | | | | $1,805,504 |
| Goods & Services[d] | $1,739,600 | $705,000 | Insig. | Insig. | | $2,444,600 |
| Proprietors Net Income | | | $1,179,243 | $467,219 | | $1,646,462 |
| D.C. Taxes | $20,764,656 | $4,926,400 | $1,704,778 | $13,340,118 | | $40,735,952 |
| Total Retained | $30,701,119 | $9,701,289 | $3,367,656 | $21,411,480 | $1,868,796 | $67,050,340 |

## Chart VIII: District of Columbia Energy-Related & Dollar Flows

**(excluding U.S. Government)[8]**

| | Electricity | Gas | Fuel Oil | Gasoline | Coal[b] | Total |
|---|---|---|---|---|---|---|
| Amount Spent | $202,270,688 | $75,439,474 | $50,019,285 | $88,326,420 | | $416,055,867 |
| D.C. Wages[a] | $4,554,271 | $3,430,069 | $347,716 | $7,253,243 | | $15,585,299 |
| D.C. Employee Income Tax | $153,794 | $145,969 | $15,011 | $198,818 | | $513,592 |
| Dividends[c] | $1,029,740 | $367,684 | | | | $1,397,424 |
| Goods & Services[d] | $1,217,720 | $683,145 | | | | $1,900,865 |
| Proprietors Net Income | | | $884,432 | $457,875 | | $1,342,307 |
| D.C. Taxes | $14,535,259 | $4,773,682 | $1,278,584 | $13,073,316 | | $33,660,841 |
| Total Retained | $21,490,784 | $9,400,549 | $2,525,743 | $20,983,252 | | $54,400,328 |

for District residents. (See Chart VIII - District of Columbia Energy Related/Dollar Flows.)

About 16% of PEPCo's workforce are D.C. residents, while 43% of its total revenue comes from the District. D.C. residents also comprise about 16% of the workforce of Washington Gas and Light, although D.C. purchases 25% of the systemwide gas. D.C. residents also hold lower paying jobs. If D.C. residents were proportionately represented on the payrolls of the two utilities, D.C. payrolls would increase from $6.5 million to $22.8 million in the case of PEPCo and $3.9 million to $11 million in the case of Washington Gas and Light.

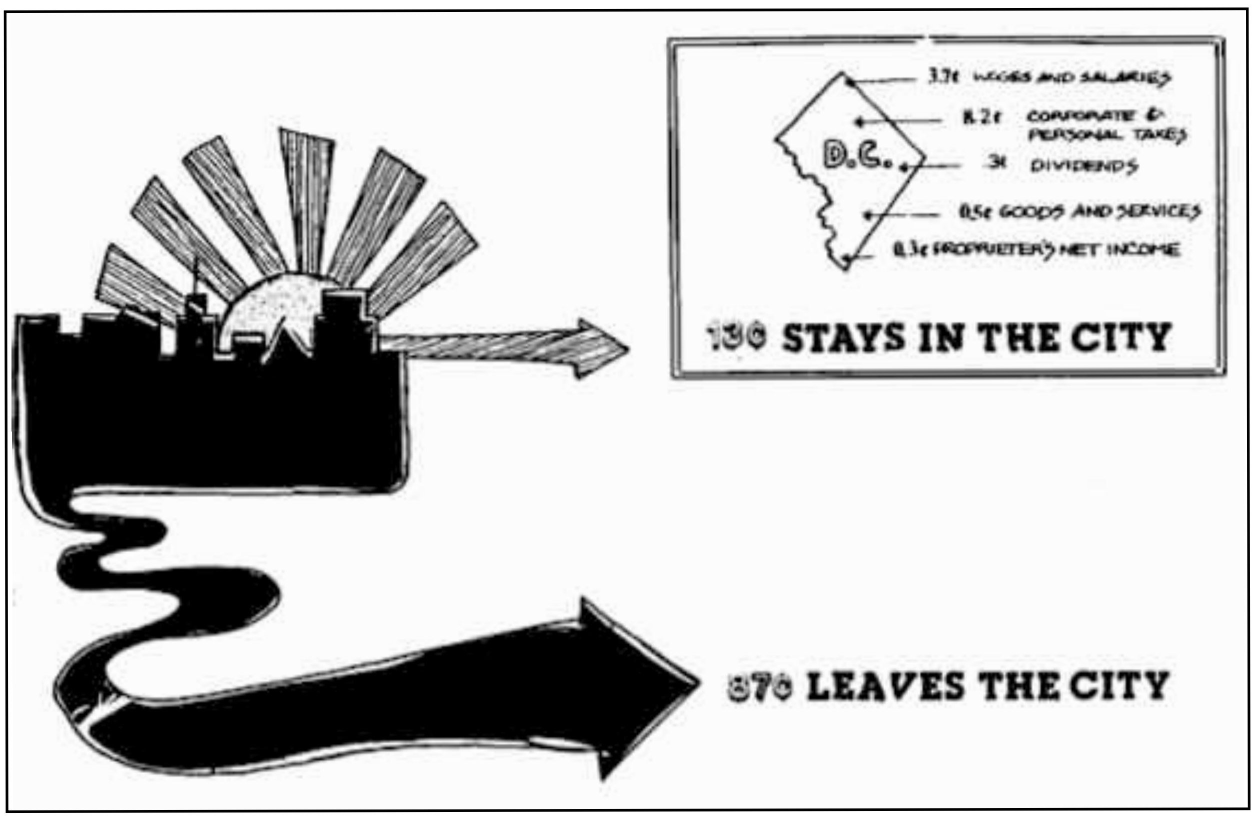
If these changes had taken place, the portion returning to the city in wages and salaries would have risen by 79%, to 54% of the total retained income. However, even with this additional income, the overall amount returning to the city would increase only by a nickel on the dollar, from 13 cents on the energy dollar to 19 cents.

Of the money which currently returns to the city, almost two-thirds or $34 million, goes to the city government in the form of taxes. However, this was surpassed by the $41 million spent by the District 'government in 1977 on energy for its own operations.

Prices of all fuels except gasoline have been rising more rapidly than the national and metropolitan Consumer Price Indices. Prices of electricity rose faster than all others, almost twice as rapidly as the national Consumer Price Index. This is doubly significant because electricity is our greatest single energy source, representing almost 42% of the total. (In these and most of the tables and charts accompanying this chapter, the U.S. Government consumption figures are generally excluded. This was done for two reasons: first, the District of Columbia has no direct influence over federal consumption patterns; second, any savings in that sector would not accrue to the local economy.) This trend is illustrated in Charts IX and X, Energy Prices and Annual Average Price Increase. (For a comparison of D.C. energy price increases compared to the national average refer to Appendix K.)

The price increases in energy will have a continuing and aggravated effect on the economy of the city. The city government is already spending more on energy than the entire operating budget of the District courts and almost as much as the operating budget of the University of the District of Columbia. Projected to 1985, residents, businesses, and city government would be spending as much on energy as its total projected 1980 budget.

Rising energy prices affect different segments of the District population differently. It has already caused

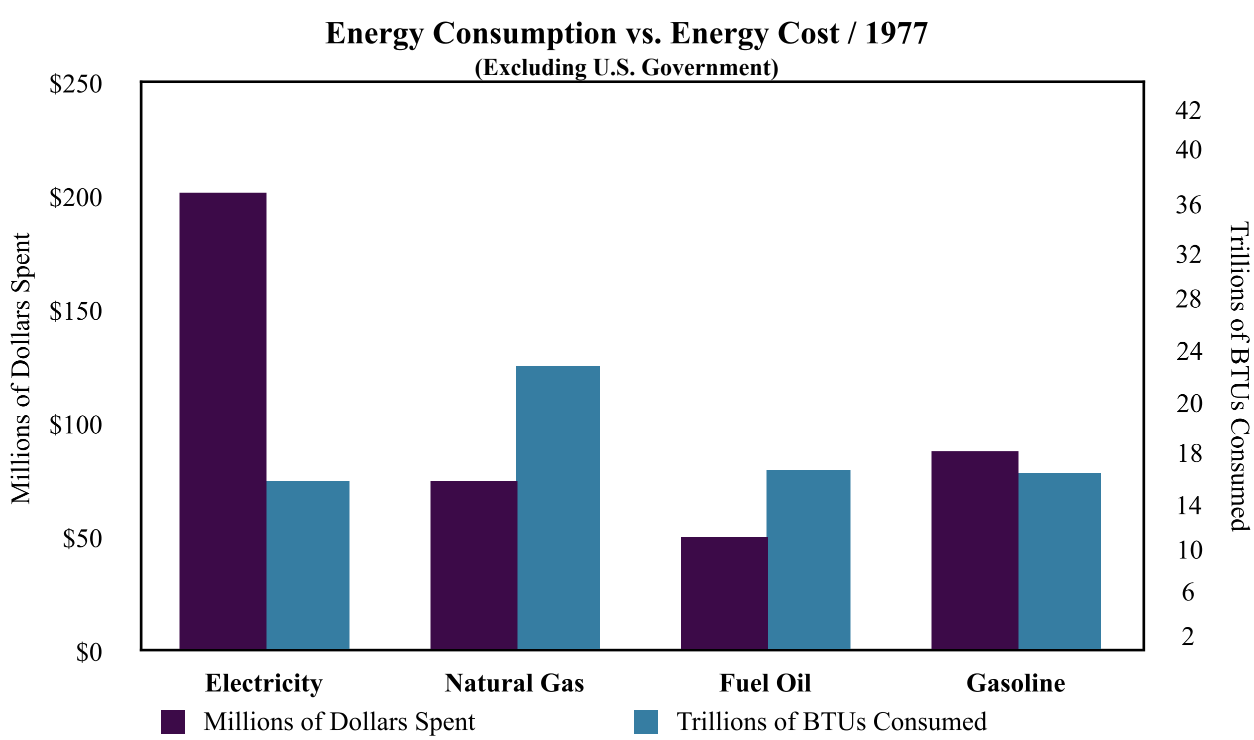


## Chart IX: Energy Prices (in cents)

| Energy Source | 1972 | 1975 | | 1977 | |
|---|---|---|---|---|---|
| | | Constant | Current | Constant | Current |
| Electricity[9] (per kwh) | 2.03 | 2.95 | 3.51 | 3.70 | 4.61 |
| Natural Gas[10] (per therm) | 13.6 | 18.2 | 21.9 | 24.3 | 30.4 |
| Gasoline[11] (per gallon) | 40 | 47 | 58 | 47 | 65 |
| Fuel Oil [12] (per gallon) | 19 | 31 | 36 | 39 | 47 |
| Coal[13] (per ton) | 1,900 | 3,600 | 4,100 | 4,300 | 4,800 |

## Chart X: Annual Average Price Increase

| Energy Source | 1972-1977 | | 1972-1975 | | 1975-1977 | |
|---|---|---|---|---|---|---|
| | Constant | Current | Constant | Current | Constant | Current |
| Electricity (per kwh) | 12.75 | 17.83 | 13.27 | 20.02 | 11.99 | 14.60 |
| Natural Gas (per therm) | 12.30 | 17.45 | 10.20 | 17.21 | 15.55 | 17.82 |
| Gasoline (per gallon) | 3.28 | 10.20 | 5.52 | 13.90 | 0 | 5.86 |
| Fuel Oil (per gallon) | 15.47 | 19.85 | 17.73 | 23.74 | 12.16 | 14.26 |
| Coal (per ton) | 17.74 | 20.36 | 23.74 | 29.22 | 9.29 | 8.20 |



tension among different sectors of the District bureaucracy. The Board of Education has recently ruled that schools cannot remain open after school hours unless those using those facilities agree to pay the greatly increased utility bills. The D.C. Department of Recreation, the primary supervisor of the facilities at this time, has disagreed with the new policy, supported by angry citizens who were previously unaware of this indirect effect of the. energy crisis.

Low-income residents spend a greater portion of their income on energy than do higher-income residents. Nationally, the wealthiest 10% of the population spend about 4% of their income on energy. The poor pay about 20 to 25%. Because the fixed monthly minimum charges comprise a significant portion of their total energy bills, they pay a greater amount per million BTUs of energy consumed than do higher-income families. Rising energy prices have already impacted considerably on the poor. A recent survey conducted in Few work State on the impact of rising energy costs on low-income elderly residents of that state found that "hardships are negatively impacting the quality of living of this group, causing negative changes in life styles, behavior, mood, health and safety."[14] The report included some comments from the elderly about how their lives have changed. Said one person: "I sit in the dark sometimes so I don't have to use lights. I used to read a lot, but I've cut back on reading. Lights are too expensive."[15]

Energy costs rose between 1972 and 1977 from 9% to 22% of operating costs for apartment and office building owners. This forced the introduction of escalator clauses in office building contracts and led to rent increases for many District residents. The D.C. Rental Accommodations Act permits a 2-9% automatic pass through of energy costs depending on what kinds of utility services the landlord supplies. In HUD-subsidized housing where tenants pay directly for electricity or other utilities, a "Personal Benefit Expense"(PBE) allowance is provided to cover the costs of these utilities where the increases push the overall housing cost above 25% of the tenant's income. This allowance is based on estimated costs and is subject to periodic adjustment.

> However, during a period of rapidly rising energy costs, realistic PBE levels are hard to set and to maintain. As a consequence, low- and moderate income tenants may end up paying considerably more of their incomes for total housing expenses than the 25 percent they are intended to pay for a period of some months before a readjustment can be effected..[16]

## Chapter 1 Footnotes

1. Total gasoline consumed in 1977 was estimated from the D.C. Department of Finance and Revenue Fuel Tax Reports which record purchases of gasoline in the District of Columbia. To this was added the energy consumed by Metrorail. In 1977 Metrorail consumed 72,732,512 kWh (obtained from PEPCO) We assumed that 70% of this was allocated for use within the District of Columbia which converted into BTUs, equals 174 billion BTUs, Added to 17.0 trillion BTUs for gasoline consumption, we estimate 18% of total energy (93.8 trillion BTUs) and 23% of total energy excluding the federal government (71.7 trillion BTUs).

2. This data was derived from: Reference Tables of Travel Data and Related Demographic Data, Department of Transportation Planning, Metropolitan Washington Council of Governments, August 1978. Using 1975 data, we find:

Total auto driver work trips by District residents (per average weekday) -164,628
Total all purpose auto driver trips by District residents (per average weekday) -750,300
Thus 21.9% of total auto driver trips by District residents were work related.
Additional calculations are contained in Appendix N—D.C. Transportation Computations.

These figures were derived from data contained in MWCOG publication cited in footnote 10.

1975 Data:

| From/To | D.C Core and Non-Core Number of Transit Trips | % of Person Work Trips |
|---|---|---|
| District of Columbia | 168,200 | 49% |
| Montgomery County | 17,700 | 17% |
| P.G. County | 25,200 | 15% |
| Arlington | 22,900 | NA* |
| Alexandria | 14,100 | NA* |
| Fairfax | 15,700 | 20% |

*Data from COG data table appears in error.

1985 Data:

| From/To | D.C. Core and Non-Core Number of Transit Trips | % of Person Work Trips |
|---|---|---|
| District of Columbia | 249,400 | 72% |
| Montgomery County | 56,800 | 46% |
| P.G. County | 95,900 | 48% |
| Arlington | 46,200 | 76% |
| Alexandria | 29,600 | |
| Fairfax | 48,900 | 39% |

5. Op cit. #1.

6. 1976 WMATA Data.

7. Data obtained from MWCOG and is based upon a 1976 VMT Summary (vehicle miles travelled.

8. (a) Disposable income. The figure excludes amount paid in Federal and D.C. income taxes. (b) U.S. Government consumes approximately 100 percent of coal used in the District of Columbia. (c) The total dividend payments within the service area were multiplied by the percentage of total service area energy supplied to D.C. (43.9% of PEPCO; 25% of Washington Gas and Light). This was multiplied again, by the difference in medium income between central city and suburban residents (50.8%, and by 75% to include federal taxes. The total dividends paid by PEPCO were $8,878,000 and by WGL, k$4,047,438 in 1977. Information on PEPCO derived from letter from Don P. Brueggeman, Financial Analyst, Department of Financial Forecasting and Tax Analysis, September 6, 1978. WGL data adapted from phone conversation with Mr. Claytor, WGL Comptroller's Office. (d) The total spent for goods and services in 1977, exclusive of purchased gas or electricity and company payroll were weighted based on percentage of D.C. sales of total system sales. The purposed of this analysis is to trace direct, primary inflows to the District economy, Since D.C. has virtually no heavy industry, all procurements of equipment by energy suppliers. would be in the form of high volume (at least in the case of the two utilities) purchases from wholesale firms or local outlets of manufacturing companies. The economic impact of these purchases is relatively low because large volume suppliers operate at low margins; costs are primarily those involving the selling of the items themselves. Labor costs and profit are relatively minor components of the selling price. For example, electrical equipment wholesalers who serve the metropolitan Washington area from who PEPCo would purchase the vast majority, are located in D.C., Maryland, Virginia, Delaware, Pennsylvania and New Jersey. A generous assumption may be made that 20% of the purchases would be from the District. Total goods and services purchased by WG&L in 1977 totaled $14.1 million. PEPCo purchased $40 million.

9. PEPCo, Rate Administration Department. These are average figures obtained by summation and division of revenue amounts for all rate codes by Kwh amounts for all rate codes.

10. WGL, Rate and Regulatory Affairs Department. These are average figures obtained by summation and division of revenue amounts for all rate codes by therm totals for all rate codes.

11. E.K. Williams Co. of Fairfax, accountants. Private communication.

12. A.P. Woodson Company and local fuel-oil companies. Private communication, consumer relations departments.

13. U.S. Government Defense Supply Center, Department of the Army, Directorate of Procurement and Production, private communication.

14. Adapted from The Impact of Rising Energy Costs on the Elderly Poor in New York State. Welfare Research, Inc., Albany, New York, January 1978 as cited in Energy Pricing Policies and the Poor by Eunice S. Grier, The Grier Partnership, a paper presented before a conference on "Energy and Equity: Some Social Concern," sponsored by the Joint Center for Political Studies, Washington, D.C., June 27, 1978, page 11.

15. Grier, George and Eunice, The Economy of the District of Columbia and the Potential Impact of Electric Rate Increases. Prepared for the People's Counsel in connection with Formal Case 685, May 1978, page 44.

16. From Energy Pricing Policies and the Poor, adapted from The Impact of Rising Energy Costs on the Elderly Poor in New York State, op. cit.

# CHAPTER 2

## A Brief Digression on Economics

When we hear the phrases, "Solar energy is uneconomical", or "It is most economical to install 10 inches of insulation in the attic in this climate", we are hearing conclusions based on a variety of assumptions that are not immediately apparent. The economics of energy, as of most anything, depends, to a great extent, upon who is doing the evaluating, and the method by which they are making the evaluation.

Not all decisions are made on the basis of dollars and cents. Individual consumers often make purchases based on qualitative criteria, such as personal satisfaction, aesthetics, etc. They may compare among different brands for the most inexpensive, but it is rare that a television set, or an automobile, or furniture is viewed with the same kind of investment criteria as would a financial investment in stocks or bonds.

Even when evaluating investments in energy using one of the procedures outlined below, consumers may decide that the qualitative factor of self-reliance may lead them to invest more money in a solar energy system than would be the case using a strict economic criteria. Businessmen, wary of future cutoffs in natural gas, may decide that they will maximize investments in conservation or switch to another fuel source, even though the economics do not at the current time seem attractive.

However, dollars and cents are the major criteria for analyzing most investments. There are three primary methods for determining the economic attractiveness of an investment.

**Simple payback analysis:** The initial cost of an item is divided by the annual energy savings. The result is the number of years required to pay back the original investment, through cumulative energy savings. The purchaser makes the decision as to the "payback period" which is acceptable for his purposes.

The payback analysis can be made more meaningful by including calculations of future price increases. Assumptions then must be made about how rapidly prices will change over time, and about the future cost of money and interest payments. The more rapidly that one assumes energy prices will increase in the future, the shorter will be the payback period and thus the more attractive the investment. (Another way of viewing this is that the more rapid the price increases in energy, the greater initial investment is justified in conservation or solar energy.)

**Return on Investment (ROI):** This analysis is often used when comparing a variety of investments. Often, the rate of return is evaluated when compared to investments which have less risk, and therefore presumably would have a lower return. For example, a savings account yields about 5% interest and a certificate of deposit returns about 8%. (One must remember to take into account the taxable aspects of the investment in this analysis.)

**Life-Cycle Costing:** The analysis of costs and savings under this method is based on the useful life of the product, equipment, or building. For example, one could compare two air conditioners which produce the same amount of cooling power, but use different quantities of electricity in production. It might be the case that the most inefficient one is also the least expensive to purchase, but over its life cycle, it would become more expensive once the operating or maintenance costs are included.

The calculations in each of these three methods are, in turn, affected by many factors. What will be the terms of the loan for the energy investment? Will it be a long-term mortgage at a low-interest rate, or a short-term home improvement loan at a high interest rate?

There are five primary actors in the energy sector: the individual consumer; the landlord; the businessperson; the utility company, and the government. The needs and investment criteria of each are unique.

The individual consumer often is concerned only with a payback period, or more likely, with the impact of the investment on his or her monthly payments. The goal in enticing the individual consumer to energy conservation or solar energy is to develop loan terms that permit most, or all, of the payments for the energy investment to be repaid through energy savings. Such financing schemes have been developed by private financial institutions, such as the San Diego Federal Savings and Loan Association, the Tennessee Valley Authority, and the Ocala Power Company. The economics of the same investment may be perceived very differently depending on the finance terms or other factors. An investment of $1,000 added on to a 30-year home mortgage at 9% interest results in monthly payments of $18.43, whereas a 3-year home improvement loan at 12% results in monthly payments of $33.40. The interest on the loans can be deducted form the homeowner's gross income. Therefore, someone in a 50% tax bracket would pay only 50% of the interest on the loan.

The landlord has usually not been concerned with energy prices in the past. Office buildings in the District of Columbia rarely had escalator clauses for utility price increases before 1974. Tenants paid their own electric and gas utilities, although heat was considered part of the landlord's responsibility. In the cases where the landlord paid energy costs, tax provisions permitted him to write these off as a business expense, thus effectively reducing by 50% the cost of the energy. This means that, given the same payback criteria as an individual consumer, the landlord would invest only half what the consumer would be justified in investing in conservation or solar energy.

For a long time, the commercial and industrial sectors have experienced very low energy costs as a percentage of their total costs. This varies, however, depending on the industry. Energy costs for supermarkets now rank second only to labor and occupancy.[1] Fast food outlets can spend as much as 7 cents on the retail dollar for energy. Businesses often compare investments based on a return-on-investment or cash-flow criteria. They also differentiate between investments in new product lines, and investments that reduce present costs. In one survey of manufacturing enterprises, it was found that many businesses require double the return or about 30% for energy-related investments as for product development investments.[2] This higher return means that energy-related investments require a shorter payback period. Added to the fact that energy costs can be deducted from business income as an expense, this makes significant energy-related investments the most difficult to justify in this sector, although it is also the business sector which has the most access to capital.

**Utility Companies:** Utilities that are regulated in this country are guaranteed a reasonable rate of return on their investments. In return for a virtually zero-risk situation, their current rates of return vary between 8-9%. This rate of return is calculated on their rate-base. There is a wide variety of accounting methods for calculating the rate-base around the country, and the controversy in utility rate cases usually revolves around three issues: the necessity for new construction; the rate of return required to attract new capital; and what other factors are calculated as part of the rate base. For example, several utilities, including PEPCo, have construction-work-in-progress (CWIP) as part of the rate-base, although the majority of public service commissions disallow this. On the other hand, no utilities at this time include investments in energy conservation in the rate base. A utility faced with the alternative of investing $1 billion in a new power plant, with a 9% return on the investment, or $1 billion worth of energy conservation, which guarantees no return, will find the former a more attractive investment, not necessarily because it is inherently more beneficial, but because the accounting procedures and rate-making structures make it so.

Public service commissions, which oversee utilities, establish the accounting procedures and the rate structures. The way the rates are established can lead the individual consumer, or the businessman, to view the economics of various energy investments quite differently.

For example, certain industries which generate waste heat in the production process have been able for many years to use the waste heat to generate electricity. However, this is economical only if they can sell the excess electricity not required within their own building to the utility company, and purchase power at other times at reasonable rates. The utilities have traditionally established rate structures which tended to discourage on-site power generation.

Studies by Stephen Feldman[3] and Bruce Anderson indicate that the rate structure is more important than any other item for making solar energy economical. (This can be as true for conservation measures.) Often at issue is whether the solar energy device displaces the need for future generating capacity, or if it only displaces fuel. This is quite important because about 50% of the cost of rate increases for electric utilities is the result of the need for additional construction. Assume that the solar energy user reduces his or her need for conventional energy sources by 90%. However, the 10% of the time he or she needs energy may occur at precisely the peak time for all users. The result is that the utility, in order to serve that solar energy resident 10% of the time, must have that peaking capacity available all the time, at a high cost to the utility. Currently, tests are being conducted by various utilities to determine how often solar.-energy usage and peak power parallel each other. However, it would be possible, as is now being done by the TVA, for a utility company to install a backup tank for the solar-energy system, with a device that would cut off the use of electricity at peak hours. The homeowner could use off-peak electricity to heat up the backup tank during periods of extended cloudiness. The utility would be guaranteed that such a homeowner would not need additional peak capacity. In that fashion, the utility could pass onto the solar energy user the savings from deferred investments in new generating plants.

The economics of solar energy, and/or energy conservation, will also look quite differently depending on the way the future cost of energy is defined. New natural gas flowing through pipeline may cost several times that of the historic price. The same is true of electricity generated from new power plants. Yet utilities normally average the new and the old, so those who are last to hook up are still paying a price based largely on the historically low cost of energy. This tends to discourage conservation and solar. The economics of conservation and solar are based on life-cycle costs, which are based on future energy prices. Ironically, however, they must be compared to current utility's rate structures, which are based on past energy costs.

Utilities are regulated by the public, and public service commissions must balance the public interest with the need for the utility to gain an acceptable return on investment to attract the capital necessary to maintain its operation.

Utilities may, however, be required to evaluate conservation and solar alternatives in the light of their marginal costs. Reevaluation is already being conducted in some parts of the country. Pacific Power and Light, in Portland, Oregon, estimated that the kilowatt hour cost of adding new power plants for new residential heating requirements was in excess of 4.2 cent per kilowatt hour. It requested, and obtained, permission from the public service commission of Oregon to install weatherization materials at no charge, to be repaid, with no interest, no later than the time the ownership of the dwelling is transferred by any means. Schedule 8 of the revised rate schedule notes, "To the extent that the average installed costs of selected energy savings materials for eligible dwellings results in a cost of less than 1.8 cents per kilowatt hour, the Company will offer service under this schedule." Portland Gas and Electric follows a similar policy. The costs of installation are included in the utilities rate base providing at present a 9% return. The Public Service Commission found that the internal economics, once marginal costing was used, was so great that it used the utilities as a mechanism for almost diving away weatherization materials (when the installation price is discounted by the rate of inflation, and the no-interest charge of money over an average 6-year period before property is transferred).

Local government can evaluate energy investments from the perspective of greatest public good. Federal law requires state governments and the District of Columbia to establish procedures for consideration of energy costs as one factor in the purchase of products. A number of states now require all new buildings which are leased or constructed in the public sector to undergo a life-cycle cost-analysis to compare different designs for total cost over the life of the building. Government is a corporation, but it is a public corporation. Its goal is not to maximize profit, but to maximize the benefits of an investment to its service area. Since the government can directly affect the way in which each of the other actors perceives the attractiveness of an energy investment (e.g. through financing mechanisms, tax incentives, mandatory legislation, utility accounting mechanisms, etc.), it can play an integrating and comprehensive role in energy planning. Energy conservation and solar energy not only save energy; they save money, and this money multiplies its beneficial impact in the local economy. (See Chapter III, page 36.) In addition, it also creates jobs oriented to locally-based, small businesses. (A local government can also take into account the qualitative measures of self-confidence and self-reliance, which can result when a local area begins to use its own resources to supply its own needs.)

Localities have already begun to enact legislation which demonstrates their realization of the multiplier benefits of local spending. Washington, D.C., as well as several other cities, requires that future public employees live within the city. Recently, the city stopped purchasing fuel oil through the federal General Services Administration, buying directly from a minority-owned, locally-based wholesaler instead. In doing so, the cost to the city was increased by about 10%; but the city was willing to pay for the benefits of buying locally.

When the private sector makes an investment, it decides what rate of return it requires to justify the investment. When the public sector makes an investment, it, too, must make a decision on the rate of return. This factor is called the discount rate, and most of the controversial decisions reported by the media concerning the funding or refusal to fund projects is based on a cost-benefit analysis which often revolves around the discount rate. The government can decide to use the same rate as the private sector. If it does so, the presumption is that it will not invest money any more rapidly than would the private sector. Conversely, it can lower the discount rate as an agent of the general public.

In the debate between Congress and President Carter on the series of water projects which he had vetoed, the controversy swirled around the discount 'rate used in evaluating the benefits, and costs, of those projects. In the 1960's, Lyndon Johnson established a 10% discount rate which the federal government would use in evaluating all investments, except water projects, where it would be 4%. This meant, basically, that an investment in most federal projects had to repay itself in fewer than 10 years, but, in the case of water projects, the payback period could extend to 25 years. The lower the discount rate, the longer the permissible payback period, and the greater the initial investment which can be justified. Dams and other water projects were believed to have a social benefit which should be integrated into the formula for evaluating investments. President Carter wanted this rate increased to 10%. By doing so, it would have rendered several projects economically unattractive.

The local government is faced with several choices. Since government tends to house itself in the same buildings for a longer period of time than would an individual homeowner or renter, a longer payback period could be justified in evaluating investments in conservation or solar energy. For example, the Maumee (Ohio) School Board recently approved certain energy conservation investments with estimated payback periods as long as 17 years. However, by reducing the discount rate or lengthening the payback period, the city is accepting the need to make larger initial investments. If one needs to be repaid quickly, one will tend to make only low-cost investments. A 5-year payback period may be used to justify an investment of $50,000 in a large building. A larger payback criteria would justify larger investments. A 20-year payback might justify spending $150,000 for the same building. However, agencies are unlikely to take this investment from current operating budgets. Therefore, most government agencies are currently conserving only when it requires no capital investment. 'The 10 to 20% savings which can be achieved even in these cases is significant, but will not economically maximize conservation or solar investments.

Nowhere is the tension between individual economics and social economics more prevalent than in the "economics" of solar energy. For example, in a recent review of studies relating to jobs and energy, Meg Schachter concludes[4]:

> For the same amount of energy, solar creates 55-80 times as many direct jobs as LNG* However, at today's LNG and collector costs for future costs greater than $15/ft1) , solar will cost more to provide an equivalent amount of energy.
> ...For the same amount of energy, solar heating systems create 2 to 8 times more direct jobs than conventional power plants.... However, at today's collector costs and electricity rates less than $0.04/kwh, solar will generally be uneconomical in comparison with conventional alternatives.

*Liquefied Natural Gas

From the vantage point of a homeowner, the solar system, based on these assumptions, would not be economical. However, the economics would change from a local government viewpoint. Assume, for instance, that Washington, D.C. assists its citizens in installing $100 million of solar systems. Assume that over 20 years the system repays only $60 million. Let us further assume, however, that under current arrangements, only 20 cents on the dollar spent for conventional energy returns to the city. Certainly most of the money for LNG ends up either in Algeria, or at Exxon, or the local utility. Let us assume further that 6:0 cents on the dollar invested in solar, returns to the city to pay for the installation by local firms, or manufacturing or assembly in local factories. Thus of the $60 million that would have been spent had not the solar installations occurred, only $12 million returns to the city. In the case of solar, 60% of the $100 million , or $60 million, returns. This retained earnings figure has multiple benefits. Local wages purchase local goods. Local businesspeople in turn purchase local goods. People deposit money in the local financial institutions and the banker loans it out to other consumers, or businesspeople. There are no very accurate estimates of this multiplier effect for small areas. Roughly, however, Washington, D.C. has a sales multiplier of 2.5 to 1. Thus $2.50 in local gross sales is generated for every $1 of additional income to local residents.

Thus in our example, the city would in the solar case be paying out $100 million and getting back $150 million in local sales. If it continued purchasing natural gas, it would pay out $60 million and get back $30 million, giving solar, from a social vantage point, a decided advantage.

Economics is not immutable. As a society we set the parameters, the criteria, the basic assumptions. The role of the city government is to develop the mechanisms to permit the individual sector's perception of self interest to coincide with that of the city as a whole.

## CHAPTER 2 Footnotes

1. Federal Energy Administration Guide to Energy Conservation for Grocery Stores, Office of Energy Conservation and Environment: Washington, D.C., U.S. Government Printing office, pages 32-33.

2. Hatsopoulos, Gyftopoulos, Sant and Widmer, "Capital Investment to Save Energy." Harvard Business Review, March-April 1978, Volume 56, No. 2.

3. Feldman and Anderson, Utility Pricing and Solar Energy Design, October 1976, Clark University, Worcester, Massachusetts, page 120.

4. Meg Shachter, "The Job Creation Potential of Solar and Conservation: A Critical Evaluation," prepared for the U.S. Department of Energy, November 6, 1978.

# CHAPTER 3

## Energy Conservation and Economic Development

**The Potential For Conservation:**
Under provision of the Energy Conservation and Production Act of 1975 and the Energy Policy and Conservation Act of 1976, the District of Columbia is required to enact the following measures in order to be eligible for continued energy-related federal funding:

1. mandatory thermal efficiency standards and insulation requirements for all new buildings;
2. mandatory lighting standards for new and existing public buildings;
3. mandatory standards related to energy efficiency in the procurement of goods;
4. at least one program to promote the availability of carpools, vanpools, and public transit;
5. right-turn-on-red-light;
6. public education programs on energy conservation;
7. availability of various levels of energy audits to businesses and residences.

The objective of these federal regulations was to reduce by 5% the projected energy consumption in 1980. Since the District has already reduced energy consumption by almost 17%, although lacking on official policy, District energy use is about 50% below that projected by the U.S. Department of Energy computer models.[1] The federal legislation cannot be seen as a spur to aggressive state or local initiatives, but rather as an inducement to begin to integrate energy concerns into local planning efforts.

The District city council is in the process of preparing its own conservation plan. The city council is adopting Bill 2-397, 1978 District of Columbia Energy Conservation Code. It will apply:

> ...to all new buildings and other structures or portions thereof hereafter erected and to existing buildings and other structures where the alteration and repair work of such buildings involves the reconstruction of the building envelope or the replacement or modification of systems which utilize energy; and to the illuminating systems of existing buildings open to the public.

The impact of this code will probably be minimal for two reasons: 1) it applies primarily to new buildings; 2) its provisions nominal. In the residential sector, housing stock turns over very slowly. New units constructed averaged between 436 in 1975, and 2,194 in 1977,[2] a peak year. With a total housing stock of 272,000 units, the maximum turnover is .8% per year. This greatly limits the impact of the proposed code.

In the commercial sector, there is a higher turnover. Of the total 46 million square feet (including that leased to federal government) 1.7 million are projected for 1978. Thus, there is a turnover of approximately 3.6% in this sector.[3]

According to one 1975 study of the impact of ASHRAE 90-75, the standards upon which the D.C. code is based, implementation would decrease by 60% the amount of energy consumed in an average office building, and there would be a 27% reduction in energy use by a conventional single-family dwelling.[4]

However, testimony from work sponsored by ILSR has pointed out that many new buildings designed in 1975-1976 and analyzed by the American Institute of Architects as an input for developing national building energy performance indices were already exceeding ASHRAE 90-75 goals.[5]

It has been difficult to ascertain the levels of energy efficiency to which new buildings are currently being designed: thus it is unclear whether the new conservation code will achieve these reductions. A recent survey of builders undertaken by Dow Chemical found that 73% in the Washington, D.C. area were building single-family homes to standards significantly higher than those required by the new energy conservation code. [6]

The Code requires a maximum lighting standard of 3 watts per square foot in existing public buildings. It is unclear what the present lighting levels of District public buildings are, but since many of them were designed more than a decade ago, when illumination design levels were lower, they may already be in compliance with this standard.

A second reason that the Code may have a marginal impact is that the standards themselves are quite minimal. The 90-75 Standard was established through a consensual process. It had to be acceptable to all members of the reviewing bodies, including builders, designers, and consumers.. Section 4.2 of the ASHRAE 90-75 standards clearly warn the user:

> The intent of this section is to provide minimum requirements for building envelope construction in the interest of energy conservation. These requirements are not intended nor should they be construed as the

> optimization of energy-conserving practices. (N.B. Emphasis in the original).

One major study of the impact of these standards found that actual construction costs would decline as a result of the decreased size of heating, ventilation and air-conditioning equipment. Design costs would rise slightly, resulting in an overall payback period of less than eight months for all types of buildings except single-family dwellings, which would have a 2.8 year payback. The report concluded, "The savings may be large enough to induce building owners to follow the standard on a voluntary basis, providing adequate information is available to them."[7] (Since this analysis was based on 1975 energy prices, and these have risen by more than 30% since then, the payback periods have dropped accordingly.)

The 90-75 standards are in the process of revision. 90-75R is about 15% more rigorous, i.e., energy-conserving, than the original 90-75 standards. Other national conservation standards are still more rigorous. For example, 90-75 requires a U (heat loss factor of BTU's per square foot per home) .21 through exterior walls, while the District Code requires .20, 90-75R requires .18, the National Association of Home Builders (NAHB) recommends .12, and the Federal Housing Administration (FHA) requires .11. The new building code permits single-family dwellings to have attic heat losses of .05 while the Suburban Maryland Home Builders Association has currently established a voluntary program which it expects the majority of builders to adhere to, one of whose criteria for the seal of approval is a heat loss of .03 or less through the ceiling.

Neither the D.C. Code nor the ASHRAE 90-75 standards require storm windows. The criteria for energy efficiency by the Suburban Maryland Home Builders Association does. The public service commission in Kansas mandates storm windows as a prerequisite to approval for new hookups for gas and electricity.

The D.C. Code requires an energy efficiency rating for air conditioners of less than 65,000 BTU/hour of 6.1, although several states, including Kansas and California, require much higher minimum efficiencies.

There is no legislation pending on conservation for existing buildings, but the success of conservation efforts in the District in the next ten years will depend primarily upon such conservation. ASHRAE is currently in the process of developing the 100.P. Standard series to apply to existing buildings. The goal of the 90-75 standards was to reduce energy consumption in new buildings by 50% below that effected by conventional building designs before the oil embargo. The objective of the 100.P. series is to bring consumption levels in existing buildings to the level of comparable buildings designed to the 90-75 standards.

Until such time as there is adequate energy audit information on various District structures, both before and after conservation efforts, it will be difficult to estimate the exact potential of conservation in the city. It is also true that no matter how effective the design, or the equipment, energy consumption depends heavily on sociological factors. "The mode of operation, and the quality of maintenance, can easily push up, or down, by 50% or more base design requirements. This is well documented ... and points up the fact that ultimately it is people that use energy, not buildings", says Fred Dubin, of the professional engineering firm of Dubin -Mindell -.Bloome Associates ar-1 Chalmers G Long, Jr.[8]

However, there is growing evidence that the potential for conservation is quite significant. The American Institute for Architects (AIA) surveyed experts in 1973 and found that, even based on those energy prices, "30% and 60% were reasonable averages of conservation potentials in old and new buildings, respectively. Studies since have reinforced these estimates to the point where they are now increasingly regarded as very conservative."[9]

Energy conservation efforts depend on two factors: what is technically possible, and what is economically feasible. Case studies in conservation from around the country consistently indicate that 20-30% savings are possible even with very short payback periods, and up to 50% of overall energy can be saved by stretching out the payback requirement. One study of New York City schools by the Board of Education found that even though N.Y.C. schools already use energy more efficiently than their counterparts in other parts of the country:

> With no mechanical changes and a dependence only on altering the use habits of the occupants and operating personnel, heating reductions of almost 25% and electrical reductions of 20% were achieved. Beyond this, our investigations project savings of almost 50% in new buildings frown the average levels, and the potential of reducing the energy expenditure in existing schools by over 25%.[10]

The first audit undertaken by the D.C. Department of General Services (DGS) concluded that Woodson High School could reduce its consumption by almost 25% merely by changing its operation, with little or no capital investment. A well-monitored four-year experiment in Twin Rivers, New Jersey realized a 65% reduction in space-heating requirements with payback periods of under ten years in existing townhouses. The authors concluded that even greater savings were possible.[11]

The American Retail Federation examined potential conservation measures under these strict assumptions: "Short payback period, wide range of applicability, ease of implementation." It concluded that, in most cases, a 20-30% reduction was possible with paybacks of less than a year.[12]

The Institute of Real Estate Management used the same criteria, adding:

> Most of the recommendations involved neither state-of-theart engineering nor dependence upon new products or technology, and will not require heavy capital investment. Savings can be achieved through better maintenance, minor modifications of environmental controls, and a positive attitude about energy conservation. Common sense is one of the most essential ingredients in any successful program.

It concluded that "...through sensible management of energy use, a 20-30% reduction is possible in apartment buildings."[13] According to the Apartment and Building Owners Association in Washington, D.C., office buildings and apartment dwellings have reduced consumption on the average about 20% since 1973 with little or no capital investment. The Federal Energy Administration (*FEA)concluded that a 10-20% energy savings was possible with no initial cost, another 10% could be achieved with minimal first costs, and another 10-20% would be saved with investments that could be repaid through savings over a period of three to ten years. A survey done by Public Technology, Inc. (PTI) in 1976 supported these conclusions, and found that a 40% reduction was possible with a payback of seven years or less.[14] In 1978, Brookhaven National Laboratories surveyed 431 owners of small schools, multi-family dwellings, and office buildings. They found that a one-to-ten year payback period was required for conservation investments. Seventy percent would accept a payback period of greater than two years, and 20% would accept a five-year payback [15]

There is no hard evidence on the extent to which conservation efforts are taking place in the District. We do know that 52% of the total single family residential housing stock was built before 1929, and that 98.5% was built before 1966.[16] We estimate that about 80% of the existing commercial office space was built before 1970.[17] Since HUD is the national leader in establishing mortgage standards and HUD did not even include energy criteria until the middle 1960's, and only required a small amount of attic insulation in 1973, it is presumed that very few buildings were adequately insulated or had storm windows in the District. Using figures from the manufacturer's Green Book, and through a survey of contractors, it is estimated that about 3,800 homes were backfitted with storm windows in 1977, about 3,000 had insulation installed, and about 2,000 had work done on HVAC systems.[18] Based on these estimates, only about 20% of single family homes have adopted significant energy conservation measures.

Current energy consumption varies widely among sectors of the local economy and, within the sectors, building consumption varies significantly. The federal government uses approximately 214,000 BTU's per square foot* per year for its buildings within the District of Columbia. The single family dwellings in the District used about 82,000 BTU's per square foot per year, and the apartment sector uses about 96,000 BTU's. The commercial office space sector uses about 109,000 and the District government uses between 138,000 and 222,000 BTU's per square foot per year. (see Chart I)

* We are using a conversion factor of 3413 BTU's per KWH. To estimate primary energy required, the conversion factor for electricity should be about 11,000 BTU's per year

* Continuing research in this area.

## Chart I: Energy Use Per Square Foot by Sector

| | BTU ($10^{12}$) | Ft$^2$ ($10^6$) | BTU/Ft$^2$ |
|---|---|---|---|
| Public Administration | | | |
| U.S. Government(1) | 19.3 | 90.0 | 214,000 |
| D.C. Government(2) | 6.60 | 29.7 | 222,000 |
| | | 47.5 | 138,000 |
| Commercial/Industrial/Inst | | | |
| Commercial(3) | -4.57 | 25.0 | 109,000 |
| Industrial(4) | * | 16.2 | |
| Institutional(5) | * | | |
| Retail(6) | 0.64 | 7.7 | 83,000 |
| | | | |
| Residential + | | | |
| Multi-family(7) | 15.2 | 158 | 96,000 |
| Single-family(8) | 17.2 | 210 | 82,000 |

+ See Appendix A , page 165 for additional discussion regarding multi-family and single-family btu/ft$^2$ figures.

(1) BTU figure source: U.S. Department of General Services and individual agencies, except for gasoline. Gasoline obtained from D.C. Department of Finance and Revenue Motor Vehicle Fuel Tax Reports.

Square footage source: National Capital Planning Commission. Building Space At Federally-Owned Sites In the National Capital Region By Political Jurisdictions and Area. 1971 through 1976. Appendix Table E-2. Revised August 15, 1978.

Federally-Leased Space And Employment In the District of Columbia - Outside the L'Enfant City - 1971 and 1976. Table 3c-5. Revised August 15, 1978.

BTU/FT$^2$: Division using the above figures.

(2) BTU figure source: D.C. Department of General Services and Department of Finance and Revenue. Square Footage source: At the time of completion, the following square footage figures were available to the study from the respective departments:

| D.C. Agency | FT$^2$ ($10^6$) |
|---|---|
| Department of Education | 16.55 |
| Department of General Services | 3.05 |
| D.C. Government leased space | 3.25 |
| Department of Human Resources | 0.90 |
| | 23.75 |

A range for total square footage is given using the partial data as fifty percent and eighty percent of total square footage.

(3) BTU figure source: Multiplication of the amount of BTU's per square foot times the quantity of square feet.

Square footage source: Coldwell Banker Commercial Brokerage Company - 42 x $10^6$ ft$^2$. Excluding D.C. and U.S. government leased space - 25 x $10^6$ ft$^2$ .

BTU per square foot source: Metropolitan Washington Board of Trade. "Overview - 1976 Building Energy Survey."

(4) Square footage source: Coldwell Banker Commercial Brokerage Company. Private communication, December 1978.

(5) There is little information concerning the amount of square footage contained in this sector. The information available indicates the quantity may be significant, equal to or greater than the amount in the commercial office sector.

The following building uses and number of buildings (with exceptions) form the institutional sector.

The institutional category is comprised of special purpose type buildings.

| Purpose | Number of Buildings in D.C. |
|---|---|
| Hotel - Small | 13 |
| Hotel - Large | 52 |
| Motel | 28 |
| Clubs - Private | 9 |
| Tourist Home | 15 |
| Dormitory | 86* |
| Transient - Misc. | 5 |
| Religious | 560 |
| Medical | 32 |
| Educational | 253* |
| Embassies, Chanceries | 833 |
| Museums,, Libraries, Galleries | 31* |
| Recreational | 39 |
| Special Purpose, Misc. | 560* |
| | 2516 |

From:
D.C. Department of Finance and Revenue Real Estate Coding Use Designation February 1, 1977.

* May include space considered in the Public Administration or another category, especially the educational classification which contains public schools (counted in D.C. square footage) and the museums, libraries and galleries classification.

The magnitude of this sector becomes more evident when a sampling of various institutional building types yielded the information below:

| Institution | Gross Square Footage ($10^6$) |
|---|---|
| Georgetown University | 2.6 x $10^6$ |
| Sibley Hospital (complex) | .3 x 106 |
| Manger/Annapolis Hotel (proposed) | .25 x $10^6$ + |

+If the average hotel square footage on a per room basis derived from information about the Mayflower Hotel is multiplied times the number of hotel rooms in Washington, D. C., the product is 7.5 x 106 square feet for the hotel section of the institutional sector.

(6) BTU figure source: Multiplication of the amount of BTU's per square foot times the quantity of square feet.

Square footage source: District of Columbia Municipal Planning Office. Concerns the Central Employment Area as defined by the National Capital Planning Commission.

BTU per square foot source: Metropolitan Washington Baord of Trade. "Overview 1976 Building Energy Survey."

(7) See Appendix C, page 183.

To arrive at these figures, we started from the actual survey data of the Metropolitan Washington Board of Trade, done in 1976. That data indicated an energy consumption, on average, of 96,000 BTU's per square foot per year for multifamily homes. Knowing the total residential energy consumption, and the total square footage of single-family homes (from computer printout provided by Municipal Planning Office) we could then estimate 82,000 BTU's per square foot per year for single-family homes.

These conclusions would tend to differ from the results of reports by Hittman Associates, and others. Most conclude that multi-family units have lower energy use than single-family homes. Since most single-family homes are townhouses, there is, in the District, shared heating space. Single-family homes might be better insulated. Also since most apartment units have group-metering, the electrical consumption could be higher per square foot in those buildings.

However, due to the differences in this report from several others, we recommend additional empirical research in this area.

(8) See Appendix C, page 183.

Detailed building audits can be extremely helpful. Ballou High School uses about 59,000 BTU's per square foot of gross area per year, while Cardozo High School uses about 81,000 - 37.5% more energy per square foot than does Ballou.[19]

Cardozo High School is 31% larger than Ballou High School, and its energy use per square foot is 37.5% higher. Yet the total difference in cost between the two in 1977 was only 5.25%. The reason was that Cardozo used almost 70% more heating per square foot, but 45% less electricity per square foot. Since electricity is more than twice as expensive as fuel oil, this variation results in a modest difference in the total costs of energy.

This example indicates the complex reality of energy analysis. One analysis of existing computer models finds that they can vary substantially when estimating energy usage in a given building.[20] "Rules of Thumb" regarding the "energy conservation potential" of classes of buildings arising from Federal government sponsored studies conflict with each other. A study by R.M. Eng for ILSR finds that extrapolations of area-wide energy conservation potential taken from such work may be very inaccurate for any specific locality.[21] Each building must be taken as a separate entity and analyzed intensively. As this process continues in the District of Columbia, we will be able to pinpoint with increasing accuracy both the sectors and subsectors which could save the most energy at the least cost, and those sectors which would be good experimental models for maximizing conservation. For example, Fred Dubin views 60,000 BTU's per square foot per year as a realistic figure for existing school buildings. Yet there are a number of existing District schools that fall below that figure. It would be an excellent case study to see if the figure could be reduced substantially even from this low point, as a benchmark. for maximization efforts for other buildings in that sector.

**Transportation**

In any discussion on the potential for conservation, first the sector should be broken down conservation in transportation to its component parts. There is the transportation of goods, and of people. Of the latter, there is the transportation required for getting to work, for short trips, and for intercity vacation trips. Each requires a different conservation strategy.

For example, a study on energy conservation in the city of Portland, Oregon, estimated that 5% of projected energy consumption could be saved if neighborhood grocery stores were revived. As in the past, people could walk to buy a pack of cigarettes, loaf of bread, or gallon of milk. Additionally, Portland has a zoning ordinance permitting. cottage industry in residential areas for a period of two years. In Davis, California, part of the implemented energy conservation plan included permitting cottage industries in residential neighborhoods specifically to reduce work-related energy requirements.

The District residents consume about 21% of gasoline on work-related transportation. [22] The most efficient means of transportation is the subway or bus as can be observed. in Chart II: Energy Requirements of Passenger Transportation Modes. However, 49% of the District's residents use METRO for work-related transportation, and this is expected to increase by 1985 to 72% for residents working within the District of Columbia. [23] If it is assumed that a rush-hour bus or subway is five times more efficient with respect to BTU's used per passenger mile travelled, then this 49%

increase in public transit riders would result in a decrease of about 1.4 trillion BTU's of gasoline consumed otherwise. [24]

The current average auto fuel efficiency is about 14 miles per gallon. Assuming that the fleet average in 1985 will be 20 miles per gallon for the average car on the road, this would represent a 43% increase in fuel efficiency.[25] Since COG(Council of Governments) projects an overall increase in mileage by District residents by the year 1985, the total reduction in gasoline consumption by automobiles from the 1977 levels will be 12% or about 1.0 trillion BTUs, would be gained.[26] Transportation Table T-4 shows the estimated gasoline consumption i n 1985 for the private auto and vehicle usage in the other sectors. (See Appendix M for additional explanation). If we assume the same percentage of conservation in the U.S. fleet, and taxicabs, and a somewhat higher (50% reduction by the diplomatic corps which has a larger number of limousines with very low fuel efficiencies), gasoline consumption will decline to 110 million gallons by the mid 1980's (we assume no reduction in D.C. fleet average consumption because a substantial proportion of the gasoline is consumed by police vehicles, although a significant increase in the fuel. efficiency of police vehicles is quite likely). Also we do not assume a reduction in the truck sector, where there is no federal mandated fuel efficiency. The reason that this figure is in the same range as that of work-related transportation reductions from shifting to public transit is that in the shift to public transit a steady working population was assumed. In the analysis of the impact of fuel efficiency, COG assumes that the number of trips taken by District residents, and therefore, the mileage driven, will be increased.

Obviously, with the most efficient new cars now able to get 40 miles per gallon, it is clear that transportation efficiencies for the private automobile can be substantially increased over the federal guidelines, reducing still further the gasoline consumed within the District.

To estimate maximum reduction in gasoline use without changing habits (i.e. without assuming increase in mass transit, car pooling, or switch to walking or bicycle beyond what it is today) we have

## Chart II: Energy Requirements of Passenger Transportation Modes

| | Assumed Passenger Loading | Vehicle Miles Per Gallon of Fuel or Equivalent | Passenger Miles Per Gallon of Fuel or Equivalent |
|---|---|---|---|
| Heavy Rail Transit (Subway) Car, Peak Load (a) | 135 | 4.00 | 540 |
| Intercity Passenger Train (b) | 540-720 | 0.50 | 270-360 |
| Transit Bus, Peak Load (c) | 75 | 4.10 | 307 |
| Intercity Bus (d) | 47 | 6.00 | 282 |
| Commuter Rail Car, Diesel Powered (a) | 125 | 2.00 | 250 |
| Heavy Rail Transit (Subway) Car, Off Peak Load (a) | 35 | 4.00 | 140 |
| Transit Bus, Off-Peak Load (c) | 30 | 4.10 | 123 |
| Rail Turbine Train (b) | 320 | 0.33 | 110 |
| Standard Size Automobile, Intercity, Maximum Load (e) | 6 | 18.00 | 108 |
| Standard Size Automobile, Urban, Maximum Load (e) | 6 | 14.40 | 86 |
| Wide-Body Commercial Jet Aircraft, 1,000 Mile Flight (f) | 256-385 | 0.14-0.22 | 54-60 |
| Twin Jet Commercial Aircraft, 500 mile fllight (f) | 68-106 | 0.44-0.54 | 37-47 |
| Average Commuter Automobile (a) | 1.4 | 13.5 | 19 |

Sources:
(a) Commonwealth of Pennsylvania. Department of Transportation
(b) National Railroad Passenger Corporation (Amtrak)
(c) Cleveland Transit System
(d) U.S. Department of Transportation, Transportation Systems Center
(e) U.S. Department of Transportation. Federal Highway Administration
(f) National Aeronautics and Space Administration

**Table T4: Estimated Gasoline Consumption in 1985 with Medium Conservation Efforts**

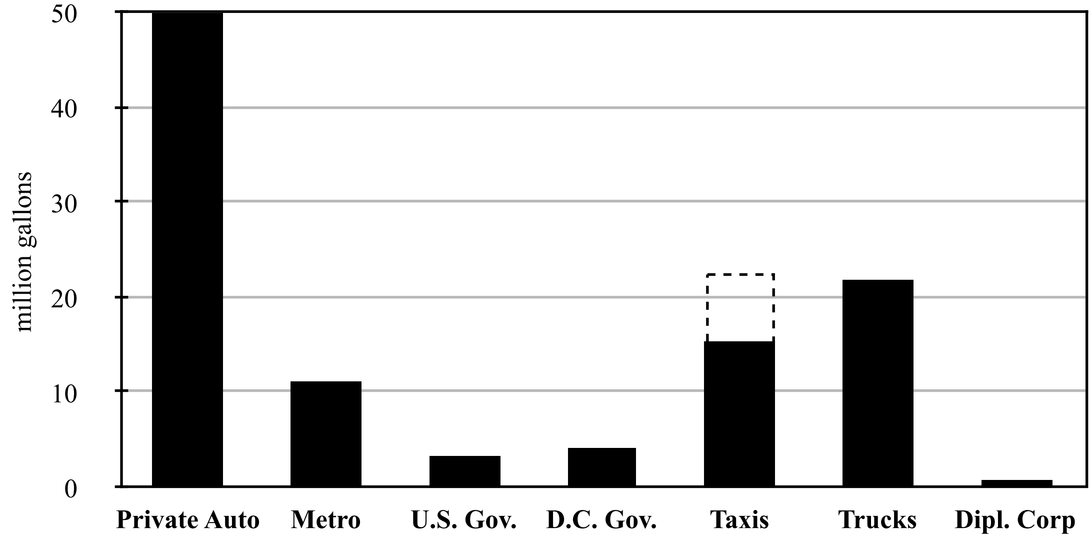
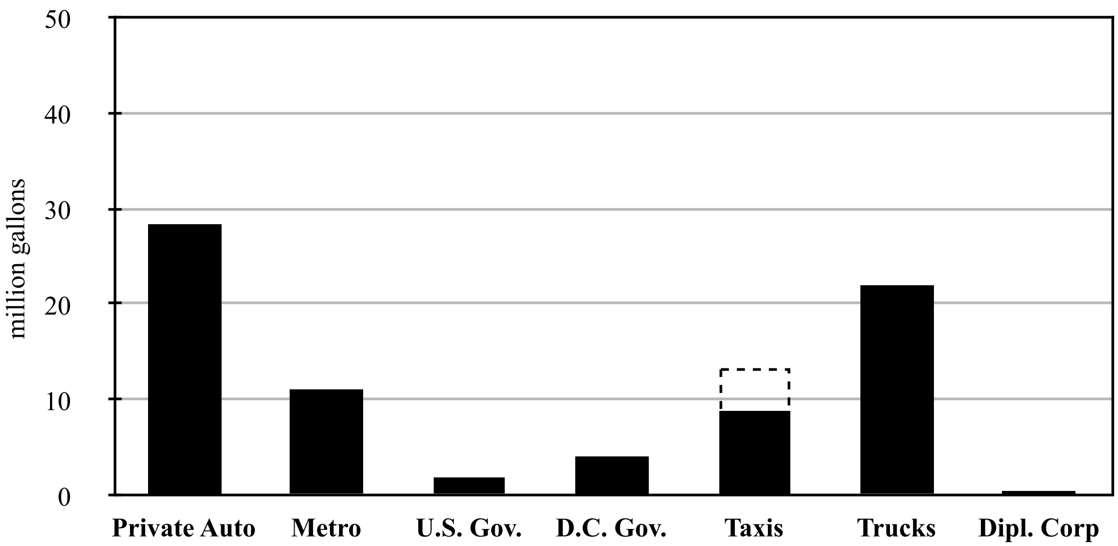



**Table T5: Estimated Gasoline Consumption in 1985 with High Conservation Efforts**




taken as the state of the art the diesel Volkswagen Rabbit, which achieves 40 miles per gallon in city driving. We assume that this efficiency would drop to an average of 35 miles per gallons the car is used. This means a 60% decrease in gasoline consumption by the automobile to 29 million gallons. We assume comparable decreases in the United States government fleet, taxis, and diplomatic corps which would result in a decline in total gasoline consumption to 79 million gallons.

In analyzing the economics of transportation conservation, one may take into account other variables as well as energy consumption. The air pollution problems of the metropolitan area, according to COG, derive substantially from automobile traffic. Runoff in sewage treatment plants is caused in significant degree by automobile traffic. The impact of noise and disease from the internal combustion car can be quantified for D.C. residents, and taken into account in developing a conservation strategy which is cost-effective.

**<u>Conclusion: The Potential for Conservation</u>**

After reviewing case studies and the patterns of current D.C. energy demand, we conclude that the following energy conservation reductions are possible:

Space heating-50%[27]; Water heating-30%[28];
Air conditioning-45%[29]
Appliances-30%[30]; Transportation-76%[31];
Process-30%[32]

It should be stressed here that these estimates do not maximize technological possibilities. They are presented because these kinds of reductions have been achieved with a relatively short payback period. By the way of comparison, the 1977 average electrical consumption of refrigerators in California was 150 kwh per month. The 1979 minimum standard for refrigerators in California is 125 kwh per month, a 20% reduction. [33] A study by Arthur D. Little, however, found that with cost effective modifications (using prices of 2 cents per kwh or less), this standard could be reduced to 52 kwh, about 60% below the 1979 standard. The energy conserving refrigerator would be about $40 more expensive than the conventional model, or about 10% more costly. [34]

Since conservation efforts will take palce over time, we have estimated the conservation potential in the year 1990. This time frame was chosen because it represents the period during which the entire physical stock of the city, excluding buildings, will be replaced. Appliances, automobiles, etc. are replaced on the average in less than 10 years. Property ownership changes hands ever 6 years on average in D.C. Thus standards which are enacted today may be 100% effective in 10 years.

As we can see from table I and table II, by 1990 the city of Washington, including the U,S. Government could economically reduce its consumption by more than 30%, including growth. By 1990 the non transportation energy use could be less than 49 trillion BTU's, with transportation adding 25 trillion BTU's , to give a total of about 74 trillion BTU's, compared to the total in 1977 of 109 trillion BTU's.

**Table I End Use Consumption -1977 and 1990 [1,2]**

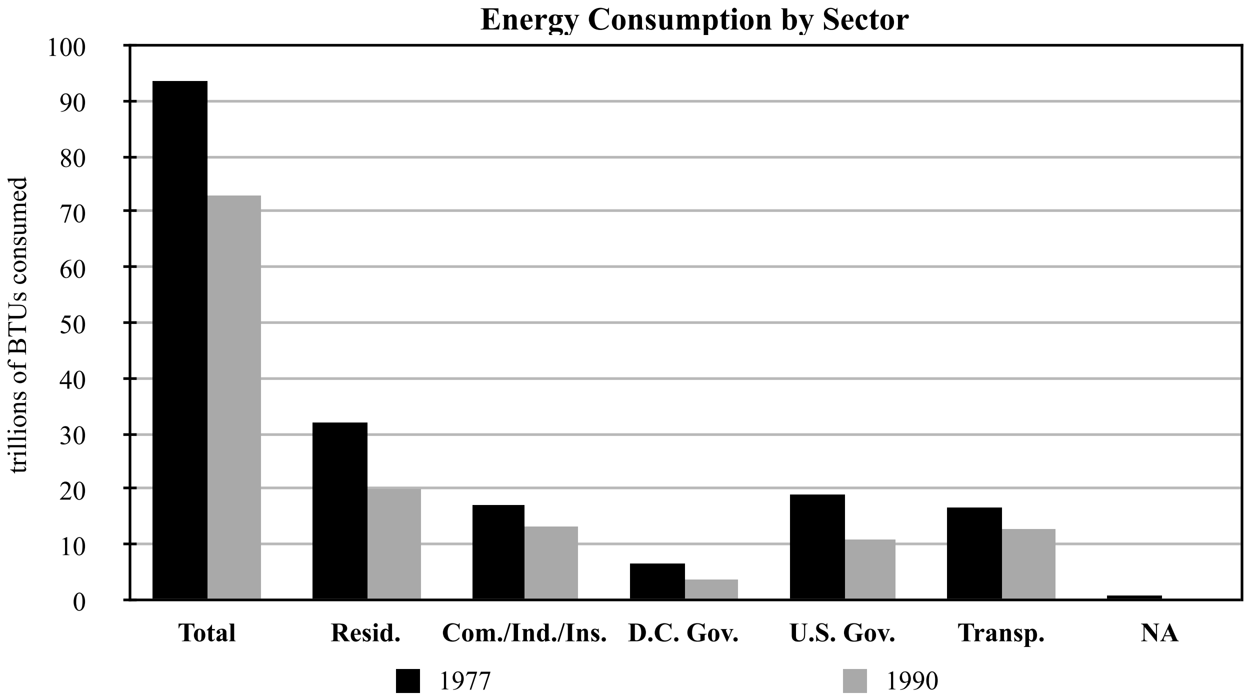
| Use | 1977 | | 1990 | |
|---|---|---|---|---|
| | BTU's ($10^{12}$) | % | BTU's ($10^{12}$) | % |
| Space Heating | 43.5 | 47 | 25.4 | 41 |
| Water Heating | 8.5 | 9 | 6.6 | 11 |
| Space Cooling | 3.4 | 4 | 2.1 | 3 |
| Lighting | 6.9 | 7 | 3.2 | 5 |
| Appliances | 1.2 | 1 | 1.0 | 1 |
| Process | 11.6 | 12 | 10.2 | 6 |
| Transportation | 17.0 | 18 | 12.9 | 21 |
| Not Accounted For | 1.2 | 1 | 0.7 | 1 |
| **Total** | **93.3** | | **62.1** | |

**Table 2 Energy Consumption by Sector - 1977 and 1990**

| Sector | 1977 | | 1990 | |
|---|---|---|---|---|
| | BTU's ($10^{12}$) | % | BTU's ($10^{12}$) | % |
| Residential | 32.4 | 35 | 20.0 | 27 |
| Com/Ind/Inst | 17.3 | 18 | 13.3 | 18 |
| D.C. Government | 6.6 | 7 | 3.8 | 5 |
| U.S. Government | 19.3 | 21 | 10.9 | 15 |
| Transportation | 17.0 | 18 | 12.9 | 34 |
| Not Accounted For | 1.2 | 1 | 0.7 | 1 |
| **Total** | **93.8** | **100** | **61.6** | **100** |

**Conservation by End Use-Net of Growth, and Including Growth**

| End Use | Percent 1977-1990 Reduction (net of growth) | Percent 1977-1990 Reduction[35] (effective, includes growth) |
|---|---|---|
| Space-heating | 50 | 43 |
| Water-heating | 30 | 22 |
| Space cooling | 45 | 38 |
| Lighting | 50 | 45 |
| Appliances | 30 | 17 |
| Transportation | 76 | 24 |
| Process | 30 | 12 |
| Not Accounted For | - | - |




**Solar Energy**

So far we have focused on conservation potential, or the demand side of the energy picture. We estimate that by 1990 the city could require approximately 62 trillion BTU's, of which 13 trillion would he used in the transportation sector, and the remainder, or 49 trillion BTU's, would be used for other functions.

We discuss the supply side of the energy picture by emphasizing renewable energy resources which can be converted to usable energy within the boundaries of the District of Columbia. The two such energy sources that could have significance are direct solar energy and solid waste conversion.

These energy sources can be viewed in two ways: those that are currently economic, and the longer term technical potential. The current market for direct solar applications in Washington, D.C. is quite limited. The most economical applications would be in new construction. The use of passive solar energy designs, which maximize south facing windows, use increased thermal mass to store energy, take advantage of wind currents for cooling, use roof overhangs to shield the inside from the summer sun, are both appropriate and cost effective.

There is a substantial amount of commercial construction which could take advantage of building designs which are adapted to take advantage of climate. There are only, on average, 1000 new single family structures built each year in the District. Only 80 to 100 are single-family detached homes. Approximately 90% are attached energy for these homes, it is tentatively estimated that no more than 100 could significantly change their design features to incorporate passive solar designs.

The most economical use of solar energy at present is for hot-water heating. The most costly hot-water heating uses electricity. There are approximately 4,000 electric hot-water heaters in the District at present. With an average usage of 4,811 KWH (or 16.4 million BTU's) per year and an average price of 4.5 cents per KWH (proposed rate changes), the average total cost per year would be $216.49 for electric-heated hot water. Assuming solar provides 75% of the hot water, the savings would be, in the first year, $162.37. Assuming a five-year, 12% loan for $2,500, and a price increase for electricity of 10% per year, a federal tax credit of 30% on the first $200, and 20% on the next $500 ($700 total),and a tax bracket of 309, (for deductions on interest),the payback period is about 10 years.

There are measures which can be undertaken to make replacement of electric systems by solar hot-water systems more attractive. For example, currently the District of Columbia is considering a 10% refundable tax credit for solar. Assuming this credit would be added to the homes. Without an exhaustive survey of the appropriateness of solar federal tax credit, it would reduce the payback time accordingly. Also, the District could develop financing mechanisms to stretch out the loan period, so that the monthly payments would be lowered. For example, a $2,500 loan at 12% for five years requires a yearly payment of $693 or a monthly payment of $57.89. A ten-year loan under the same terms would require a yearly payment of $442, or a monthly payment of $36.87. The federal tax credit can be taken in full, provided one has sufficient tax liability to offset the credit in one year, even though the system has been financed. If the District refund provision works in similar fashion, one can conceivably get a $950 rebate on the solar hot water system, even though one might have put no money down, and be paying it off with monthly payments of between $36 and $56. If this were the case, the rebate could cover the cost of the system for the first few years, or until the energy prices increased to the point where they became comparable to the costs of the loan.

The city could improve the economics of solar by purchasing solar systems in bulk, as was done by TVA, forming cooperatives for this purpose. This would lower the price of installed systems to below $2,000, and reduce the payback period to (approximately) seven years. The city could also establish leasing systems, lowering the costs to its residents, and also providing a hedge against rapid technological advances in the solar field.

Finally, the city and the local utility could develop a pricing mechanism that would encourage the use of solar energy by developing methods for solar to displace the need for future peaking-capacity. A large backup storage tank which can only be linked to off-peak electricity could permit the resident to take advantage of the low costs of off-peak power and, in addition, could save the utility company from the necessity to add peaking capacity. The savings could be split between the resident and the utility in rate-structure mechanisms.

It does not appear, however, that any of these mechanisms would make solar economically attractive for those who use gas or fuel oil. It is also the case that there are effective measures for hot-water conservation which could reduce the average consumption significantly. This is especially the case in gas hot-water systems, where one could eliminate the pilot light, add extra insulation, lower the thermostat setting, and install flow restrictors on faucets and shower heads. Yet even with electric hot-water heaters, there could be a 15 to 20% savings in energy, lengthening the payback period for solar accordingly.

It is obvious that there is a total universe of potential solar customers of about 4,000 families in Washington, D.C. This, however, could be significant in establishing an initial market. Solar energy will become increasingly cost-effective in the future. It is important for the city to encourage its use now, even though the economics are still marginal, in order to demonstrate its utility, to develop predictable measures for its interrelationship to backup systems, and to develop a workforce with expertise in this area. With the deregulation of natural gas, and possibly substantial increases in the price of fuel oil, many areas of Washington, D.C. will find solar energy a more economical possibility in the near future.

**Resource Recovery**

Another potential source of energy for the District of Columbia can be achieved through its solid waste stream. The District generates 2,000 tons per day or 478,000 tons of solid waste per year. The average energy yield per pound would be 4,500 BTU's providing a total of 4.2 trillion BTU's or approximately 5% of the total, excluding gasoline.

However, a substantial portion of the solid waste stream can, and should, be recycled. If this is done, the remainder, or 50% has a slightly higher heat release (5,500 BTU's per pound) and would generate 3.6% of the total (excluding gasoline) or 3 trillion BTU's. Resource recovery plants have been operating for several years in many parts of the country. There is concern about their operating economics, especially given air pollution problems and reliability. It can, however, represent a significant resource.

Potential for Energy Self-Reliance

Solar technology is rapidly advancing. When one realizes that it is less than five years since solar technologies entered the marketplace the pace at which the many forms of solar technologies is advancing is astonishing. Flat-plate collectors, concentrator collectors, combination solar electric and solar thermal systems, are all proving reliable and increasingly cost effective. During the next five years we can expect their cost to decrease, and the reliability and sophistication of the systems to improve.

There are relatively few analyses which have tried to maximize solar energy collection per land area. Tradeoffs are involved. The flat-plate collector, for example, with a year-round system efficiency of about 40-50%, requires about 2.5 square feet of land area for every square foot of collector, assuming that the collector is tilted to collect solar energy in optimum fashion. This is a result of the fact that the shadowing effect of one collector on another forces them to be spaced several feet apart. The same ratio obtains for flat-plate silicon solar cells, which generate electricity from sunlight with a system efficiency of about 12%. (See Chart I, Insolation Calculation, next page.)

## Chart I: Isolation Calculation[1]

**40° N. Latitude**
**(solar collectors fixed at 50°**

| | % Loss of insolation (shadow factor)* | Total insolation BTU/sq.ft. (100% Sunshine) | Isolation with shadow factor BTU/sq.ft. | Insolation with shadow and sunshine factors BTU/sq.ft | Efficiency of solar system 40% BTU/sq.ft. |
|---|---|---|---|---|---|
| January | 20 | 59,086 | 47,269 | 30,384 | 12,153.6 |
| February | 17 | 63,858 | 53,002 | 35,040 | 14,016.0 |
| March | 14 | 70,804 | 60,891 | 41 741 | 16,696.4 |
| April | 10 | 65,040 | 58,538 | 40,483 | 16,193.2 |
| May | 7 | 63,240 | 38,813 | 41,393 | 16,157.2 |
| June | 3 | 59,220 | 57,443 | 42,531 | 17,052.4 |
| July | 3 | 62,186 | 60,320 | 43,025 | 17,520.0 |
| August | 7 | 65,224 | 60.658 | 44,171 | 17,668.4 |
| September | 10 | 55,460 | 58,914 | 42,901 | 17,160.4 |
| October | 14 | 65,038 | 55,933 | 40,048 | 16,016.0 |
| November | 17 | 65,100 | 54,033 | 36,380 | 14,552.0 |
| December | 20 | 53,940 | 43,152 | 27,475 | 10,990.0 |
| **Total** | **N/A** | **758,196** | **668,958** | **466,477** | **186,225.6** |

* The optimum spacing between collectors was estimated to gather the most energy throughout the years. In the optimum arrangement, there is a slight shadow effect of the front row of collectors upon those placed behind them.

[1] Stephen R. Pace, from a report submitted to Dr. Francis C. Lutz, Director and Dr. Donald C. Eteson and Dr. John T. O'Connor of the Washington, D.C. Project Center,.Worcester Polytechnic Institute, December 17, 1976. Report entitled: Solar Energy as an Alternative Energy Source in Washington,D.C. in cooperation with ILSR staff.

There are now parabolic solar collectors, which track the sun both vertically (which takes into account the variations in the height of the sun over the horizon at different seasons), and horizontally, (which tracks the sun during the day as it moves from east to west). These collectors achieve higher temperatures, and can be used for air conditioning. They also have greater efficiencies, and collect a greater amount of solar energy per square foot year round. There are also combination thermal and photovoltaic systems which are fully tracking, and generate both electricity and heat. However, these systems require collectors to be spaced further apart, with a commonly-accepted ratio of about four square feet of land area to one square foot of solar-colleotor.

The final aspect of solar energy is the storage issue. Most solar energy systems currently are being used for hot-water heating, and there is very little storage involved, usually no more than a day or two. Yet studies now indicate that it may be economical, especially in northern latitudes, to develop seasonal storage systems. More than twice as much solar energy can be collected during the summer than during the winter, through a combination of longer daylight hours, greater solar intensity, and less cloud coverage. In 1939, the first MIT house employed 17,000 gallons of water in a basement tank surrounded by two feet of insulation. No auxiliary heating was required over the two full heating seasons during which the house was in operation. Currently, a 30-unit apartment house in Alymer, Ontario, will be 100% solar-space-heated using seasonal storage, and almost 100% hot-water heated, with a ratio of about ten-to-one of floor are to collector area.

Washington, D.C. is an interesting area to examine the potential for solar energy systems. It has a height limitation, so that its apartment buildings are no larger than 8 stories, and its office buildings are no higher than 10-12 stories. The downtown area tends to have flat rooftops, even among the townhouses. Sloped roofs are the fashion in the peripheral neighborhoods, where there is also more land area available for solar collection and storage.

This is an option which demands more detailed investigation. The relationship between land area requirements, economics, and overall system efficiency, must be examined in the context of the District. The relationship between storage space and number of collectors is another area which requires detailed investigation based on actual performance characteristics.

For example, the tilt of collectors requires a great amount of overall land area. This is done because the cost of collectors is high, and the year-round economics can be optimized by angling the collector to gain the best tradeoff between the high, intense summer sun, and the low, moderate, winter sun. However, it may be that for stand-alone systems which require no backup and therefore displace new generating plants, and which have seasonal storage, horizontal collectors can be justified. If such were the case, with the total flat-roof area covered with collectors, the yield per square foot of space would increase by more than 100%, permitting a greater degree of energy self-reliance.

Washington, D.C. is an excellent laboratory involving back-fitting solar on existing buildings, and analyzing the interrelationships of slope, storage, economics, and system efficiency.

Although solar applications currently serve individual houses, the pattern in the future, especially in dense urban areas, may be to develop district heating systems, or community systems. Thus the excess from one building could be used in another building. The excess in a warehouse neighborhood could be used in the residential townhouses abutting it. Storage systems, and distribution systems, are now available to permit this.

Thus in analyzing the potential for energy self-reliance for the District of Columbia, we took the entire rooftop surface as the potential solar collector area, and assumed that we could shift and distribute the excess within the city.

Using an aerial survey of Washington, D.C., we estimated total square footage of rooftop space as 327 million square feet. This includes all rooftops, residential and commercial. Added to this is the projected growth in buildings between 1977 and 1990. The final total is about 360 million square feet of rooftop space. We assumed that annual storage systems are available, that is, that the excess summer solar energy could be stored for use during the winter. (Without such assumption the totals would drop by about 40%). We also assumed that 100% of the rooftop space would be available for solar energy applications. This last is a generous assumption. However, D.C.'s height limitation and abundance of flat rooftops probably increases the percentage of available space for solar energy systems. In Memphis, Tennessee, surveys of hundreds of residential buildings found that 90% were suitable for solar domestic hot water applications. Finally, we did not assume collectors that are on the sides of buildings, nor on overhangs over roadways, nor in backyards.

Four types of energy are needed to meet D.C.'s demand picture. Low temperature applications can be met through use of flat plate collectors. Higher temperatures are required for air conditioning. If air conditioning uses thermal energy, rather than electrical energy, we assumed a 60% conversion efficiency. Thus the 3.5 trillion BTU's of end use energy required for space cooling would need about 5 trillion BTU's of thermal energy at a medium high temperature at its input. Tubular collectors, and concentrator collectors reach temperatures useful for space cooling. We expect that within the near future flat plate collectors may be used for air conditioning, and in our calculations, (see Table III) we have assumed this to be so.

The third end use is electricity. This can be produced by concentrator collectors, or by direct conversion to electricity by solar cells.

Finally, transportation energy is required. This energy can take two forms. If we continue to rely on the internal combustion engine, we will need liquid fuels. The District of Columbia can produce liquid fuels through biological conversion of organic wastes, but the amount so generated is quite small. The District could also shift toward the use of electric vehicles for local transportation. Already, at the University of Florida, a residential rooftop contains an array of solar cells that not only generates electricity for domestic use, but for the family electric vehicle. The operating characteristics of electric vehicles are quite relevant to Washington, D.C. Their speed averages 40 miles per hour, which is within the average speeds of metropolitan traffic, and well above the 11 mile per hour District core rush-hour travelling speed. The average work-related trip in the metropolitan area is less than 8 miles, well within the 40 to 60 mile operating range of currently available commercial electric vehicles.

Electric vehicles have other advantages. They are quiet, non polluting within the city, and lighter in weight than internal combustion engine cars. They offer the city economic benefits resulting from these factors. Already in Australia, demonstration electric vehicles plug into electric meters, which look like parking meters. In Amsterdam, in the Netherlands, a former city council member has established a membership organization for electric vehicles. Two charging stations in the city accept membership credit cards, which are slipped into the ignition at the beginning of the trip. Members are billed at the end of the month, based on the number of miles driven.

We have estimated the total generation of electricity possible by installing solar cells on parking lots, gas stations, and parking garages. The total space available is 10 million square feet. Assuming solar cell system efficiencies of 12%, a total of 78 million kilowatt hours could be generated per year, 13% of total private automobile electricity and 52% of total work related auto travel. See Table T6.

In our overall survey of the potential for solar energy, we included all rooftop space. However, in a specific study, we separated out the rooftop space available in garages, parking lots, and gas stations. The results of the study are provided in detail in Appendix H. We concluded that 52% of work related transportation could be met through the use of flat-plate solar cells if 100% of work related transportation were done with electric vehicles.

**Table III**

| End Use Requirements (BTUs $10^{12}$) | 1990 |
|---|---|
| Thermal | 36.6* |
| Electricity | 14.8 |
| Transportation | 25.0 |
| *including air conditioning at a 60% conversion efficiency | |

If we add the energy generated from solid waste conversion (3 trillion BTU's) to that generated by the various direct solar technologies, we conclude:

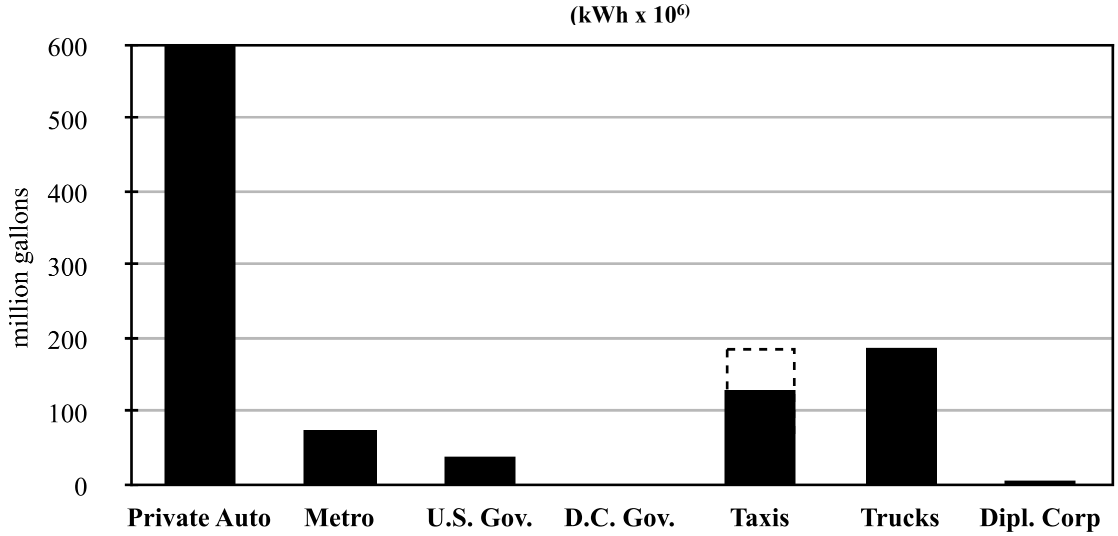
1. Using a two axis tracking solar system we can generate 63% of total thermal requirements, and 36% of electrical requirements. This represents slightly more than one third the total D.C. energy demand projected in 1990, including the U.S. government and transportation.
2. Using flat-plate collectors or tubular collectors optimally tilted for most economic use, we can generate about 100% of thermal needs, but no electricity. This represents about 50% of total D.C. energy demand projected to 1990, including U.S. government and transportation.
3. Using horizontal flat-plate collectors to maximize energy generation, we can generate 163% of thermal requirements, but no electricity. Since the excess heat would be wasted, the overall contribution would be similar to that in case #2, or 50%.

We therefore conclude that the city of Washington, using feasible conservation measures, and a maximum of solar technology, could generate between one-third and one half of its total energy through indigenous energy sources.

One interesting note on our analysis is that there is a clear relationship between density and the portion of total energy that could be met through direct solar conversion. (see Appendix G ). Interestingly, in the less dense areas, such as the peripheral neighborhoods with two story single-family dwellings, sufficient solar could be gathered on a single rooftop to meet all the building's needs, with enough left over to power the family electric car. In downtown, dense sections, solar would be able to meet only a minor portion of total energy needs. However, it is precisely these areas where district heating and cogeneration (the production of both heat and power simultaneously) are most economical. Thus in these areas the possibility of decentralizing energy generation, while still using fossil fuels, is quite real. According to various studies this would provide a conversion benefit to the city, and, depending on the current price of fuel, an economic benefit to the consumers. (See page 59 on cogeneration) .

**Table T6: Kilowatt Hour Requirement to Power the D.C. Transportation System, 1977**

**(kWh x $10^{6}$)**



**Financing Energy Self-Reliance**

To save about half of our energy, excluding transportation, about $500 million would have to be invested. If this were accomplished over a 7-year period, about $70 million per year would be necessary. This would represent a large increase over the appropriate $10 million invested in energy improvements.[36] The financing for such a conservation effort is available within the District of Columbia. The total amount deposited in District banks as of December 31, 1977, was $4,945,525,000. The amount deposited in savings-and-loan associations was $4,284,832,000. Credit unions held $723,300,000 in deposits. Although federal regulations may affect the kinds of loans and investments which can be made by the various financial institutions, it is clear that there is sufficient capital available to finance major energy-related efforts.

**Energy Generation Potential**

| Technology | BTU's ($10^{12}$) | % of End Use Requirements |
|---|---|---|
| Solid Waste | 3 | Thermal—8% |
| Flat-Plate Solar (optimum tilt) | 33.6 | Thermal—91% |
| Flat-Plate Solar (horizontal) | 56.2 | Thermal—154% |
| Tubular | 33.6 | Thermal—91% |
| Two-axis tracking solar electric/thermal | 17.3-thermal 5.4-electric | Thermal—55% Electric—36% |

However, the availability of capital for energy self-reliance depends in large degree on the willingness of financial institutions to use it for such purposes. A survey of the large financial institutions in the District revealed that none were currently using energy costs as a factor in appraising houses or evaluating the ability of homeowners to repay mortgages. The bankers are still relying on the traditional PITI formula (principal, interest, taxes, and insurance), even though energy costs now represent, nationwide, about 15% of mortgage costs and, in the D.C. area, are, in many cases, higher than either insurance payments or taxes.

The education of financial institutions in energy matters, and their participation, may be growing. The National Energy Act mandates some changes in how federal housing finance agencies deal with energy. The Act expands the definitions of home improvements eligible for federal insurance to include wind and solar equipment. The mortgage loan ceiling for FHA loans and guarantees has been raised by 20% if solar equipment is purchased and installed with mortgage financing. The Government National Mortgage Association (GNMA) has been authorized $3 billion for the purchase of loans of up to $2,500 at interest rates ranging from 9-12% interest for energy conservation by low-income families. It has also been authorized $100 million for the purchase of solar energy loans with a maximum of $8,000. at interest rates of 9-12%. There have been no appropriations yet.[37]

The secondary mortgage market buys the loans made by the local financial institutions. The government does not loan the money directly. However, it is an incentive for local financial institutions to make such loans. Currently, most of GNMA money goes to purchase long-term home mortgages. There is a program for the purchase of home improvements.

Perhaps the most important aspect of this arrangement is that GNMA requires, for energy conservation loans, a duration of 5-15 years. For solar energy loans, there is a maximum loan period of 15 years, but no minimum. Since currently District financial institutions are providing home improvement loans for only 3 years, and current GNMA regulations concerning the purchase of home improvement loans would restrict those of $2,500 to three years, this new program would tend to increase significantly the loan repayment period. This, in turn, would lower the monthly payments, and permit the homeowner to make more substantial investments in conservation and/or solar while still repaying the loan through energy savings.

GNMA money is not allocated on a formula basis. However, if the money were available on a per capita basis, the District would be eligible for about $20 million for energy conservation loans for 10w-and moderate-income residents. It would require an annual investment approximately that large for several years to achieve a 30% reduction in residential space-heating.

Already a growing number of financial institutions in other parts of the nation have developed programs to encourage conservation and solar. The San Diego Federal Savings and Loan will finance solar equipment for residents with which the savings-and-loan already holds a mortgage, at the same interest rate and for the same monthly payments as the existing mortgage. The mortgage is lengthened to pay for the increased debt, and the down-payment is a fixed fee of $200.

San Diego Federal Savings and Loan also offers a one-percent reduction on the regular loan rate for home improvements for solar installation. Their only stipulation is that the cost of the improvement not exceed 10% of the value of the house.

In Rockford, Illinois, Home Federal Savings and Loan is providing a one-half percent reduction on their regular mortgage rate for solar systems. Home Federal also gives a 1/4 percent reduction for energy efficient homes.

Seattle Trust permits interest reductions of 2 to 3% for energy efficient appliances, automobiles, and homes. In Washington, D.C. McLachlen National Bank established a policy of reducing interest rates by a small percentage for energy-efficient loans, but discontinued the policy last year.

The key to encouraging conservation and solar in the District is in the financing terms. A $2,000 conservation loan as part of a 30-year mortgage at 9% requires monthly payments of $36.85. The same loan as a three-year home-improvement loan at 12% requires monthly payments of $66.80. The majority of banks surveyed require threeyear/128 terms for energy loans.[38] The objective of a financing program should be to permit the person taking out the loan to repay it through energy savings, rather than through increased payments. The District can use its own financing mechanisms to help this to happen.

For example, the District will receive $32 million in fiscal year 1979 for Community Development Block Grants. (This will decline to $26 million the next year, and $22 million in fiscal year 1981.) This money has been used for energy purposes in a number of cities. It might be used in a similar manner as a program in Cambridge, Massachusetts, where those who rehabilitate their homes receive a rebate from CDBG funds on a portion of their costs, depending on their income levels. Alternatively it could be used, as in Dayton, Ohio as a revolving-loan fund for conservation efforts. It also might be used to lengthen the loan terms or to reduce the interest rate from financial institutions for certain income classes in the District.

A new regulation to the Community Development Block Grant program, implemented in January 1978, permits a city to borrow against future CDBG obligations. This does not add to the city's bonding authority, and Washington, D.C., should be eligible for this. The maximum loan amount cannot exceed three times the amount of the entitlement grant approved for the applicant. It must be repaid within six years, although this can be exceeded in special cases where it is deemed necessary to achieve the purpose. The Act permits up to 30% federal subsidy of the net interest cost. However, currently there is no appropriation for that purpose, so the interest would be about 9% at this time. Thus, the District, with approval from HUD, could borrow up to $75 million if the purposes are written into the CDBG plan.[39] This is more than half of that required to reduce space-heating costs in the residential sector by 30%.

The District enacted a depository law in 1977 which requires that the District deposit its own money in financial institutions which have a history of offering loans within the District of Columbia.[40] As of the end of December, 1978, the District government began using term deposits for its money. It is anticipated that there will be an available cash-flow at any given time of about $30 million.[41]

The firemen's and policemen's retirement funds are financed from cash-flow, but there are invested retirement funds for D.C. teachers and judges.[42] Given the low-risk nature of energy conservation loans, it is quite possible that these funds could be tapped for energy related financing.

The District could also use its weatherization monies for low-income residents. The District will receive over $900,000 for low-income weatherization this coming year with a maximum of $800 per house. The Department of Energy regulations do not permit this to be a loan program, and a majority of the weatherization funds come from the U.S. Department of Energy.[43] However, the Community Services Administration, which also provides weatherization money, does permit this.

The District is receiving $39 million in the current fiscal year in Comprehensive Employment Training Act (CETA) funds. Although this money is used for employment training, not for financing, there is some discretionary money, and the program can be an integral part of a development strategy.[44] The new amendments to the CETA Act passed this session of Congress include provisions in which CETA sponsors shall provide employment and training opportunities in the development and use of solar, geothermal, hydroelectric and their alternative energy technologies, and that the Department of Labor is to ascertain on an annual basis, the employment impact of energy development and conservation.

The District government will receive several million dollars for energy audits and implementation of audit recommendations.[45] Initially, there will be several hundred thousand dollars for audits, and later money for technical assistance. It appears that during the first year approximately 65% of the total money for energy conservation in schools and hospitals will be for financing conservation (there is a matching requirement of at least 50%). During the third year of the three-year program, this position will rise to more than 95%, and the total funding level should more than double. The District will have to provide most of the money. However, in the health field it may have a close and wealthy ally. In Pennsylvania, the Hospital Association of Western Pennsylvania, after initiating audits and conservation measures on their own, have received $1 million in support through the Blue Cross-Blue Shield Association. As an insurer of hospital costs, Blue Cross finds that such an investment is a wise one. With respect to local government and public care facilities, the District will receive money for preliminary energy audits and technical assistance, but any funding to implement the recommendations must be appropriated by the municipal government.

**Economic Development and Conservation**
Energy conservation often has two benefits direct to the local economy. Since energy conservation efforts can be spearheaded by locally-based small businesses, and can be done by skilled and unskilled workers, a great deal of employment can be generated in the process of achieving the energy usage reductions. And, once the conservation efforts have been completed, the District will continue to enjoy the multiple benefits of the cash savings flowing through its economy.

Yet, although there are positive benefits to energy conservation, there may also be short term negative impacts. Investments in conservation or solar divert money that ordinarily would flow into other channels. The District of Columbia economy is peculiar in that it has a vast preponderance of service and workers and office workers. These are the most labor intensive sectors of the economy. Therefore, when individuals divert money to invest in conservation and solar, they will be taking money away from more labor intensive sectors. This will mean a drop in employment during the first few years, and a drop in earnings on the part of local workers during that same period.

This short term negative impact will be superseded when the dollar savings as a result of the investments in conservation and solar occur. As these savings are spent in other parts of the economy, the number of jobs and the earnings of D.C. residents increases rapidly.

We have concentrated so far on the direct job creation aspects of conservation and solar investments. But there are significant impacts as well. Since money spent in more labor intensive sectors is re-channeled into capital intensive conservation and solar activities, there is a net reduction in earnings and employment during the first few years. In the case of a 30% reduction in current (1977) energy costs in residential space heating there would be a reduction of $1.3 million dollars in local earnings in the first year, rising to $1.8 million the second year. By the end of the fourth year earnings have become positive, as the impact of conservation on individual income occurs. By the end of the 10th year an additional $27 million in local earnings is generated.

Approximately 570 man-years of employment will be lost during the initial investment phase, peaking at 900 lost jobs in the third year of the investment cycle. By the sixth year, once again as a result of savings due to the conservation investments, almost 600 man-years of work would be created. By the end of the 10th year more than 6,000 additional man-years will be created through the spending or investment of dollars saved through conservation efforts. A 50% reduction in residential space heating costs would result in the loss of 1500 jobs by the third year of the investment cycle. There is a net addition of local employment by the 6th year, and at the end of the 10th year an additional 11,000 man-years of employment are created. Local earnings decrease by a maximum $3.5 million by the second and third year, but by the tenth year additional earnings rise to $10.8 million.

As two examples,[46] we assumed a 30% and a 50% reduction in residential space-heating requirements with an average payback period of 7 years. The first would take place over five years. The more substantial reduction would be accomplished over 6 years.

In order to achieve the 30% reduction 2,263 man years of labor would be created. Since there are currently 134 firms operating in the District of Columbia which perform conservation and which employ an average workforce of 10 people, this would mean an increase in the workforce of 30% each year for five years.

A 50% reduction in space-heating usage requirements can be accomplished with 3,847 man years of labor. This would increase the workforce of currently operating companies by 60%.

In order to gain a rough perspective on the total amount of labor which would be created in backfitting the entire District (excluding the U.S. government operations) to gain a 45% reduction in energy use (excluding the transportation sector), the Federal Energy Administration's estimates were included. Assuming a 15% reduction could be achieved with less than a one-year payback, an additional 15% with a three-year payback, and an additional 15% with a seven-year payback, we find that 8,740 man years of work are created, or an average of 1,250 jobs. This would reduce D.C. unemployment by about 5%. (See Appendix F for methodology)

The first step in energy conservation is an energy audit. Jobs will be created in this field as well. There are two primary types of audits. One is a basic walkthrough coupled with an analysis of the energy bills. The other is a complete audit, which includes investment possibilites and a detailed analysis of the operation of the building. Using figures from Public Technology, Inc., and the D.C. Department of General Services, a professional engineer would require 1-3 days for a preliminary audit of a building 35,000 to 100,000 square feet, and 5-10 days for a complete audit of a building of 100,000 square feet. Using an average of 3 days per 100,000 square feet for a preliminary audit, it would require approximately 3.5-5 work years to complete a preliminary audit of the District's facilities. Using an average of 7.5 days for a complete audit, it would require 9-13 work years to complete the task.

The National Energy Conservation Policy Act of 1978 mandates the federal government to undertake an energy audit of all existing federal buildings, and to phase in economically attractive conservation measures through 1990. There are 90 million square feet of federally-owned or leased space in the District of Columbia. According to the General Services Administration, the process of auditing is just getting underway. It is reasonable to expect that, upon request from the District, government, such contracts would be awarded to District-based professional engineering firms or private groups, or as part of job-training efforts within the District. Using the above time estimates, this would require 11 work years for a preliminary audit of all existing buildings, and 25 work years for an in-depth audit, assuming trained, experienced personnel undertaking the analysis.

As noted in the section above, the economic attractiveness of solar energy is at present restricted to these buildings which are using electricity for hot-water heating. Thus, a total of about 4,000 buildings comprise this market potential. If it is assumed that 50% of these currently have the roof orientation and other characteristics that would make solar economical and feasible, the universe is approximately 2,000 installations. Assuming 30 man-hours for installation, the result is 32.3 man-years of work.

However, as mentioned above, this is only the beginning of the potential for solar energy. The economics of solar and the potential for jobs in this sector will increase dramatically in the future. There are 150,000 dwellings and most would lend themselves to some application of solar energy. Those firms which train workers in the required skills will find the marketplace opening up significantly by the early 1980's.

The District may be able to design policies which choose between maximizing jobs and minimizing payback periods. For example, Lawrence Berkeley Laboratory noted during one study that one had the option of manually changing fluorescent light fixtures, or installing a highly efficient Phantom Tube TM. 47 The manual retrofit would generate $6.66 in labor but would have a payback period, at 2.6 cents per kilowatt hour, of 3 years. The Phantom Tube TM would have a labor cost of 64 cents, but would repay itself in 16 months.

Similarly, it will require more labor to assemble solar systems on-site, or in local factories, than to import totally prefabricated systems, but, in turn, we will be generating more work for District residents. These are some of the choices facing a city which wants to integrate energy planning with economic development.

Once the conservation is effected, there is a substantial amount of savings. A 30% reduction in residential space-heating would save the residents of the District about $20 million, in 1977 prices. As this is cycled through the local economy, it generates approximately $50 million in total sales volume, and just over $9 million in retained income in the total economy(wages, salaries, and profits). Over 2600 annual jobs are created in the process. (See Appendix F)

A 50% reduction would generate initial savings of $34.5 million, which, in turn, generates approximately $83 million in economic activity and just over $12 million in retained income in the local economy. About 4,560 jobs are created in the process.

## Chapter 3 Footnotes

1. Energy Conservation Plan Report Pursuant to the 1975 Energy Policy and Conservation Act, D.C. Municipal Planning Office, p.5, July 15, 1977.

2. Department of Human Resources, MWCOG, Summary of 1977 Residential Building Permit Authorizations for the Washington Metropolitan Area, Table 4.

3. Caldwell Banker Commercial Brokerage Company.

4. Arthur D. Little, Energy Conservation in New Building Design: An Impact Assessment of ASHRAE Standard 90-75, Federal Energy Administration, 1976.

5. "The Ronald M. Eng, in testimony before D.C. City Council in hearings on Bill 2-397 1978 District of Columbia Energy Conservation Code" Nov. 1, 1978

6. Survey of Washington Metropolitan Area Homebuilders, performed for Dow Chemical Company by Daniel J. Edelman, Associates, December 4, 1978.

7. Arthur D. Little, Op. cit.

8. Fred S. Dubin and Chalmers G. Long, Jr., Energy Conservation Standards, McGraw Hill, New York, 1978, p.12.

9. A Nation of Energy Efficient Buildings by 1990, American Institute of Architects, p.3.

10. Richard Stein, Architecture and Energy, Anchor Press, 1977, p.173.

11. Energy and Buildings, April 1978, the entire issue is devoted to the Twin Rivers project. See especially pp. 243-260.

12. Energy Cost Reduction in Retailing, American Retail Federation, 1977.

13. Energy Cost Reduction for A prtment Owners and Managers, Institute of Real Estate Management, 1977.

14. An Energy Conservation Retrofit Process for Existing Public and Institutional Facilities, Public Technology, Inc. 1977, p.22.

15. Honeywell, Inc. Automated Energy Management Systems (AEMS) For Small Buildings, Unpublished report being prepared by (Brookhaven National Laboratories), August 1978.

16. From computer printout entitled "Floor Area in Heating System Combination for Single-Family Dwellings in the District of Columbia As Of 1977," obtained from Nat Levy of the District of Columbia Municipal Planning office.

17. Caldwell Banker Commercial Brokerage Company estimates that 1.3 million square feet of commercial office space was constructed in 1978. We assume that the construction would have been lower in the years immediately preceding this due to the shortage of mortgage money, and the recession following the oil embargo. Based on a total of 46 million square feet, we estimated that approximately 37 million was built before 1970.

18. From the 1978 Home Improvement Contractors Green Book we gained the following estimates of purchases by companies in the metropolitan area.

| | |
|---|---|
| storm windows | 3.2 million |
| insulation | 3.7 million |
| HVAC* | 4.67 million |

These are wholesale prices. A survey indicated that all work was done on existing dwellings. We assumed one third of the work performed with the District of Columbia, consistent with its population ratio to the metropolitan area.

Assuming 14 windows per house, each at a wholesale price of $20 equals $280 per house. The total purchased was $3.2 million. The total homes done in the metropolitan area was 11,428, and in the District was 3,810.

Assuming an average house costs $00 to insulate, and a total for insulation in the metropolitan area of $3.7 million, we derive 9,250 houses done in Metropolitan D.C., or 3080 in the District.

Material costs for HVAC work range from $700-$900 on the average. Assuming $800, the total for the Metropolitan area is $4,670,000. The number of homes completed was 5,838. It is estimated that the District's share is 1,950.

19. ILSR document concerning energy consumption by building within D.C. Government sector.

20. Lawrence Spielvogel - paper presented at conference entitled: Building Energy Management at Iowa State University, October, 1978.

21. Ronald M. Eng, Indications of Limitations in the Present Application of the "Prototypical" Approach to Estimating the "State/City-wide" Potential for Energy Conservation of Buildings., unpublished manuscript prepared November 1978.

22. Methodological Footnotes/Transportation Section

This figure was derived from data contained in the following publication: "Reference Tables of Travel Data and Related Demographic Data" Department of Transportation Planning/Metropolitan Washington Council of Governments, August 1978.
*HVAC - Heating ventilation and air conditioning (systems)

Calculations were broken down by automobile energy consumption. Using 1975 MWCOG Data we obtain the following data for automobile energy consumption - total auto driver work trips by D.C. residents (per average weekday) = 164,628 trips.

Total all-purpose auto driver trips by D.C. residents (per average weekday) = 750,300.
Assumed average trip length for work = average trip length, allpurpose, by dividing: 164,628 / 750,300 = 21.9% the percentage of total auto driver trips by D.C. residents which are for work purposes.

By taking this 21.9% figure and multiplying it by the total amount of automobile gasoline consumption in the District of Columbia, we obtain the total work-related energy consumption by automobiles. (By subtracting 1.8 trillion BTU's, the amount of gasoline for metrobuses obtained from WMATA, we obtain total automobile gasoline consumption) .219 x (32.2 - 1.8) = 6.66

Using 1975 MWCOG data, we obtain the following data for Metrorail
energy consumption. We can obtain an annual kwh/ year figure for Metrorail work trip which is equal to 21,704,000 x 3413 = 74,054,048,000
$.074 \times 10^{12}$.

Thus, our total work-related transportation energy consumption = 6.66 trillion BTU's for automobiles, .074 trillion BTU's for Metrorail equals 6.73 trillion BTU's.

6.73 / 32.4 = 20.8% work-related transportation as percentage of total transportation equals 20.8%.

23. See footnotes 1-6, Chapter 1. See also Appendix M.

24. An ILSR calculation based on data previously cited in the chapter.

25. Based upon fuel-efficiency standards adopted by the United States Congress in the 1975 Energy Policy and Conservation Act. The standards are meant to be a sales-weighted corporate averages, and the percentages represent percentage fuel-efficiency improvements from a reference year, 1974, when the average fuel-efficiency was assumed to be 14 mpg, and the 1980 of 20 mpg, and 1985 requirement of 27.5 mpg. This information was obtained from the U.S. Department of Transportation, Office of Fuel Economy Standards.

26. "Reference Tables of Travel Data and Related Demographic Data," Department of Transportation Planning, MWCOG, August 1978.

The calculations were made to compare gasoline consumption during 1975 and 1985 given the following assumptions:

(a) the typical fuel efficiency for the fleet in 1975 is 14 miles per gallon;

(b) the fuel efficiency in 1985 is projected to be 20 miles per gallon;

(c) the total number of miles to be driven in 1985 is expected to be 23% higher than in 1975.

Therefore, assuming 1985 fleet average fuel-efficiency of 20 mpg, and 23% increased mileage, we will have a 12.5% reduction, or total gasoline consumption in 1985 will be equal to 87.5 of the total gasoline consumption of 1975.

27. The Twin Rivers, New Jersey project, which is probably the most heavily-monitored project in the country on space-heating, found a 65% reduction in space-heating for existing townhouses, without installation of wall insulation. These buildings already had storm windows, and the authors believe that further reductions were possible. The payback period was estimated to be 10 years. For specific measures, we estimate the following reductions. They are not additive.

Automatic night setback of thermostat - - 10%

Electronic lighter device for furnace - - 10%

Flue restrictor and small diameter burning orifice - - 25% (based on study by the Michigan Consolidated Gas Company related specifically to natural gas which provides for the majority of all space-heating in the District

Insulating under-insulated attic- -20%

Adding storm windows - - 15%

28. Specific measures which are not additive:

Lowering thermostat from 140 to 120 degrees- -8%

Flow restrictors - - 11%

Electronic ignition - - 15%

Water Heater Insulation - - 8%

29. The Metropolitan Washington Council of Governments, in a 1975 report, Energy Balance for the Washington Metropolitan Area for 1973, p.16, took as an average an energy-efficiency rating (EER) of 5 for window air-conditioners and 8 for central air conditioners. California's most recent survey of manufacturers products in that state found the most efficient product had an EER of 11. We assume an increase in EER of from 6 to 10, a 44% reduction.

30. Modern office buildings have lighting to 4 watts per square foot. New code requirements lower this to 3 watts per square foot, and according to a number of experts, 2 watts per square foot is perfectly acceptable. (e.g. Stein, Dubin) The use of automatic shut-off devices in both the commercial and the residential sector, as well as the substitution for more efficient lighting systems can reduce consumption by up to 50%.

31. This is an overall estimate based on the appliance-efficiency voluntary standards developed by the U.S. Department of Energy as a target for the increased efficiency of 1980 appliances over the 1972 stock.

32. The fuel efficiency of cars in 1975 was 14 miles per gallon. We assume an increase in overall fuel efficiency to 25 miles per gallon by 1990.

33. Arthur H. Rosenfeld, David Goldstein, Allen J. Lichtenberg, and Paul P. Craig, Saving Half of California's Energy and Peak Power, in. Buildings, May 1978. See especially p. 11.

34. Arthur D. Little, Op. cit.

35. The total number of BTU's. The percentage which the specific end-use is of the total BTU consumption of the sector is multiplied by the average twelve year reduction in consumption resulting from conservation. For example, reduction for the space heating component of the residential sector is estimated to be 50% of the 1977 base year demand. This amount is added to the same factor increased to account for the average twelve year growth of the sector. All post-1977 growth in consumption is assumed to occur with conservation measures.

The twelve percent growth factor residential consumption is derived from MWCOG data regarding the increase of District of Columbia households in the period 1980-1990.

The thirty-six percent increase in the Commercial/ Industrial/Institutional demand is estimated from the average of 1977-1980 actual and projected square footage of new construction in D.C. commercial buildings. Sources are Caldwell Bankers and the D.C. Office of Planning and Development.

In transportation the distance travelled in miles is estimated to increase by 31% from 1977 to 1990, based on a linear extrapolation of MWCOG transportation data for the year 1975-1985. THus the miles travelled increases by 31%. Multiplied by a fuel efficiency increase of 76% (fleet average miles per gallon increased from 14 to 25), this translates into an effective 24% reduction.

The government sectors are assumed to remain the same size, and therefore to consume, before conservation, the same amount as the base year, 1977. End use is estimated by apportioning the percentage amounts according to the commercial percentages. That is, the percentages which are used for the different end use categories in the U.S. and D.C. government sectors are assumed to be the same as in the Commercial/Industrial/Institutional sector.

36. See footnote 18.

37. National Energy Conservation Policy Act of 1978.

38. Information obtained from D.C. Department of Housing and Community Development, Office of Program Policy.

39. Community Development Block Grants: Loan Guarantees, Federal Register Vol. 43, No. 12 - Wednesday, January 18, 1978; Title 24 Chapter V, Part 570.

40. D.C. Law 2-32, District of Columbia Depository Act of 1977; October 26, 1977.

41. Information obtained from communication with William R. Krause, Deputy Director for Financial Operations, D.C. Office of Budget and Management Systems.

42. Information obtained from communication with Thomas O'Brien, D.C. Office of Budget and Management Systems.

43. National Energy Conservation Policy Act of 1978.

44. Information obtained from communications with William Drew of the D.C. Department of Manpower and Hugh Davies of the CETA Program Office of the U.S. Department of Labor.

45. National Energy Cosnervation Policy Act of 1978.

46. See Appendix F for methodology.

47. S.M. Berman, et. al., Preliminary Report on Assessment of Energy Conservation Strategies and Measures, October 1976, Lawrence Berkeley Laboratory, University of California at Berkeley, page 15.

# Chapter 4

## Legislative Initiatives

The first step in developing a comprehensive energy policy for the District of Columbia would be for the City Council to enact a resolution declaring that energy consumption levels are a public concern, and that the executive branch is directed to develop a program to reduce the levels of consumption and increase the use of renewable energy resources. The City Council could direct the establishment of community energy councils to establish goals for the city. Oregon's state legislature, for example, established a voluntary goal of a 20% energy reduction in public buildings by 1980.[1] California has established a goal of 1.5 million homes using solar energy by 1985. The Seattle City Council has set a steady state per capita energy consumption goal for the year 2000.

Once it is established in law that energy is a public concern, and that certain goals are specified, there are a number of options for the city government. In this chapter, we will present a selected list of the measures enacted in various municipalities and states which seem pertinent to Washington, D.C.

**Tax Incentives:**
It is now accepted throughout the country that there are direct and indirect economic benefits to the locality, and the nation, in the conservation of energy and the use of solar energy. As a result, many jurisdictions are developing incentives for their introduction.

At least 25 states have enacted property tax exemptions for solar energy systems.[2] The District's current tax rate is $1.54 per $100 assessed value at 100% of market value, and for businesses is $2.82 per $100 of actual value.[3] A solar hot-water system costing $2,500 would,under the present regulations, increase property taxes by $38.50 per year. Over the life cycle of the system, assuming 20 years, this would increase the cost by $770, or about 20-30% of the cost (although part of this would be deductible from D.C. and federal income taxes.)

Several states go further. Kansas provides for a rebate equal to 35% of the total property taxes paid on a building equipped with a solar energy system capable of providing 70% of its heating and cooling needs. This rebate is extended for five consecutive years.[4] Assuming a market value of $50,000 for a D.C. house, at an assessed value of $1.54 per $100, the rebate would produce a property tax reduction of $270 per year for 5 years, or a total of $1,350.

In Maryland, any city within any county is authorized to provide a credit against local real property taxes for those residential or nonresidential buildings using solar heating or cooling units. The amounts and definition are left to the discretion of the local jurisdiction.[5] To date, Harford County has been the only locality to take advantage of this enabling legislation. It provides that the credits can be taken over 3 years. The total tax credit allowed is the lesser of (1) the full amount of the cost of materials and installation or construction of the solar energy units; or (2) the total amount of the real property taxes, levied against the buildings or structures (not including the value of land) which is to be paid by the taxpayer for a consecutive three-year period following approval of the application.[6]

At least 6 states have sales tax exemptions or refunds for solar energy equipment sales.[7] This would be equivalent, at current D.C. sales tax rates, to a 5% incentive for solar energy.

At least 6 states have enacted an income tax deduction for solar energy systems, and another 8 states allow tax credits.[8] Tax deductions benefit those in the highest tax brackets, for the deductions are taken on gross income. Tax credits provide for a deduction directly from the tax liability.

Tax credit regulations vary widely, ranging from a modest 5% in North Dakota, to a substantial 55% in California. The maximum credit is usually $1,000, as is the case in Oregon, North Carolina, New Mexico and Arizona; although in Oklahoma, it is $2,000, and in California, the maximum. is $3,000.[9]

In most states, there are carryover provisions since state income taxes are relatively low and individuals would not be able to take full benefit of the credit against their tax liability in one year. North Carolina has the most limited tax carryover, two years, while Kansas and Oklahoma permit the carryover to be four and five years respectively. California permits the tax credit to be carried over indefinitely until exhausted. [10]

In Washington, D.C., 27% of the population paid less than $116 in District of Columbia income tax in 1976.[11] As a result, even an extended carryover would be relatively useless to them. New Mexico, which permits a tax credit only on materials, but not on labor, includes a rebate provision, refunding the difference between the credit and the liability.[12] Presently the District of Columbia is considering a 10% rebate on solar energy systems.

States vary with respect to the relationship between their tax credits and the federal tax credit. Arizona, California and New Mexico will deduct the federal credit from their own. Kansas, Oklahoma, Oregon and

Wisconsin add the federal tax credit to their own, thereby, in some cases, providing for up to a 50% total effective tax credit. [13]

In all states, the credit is available only for a limited time period. In several states, such as Arizona and Wisconsin, the credit is reduced each year, encouraging homeowners to purchase solar when industry most needs the impetus. In Wisconsin, it has been proposed that a higher tax credit be given for existing buildings than for new buildings, under the assumption that it is more expensive to retrofit than to integrate solar into a new building. Solar can be financed in a new building under a long-term lower-interest mortgage, whereas retrofits tend to be high-interest, short-term home-improvement loans.[14]

Finally, California's tax credit is available to builders as well as homeowners. If the solar system is installed in a building other than a single-family residence, and the cost is greater than $6,000, the tax credit is 25% or $3,000, whichever is greater. The builder can take the tax credit and convey it to the homeowner he or she wishes. [15]

Regulations relating to these credits vary substantially. In most states, certification guidelines have been developed. In Hawaii, no independent certification is required.[16] To qualify for California's tax credit, collectors for space-heating must face within 45 degrees of true north if mounted on a wall, or 60 degrees of true south if mounted on a roof. [17] (However, recent evidence indicates that the loss from east-west facing collectors is not substantial enough to disqualify a taxpayer from receiving the credit, and these regulations may be altered.)

In California, conservation is required before solar. A domestic solar water-heating system must include an insulated jacket for a back if up water heater with an insulation level of at least R-12 to qualify, and water-flow restrictors must be installed in shower heads and hot water faucets in new buildings. Rooms heated or cooled with an active solar space-conditioning system must have weatherstripping and 13 attic insulation in accessible attic space above heated rooms.[18]

The federal tax credit permits taxpayers to take a credit of 30% for the first $2,000 and 20% for the next $8,000 for a maximum credit of $2,200. The tax credit includes passive solar features such as south-facing windows, but exempts those features which would be included in the structural aspects of a house, such as thermal mass. Several states, including California and New Mexico, have specific passive solar energy regulations in their tax credit provisions. Virginia exempts passive solar devices from property-tax assessment.[19]

**Other Economic Incentives:**

Oregon requires utilities to provide weatherization services to their residential space-heating customers. For public utilities this includes arranging financing through commercial lending institutions at a maximum interest rate of 6.5%. The difference between the 6.5% interest rate and the market rate for these types of loans up to 12%, is bridged by a tax credit to the lending institutions.[20] Investor-owned utilities are required to provide 6.5% financing themselves.

Oregon also permits a tax credit to individual taxpayers for their principal residence, or the principal residence of their renters, not to exceed the lesser amount of $125 or of 25% for conservation materials and installation.[21] Alaska permits a 10% tax credit for conservation, up to a maximum of $200.[22]

Oregon has appropriated $4 million or about $2 per capita (equivalent to $1.4 million for the District of Columbia) for low income elderly home weatherization programs. Since the federal weatherization funds are oriented primarily toward households below the poverty level, this fund is specifically designed to assist those between the poverty level and $7,500 annual income.[23]

Several states, including Montana, Illinois, New Mexico, California, and Iowa, have small grants programs to encourage individual demonstrations of solar energy and energy conservation. The city Seattle has established such a program as well, both through its municipally-owned utility, and through a non-profit organization financed by community development block grant (CDBG) money.

**Appliance Efficiency:**

Several states have enacted specific measures relating to the efficiency of new appliances. In Kansas, the Kansas State Corporation Commission (the state's utility regulatory body) prohibits-new hookups for gas and electricity unless certain energy efficiency standards in air conditioners are met, and unless the building has storm windows installed.[24] The Iowa legislature has mandated its state Department of Commerce to enact regulations to prohibit the sale of continuous-burning pilot light gas furnaces. In Oregon, all new gas-fired forced-air central space-heating equipment, swimming pool heaters, clothes dryers, or domestic ranges must be equipped with electronic ignition devices in place of pilot lights starting January 1, 1979.[25] California prohibits the sale of gas appliances with pilot lights, and requires specific energy efficiency levels for refrigerators, freezers, and air conditioners.[26] The argument in favor of banning pilot lights is straightforward. Many new appliances are already converting to electronic ignition devices.

The argument in favor of establishing mandatory efficiency electric appliance ratings is somewhat different. These electric appliances contribute to the peak-load of the utility company, especially in the case of air conditioners in high summer peaking areas. Energy efficiency in air conditioners and refrigerators tends to directly displace costly capacity. This saves not only fuel costs, but the costs of adding new peaking facilities. The argument against the District of Columbia enacting such legislation is that shoppers could easily purchase their goods in the suburban areas. While that is true, it may also be true that it would be an effective marketing measure, for consumers would know that they could choose from a wide array of brands and models in the District and all would be energy efficient. On the other hand, in suburban areas without this legislation, the consumer would have to rely on energy-related information from the salesman, and understand the energy efficiency ratings formula.

**Public Buildings:**
At least six states have life-cycle costing required for the purchase and/or lease of public buildings.[27] These states are currently developing formulae for enacting regulations. Life-cycle costing is a methodology which includes not only the initial cost of the building, but also the operating costs over its life-cycle. Future energy prices, the life of the building, and the appropriate discount rate must be projected.

**Existing Buildings:**
The major difficulty in achieving maximum energy conservation will be in existing buildings. In this case, the District has three alternatives.

First, it can establish a building code for existing buildings. There are no jurisdictions to our knowledge which currently have this type of code, although Davis, California[28] is in the process of designing one. ASHRAE is presently developing its 100-P series of standards for existing buildings. Its goal is to achieve the same consumption levels in existing buildings as would the adoption of ASHRAE 90-75 for, new buildings. Since housing stock changes ownership in the District once every 6 years, this type of legislation would have a rapid impact.

Second, the city could require certain conservation levels as the basis for transfer of property. The State of Minnesot requires an energy audit at the time of sale of property. In this way the buyer knows how much the operating costs of the building will be and has the opportunity to integrate the energy conservation measures into the long term mortgage for the house. Minnesota also requires that minimum attic insulation levels be met upon transfer of property. The State is presently investigating further conservation measures which could be required upon sale of property.

Portland, Oregon recently passed an energy conservation plan which mandates that all existing buildings meet the state conservation code required for new buildings within 5 years. This includes rental and owner occupied housing.

Third, the city could also use certain existing ordinances to encourage conservation in existing buildings. For instance, the D.C. Rental Housing Act of 1977 has certain provisions which are directly applicable to energy conservation. The Act specifically exempts buildings with four units or fewer, which would exempt 50% of the housing stock. It also exempts public housing, dormitories, hospitals and old-age homes.

The Rental Housing Act specifically permits a rent increase to cover the cost of capital improvements if "the improvements will provide an energy savings or is to comply with environmental regulations." The Act permits an automatic increase based on the following percentages, as applicable:

a) 2%, if the rent does not cover the cost of utilities; or,
b) 7%, if the rent covers the cost of heat and hot water; or,
c) 8% if the rent covers the cost of heat, hot water and general purpose electricity, but not air conditioning or cooking fuel; or,
d) 9% if the rent covers the cost of heat, hot water, general pur pose electricity, other cooking and air conditioning.

This provision could be revised so that the automatic passthrough can take place only if the building meets certain standards, such as the ASHRAE 90-75 standards.

There are specific provisions in the Rental Act dealing with the meaning of substantial rehabilitation. It is an improvement or renovation to a housing accommodation costing 50% or more of its assessed market value.

The regulations governing this section could be revised to include a provision that if a landlord is permitted to raise rent, or to evict tenants temporarily for a substantial rehabilitation, that the building must meet certain energy requirements upon completion of the rehabilitation. This would be compatible with the current proposed provisions of the D.C. Energy Conservation Code, which indicates that its provisions will apply to buildings substantially renovated as well as new buildings.

**Zoning and Planning:**

Several states require energy conservation as a factor in comprehensive land-use planning. Oregon established a Land Conservation and Development Commission charged with the responsibility of developing mandatory statewide land-use goals and guidelines, and has incorporated energy conservation as one of the statewide goals.

Of the 25 states which have adopted environmental impact legislation or regulations modeled on the National Environmental Policy Act of 1969, nine explicitly require analysis of the energy demand generated by the project and of the sources of energy to meet the demand.[30] New York and California have gone further, by requiring an analysis of measures to conserve energy resources. In California, the environmental impact report contains "mitigation measures proposed to minimize the impact, including but not limited to, measures to reduce wasteful, inefficient and unnecessary consumption of energy". In Florida, energy impact statements are required by the South Florida Regional Planning Council.

The dynamics of such impact statements can yield excellent results.

> In a case involving a large scale development in Homestead, Florida, questions asked by the SFRPC (South Florida Regional Planning Council) prompted the developer to discuss the possibilities for energy conservation through site design, layout and landscaping, building design and construction, use of solar energy, and other alternative energy sources, as well as the provision of park-and-ride facilities, and bicycle and pedestrian paths. On the basis of the information provided by the developer, the council staff prepared an impact assessment report recommending that the development be approved, provided that, among other conditions, there was an overall 30 percent reduction in the electrical energy consumed per residential unit. It also recommended that prior to the approval of each major phase of development, the applicant submit to the city of Homestead a written statement of proposed energy conservation measures and of progress made toward the overall goal.[31]

The District already has provisions for planned unit developments. There are a variety of bonuses given to developers in return for energy efficient designs. Prince George's County gives density bonuses out to developers who provide pedestrian paths linking housing to transportation terminals. San Francisco awards density bonuses for buildings which are close to transit stations or that provide access to rapid transit.

**Public Utilities:**

The two D.C. energy utilities, Washington, Gas and Light, and PEPCo, provide 61% of total energy consumed in the District, excluding the transportation sector. Thus, they will play a vital role in conservation and solar energy policies. Through rate structures, they can encourage, or discourage conservation and/or the use of renewable energy resources. The National Energy Conservation Policy Act of 1978[32] requires utilities to actively involve themselves in energy audit programs, and to provide lists of lending institutions, suppliers, and installers. The utility can become the bookkeeping agent for the lending institutions, with the customer paying back the loan through the utility monthly bill. However, the utility is prohibited from supplying, installing, or financing conservation or solar measures except for furnace-efficiency modifications, clock thermostats, and load management techniques associated with the type of energy sold by the utility, or for loans not exceeding $300.[33] There is a broad exemption under section 216(d) in which the utility can provide such services if: it was already doing so at the date of enactment of the Act, or; if it was broadly advertising such services or; if the state had enacted a law or regulation requiring explicitly that the public utility provide such services. It is unclear whether District utilities would be exempt under these provisions.

In President's Carter's energy address in July 1979 he recommended that the prohibition of utility financing of conservation be overturned. Utilities would be required to adopt the "Oregon plan". Under that plan utilities, upon request, do an audit of the homeowner's structure, and makes conservation recommendations. These recommendations are based on the marginal cost of new electricity to the utility company A private contractor installs the measures, the utility pays the contractor. The cost of the audit and the conservation measures becomes part of the utility's rate base, and a rate of return is provided. When the homeowner sells the property the utility "loan" is repaid, without interest. In Oregon a lein is put against the home by the utility.

The Oregon plan makes possible mandatory conversion to conservation. This is especially important for rental units, where absentee landlords who write off energy costs as a business expense have less motivation for moving toward conservation. The landlord invests no money upfront. When he sells the building, he repays the loan, with no interest. However, since the value of the building will increase at least by the amount of conservation investment, in effect, the work is done "free".

By putting conservation investments is using the theory of the commons. If I undertake conservation, and my neighbor does not, he still pays slightly higher raters. This acts as an incentive for him to undertake conservation as well. If I conserve energy, I save my neighbor money because it delays the need in the rate base, the utility for new energy generation investments on the part of the utility.

It appears the case in Oregon, however, that utilities do not aggressively promote this program. They would be the financing mechanism, but citizen organizations would have to advertise and assist homeowners and renters in taking advantage of its provisions.

Bills submitted to the House Commerce Committee related to the utility financing measure are in three forms. All include renewable energy resources as part of the definition of conservation. One makes the utility financing mechanisms compulsory, and another permits it to be voluntarily adopted. One bill would establish a set
period of time during which the investments by the utility remain part of the rate base. Thus, rather than removing it form the rate base whenever the property is transferred, it would be retained for, let's say, 10 years. This helps the utility in doing long range financial planning.

The Public Utility Regulatory Policies Act of 1978 requires all state public utility commissions to initiate proceedings to investigate the feasibility of electric rate structures which would encourage both conservation and small power production. The Act
does not apply these provisions to gas utilities. The Public Utilities Commission is not compelled to enact the measures outlined in the Act, but if it does not do so, it must state, in writing, the reason for not doing so, and the statement must be available to the public. The following Federal standards are established:

(a) cost of service rates charged by any electric utility for providing electric service to each class of electric consumers shall be designed to the maximum extent practicable to reflect the costs of providing electric service to such a class
(b) declining block rates
(c) time-of-day rates
(d) seasonal rates

Several state legislatures, and public regulatory commissions, have mandated energy conservation and solar energy measures by utilities as part of an overall energy policy. The Public Utilities Commission of Oregon, in response to a petition from the Pacific Power and Light Company, has permitted that utility to install up to $30 million of weatherization materials in residential single-family homes and duplexes. The weatherization is installed initially without charge, but must be repaid, without interest, no later than the time the ownership of the dwelling is transferred by any means.[34] In New York State, utilities are required to arrange for financing for conservation measures. If they provide financing themselves, they are repaid with an interest no higher than their rate-of return.[35]

Tho Sections 231 and 210 of the Public Utility Regulatory Policies Act of 1978 requires that utilities permit onsite poorer producers to interconnect with the grid, that they permit the small power producers to wheel electricity over power lines, that they purchase excess electricity at reasonable and fair prices, and that they provide backup energy at fair prices. The criteria for evaluating the price that the utility should set will be established by the Federal Energy Regulatory Commission Criteria must be promulgated by November 9, 1979, and state Public Utilities Commissions must implement their own regulations within 12 months after the FERC rules are made public.

PURPA also permits the Federal Energy Regulatory Commission to exempt small power producers from federal, and state regulatory procedures, as a way to encourage small power production. Small power producers are considered to be those who generate less than 80 MW, including those that use renewable resources and those that use cogeneration. If the power producer generates less than 30 MW (equivalent to the electrical needs of 5-30,000 homes) he can be exempted from federal and state regulations. Since the Treasury Department in March 1979 decided that energy generators not regulated are eligible for investment tax credits such an exemption can change the economics of small power production greatly.

In New Hampshire the public service commission in spring 1979 required the utilities to purchase electricity from hydroelectric facilities of less than 5 MW, at a price of 4-4.5 cents per kilowatt hour, depending on whether the electricity is firm or as available. The utilities have been paying 2 cents per kilowatt hour. The PURPA regulations indicate that the price the utility should pay can be no higher than its incremental cost of getting an additional unit of energy from another source. FERC staff as of the summer 1979 had defined this as meaning that a capacity credit should be a part of the purchase price. That is, the utility must pay not only the displaced fuel cost, but also future costs of adding generating facilities.

In California the Southern California Edison Company lets those who own wind generators to turn the electric meter backwards, in effect ,paying the retail price for energy to these small power producers. The Public Utilities Commission in California is currently examining the feasibility of making this a mandate statewide.

## Chapter 4 Footnotes

1. Oregon Legislature, HB 3309, passed in 1977.

2. Porte, Joan E., Solar Legislation in the Fifty States, Consumer Action Now, Inc.

3. D.C. Department of Finance and Revenue.

4. HB 2618, 1977 Session Laws of Kansas, Chapter 345.

5. Maryland Laws of 1976, Chapter 740.

6. Maryland Bill No. 77-32, March 1977, Chapter 11, Article 2, Section 11-39 of the Harford County Code (1975).

7. Porte, op. cit.

8. Ibid.

9. State Solar Legislation As of July 1978, National Solar Heating and Cooling Information Center.

10. Telephone Survey conducted during July 1978.

11. D.C. Department of Finance and Revenue.

12. New Mexico Statutes Annotated, Section 72-15A-11.3, 1953 Income Tax Act.

13. Arizona: Chapter 81 of Laws of 1977 as amended by Chapter 112 of Laws of 1978; California: Chapter 168 of Laws of 1976 as amended by Chapter 1082 of Laws of 1977; New Mexico: Chapter 12 (1975 Special Session) as amended by Chapter 170 of Laws of 1978; Kansas: Chapter 434 of Laws of 1976; Oklahoma: Chapter 209 of Laws of 1977; Oregon: Chapter 196 of Laws of 1977; Wisconsin: Chapter 313 of Laws of 1977.

14. Proposed, Wisconsin Administrative Code, Chapter IND 18.

15. From Essential Features of California's Solar Energy Tax Credit Guidelines, Office of The Secretary, Business and Transportation Agency, State of California, February 1975.

16. Letter from Tomsteru Ogai, Department of Taxation, State of Hawaii, November 27, 1978.

17. From California Solar Tax Credit, California Energy Commission.

18. Ibid.

19. "Solar Energy: Criteria for Tax Exemption", Virginia State Board of Housing, October 1977
.

20. Oregon Legislature, HB 2157.

21. Oregon Legislature, HB 2701.

22. Laws of Alaska, 1977, Chapter 94. 23. Oregon Legislature, SB4, 1977.

24. State Corporation Commission No. 110,766-U.

25. Oregon Legislature, SB 818
.

26. California Administrative Code, Title 20, Chapter 2, Subchapter
4: Energy Conservation, Article 4; Appliance Efficiency Standards.

27. Porte, Op. cit.

28. See report of Sedway/Cooke, Davis Energy Conservation Retrofit Program: Analysis of Energy Conservation Techniques, April 19, 1978.

29. Livermore, California, City Code - Section 6.51, Article X, Energy Conservation

30. This section taken primarily from Corbin Crew Harwood, Strategies for Energy-Efficient Land Use, Ballinger, 1977.

31. Ibid., p. 197.

32. National Energy Conservation Policy Act of 1978, Section 216.

33. Ibid.

34. Oregon Public Service Commission, Ruling regarding Pacific Power and Light Company's petition to institute weatherization program.

35. New York State

36. As reported in Inside DOE, August 21, 1978, p. 10. of the State of Kansas, Docket

# Chapter 5

## Energy, Neighborhoods and Organizational Structure for Energy Relative Services

**Citizen Involvement:**

The city of Washington is unique among the recipients of federal energy money. It has a clearly defined physical stock of structures. It knows, within certain narrow constraints, what its population, housing stock, and land area will be in ten or twenty years. It thus has the ability to gather data which is quite specific to its planning needs, and rely on computer models a great deal less than would be the case in other jurisdictions. Within a relatively brief period of time it can develop a data base which can be useful in estimating the impact of certain conservation measures, the performance of solar systems, and the variety of consumption habits within certain physical structures, and sociological groups.

Just as a state, in implementing or evolving a successful plan, would decentralize administration to involve as many localities as possible, the District of Columbia, as a city-state, would use its neighborhoods as the basis for planning, education, and implementation. For energy self-reliance to become a reality, it must be developed at the community level. There are two prerequisites for the maximization of municipal energy self-reliance:

1) Accurate data-gathering. National data can be useful in evaluating maximum energy-efficient designs for different climates, but only with actual audit data collected over a period of time can we estimate such things as the genuine potential for conservation -- or the performance characteristics of solar or on-site energy generation systems.

2) Citizen support and involvement. Not only will this be important in the passage of energy-related legislation, but citizen involvement is important because of the fact that individual behavior patterns can be almost as important in operating a building or other energy system as can the design of the building equipment. Studies indicate that there can be a 100-200 percent variation in energy use within buildings of the same type, with the same number of occupants, simply because of differing energy use and personal habits. People who do not maintain their furnace, who keep the windows open in the winter, who set thermostats at 80 degrees, or who do not install flow restrictors, can easily undermine any municipal energy conservation objectives. Public education and citizen involvement are the keys to any demonstrable success.

There are two further reasons for developing a strong neighborhood basis for energy planning:

1) Involvement in energy planning can provide the educational experience for citizens to become involved in much wider areas of planning. Too often, neighborhoods -- even in the District, where neighborhoods are recognized by the city charter and by the courts as having a role in planning decisions -- are involved after the fact and respond only from a position of vested self-interest. Comprehensive energy planning can involve all of the citizens, agencies and businesses in the District from the beginning. In planning for self-reliance, citizens will need to gather accurate data, to understand the tradeoffs between peak and off-peak power and between storage and generation systems, to realize the impact of individual behavior or the system as a whole, to understand the tradeoffs between cost and reliability, and the impact of various scales of generation systems. These concepts can be simplified through the use of citizen education outreach programs. Once mastered, though, the same concepts can be applied in other types of planning, such as planning for meeting air pollution standards, for traffic patterns, or for economic development. Through participation in energy planning, citizens can understand how they relate to larger systems and can appreciate the costs of the many alternative actions -- and that knowledge is transferable to other issues.

2) There is now a real potential for completely decentralized energy systems. The Public Utilities Regulatory Policies Act requires that the Federal Energy Regulatory Commission investigate the reliability of small power producers versus centralized energy generation and enact rules permitting the interconnection of small power producers with larger grid systems. The new advances in solar technology, in cogeneration, and in fuel cell technology, along with new concepts in storage systems, make it likely that our future energy system will be very different from our present one. It is conceivable that future systems will be neighborhood-based, with a wider backup system. Such a development must be understood by neighborhood organizations and residents, and the organizational structures which might complement these new technologies must be a matter of debate among-neighborhood groups, as well as among businesses and city officials.

With respect to energy planning, the city could be divided into geographic areas. Each area would measure its energy intensity. Areas in which office buildings predominate will have different energy self-reliance programs than will less dense, residential areas on the periphery of the city. The industrial areas in upper Northeast, with large warehouse space, would have to develop another policy as well, one which is appropriate to its energy usage patterns. Then a neighborhood-based program need not be limited only to well-populated residential areas. It can include organizations of retail merchants, or office building owners, since energy is an issue for everyone.

One of the first steps in involving people in energy matters is to make energy itself comprehensible to them. Of first importance is to translate all energy into a common measurement, such as BTUs. Currently, the gas bill is measured in therms, the fuel oil in gallons, the electricity in kilowatt hours. The food energy we consume is measured in calories. It makes it difficult for the average citizen to understand that each term describes energy, and that one is convertible into the other. A therm equals 100,000 BTUs,.a gallon of fuel oil (depending on what kind) equals between ] 18-154,000 BTUs, a kilowatt hour equals 3,413 BTUs, a calorie equals 4 BTUs.

Throughout this paper we have converted all energy into BTUs. It would be quite possible for the District of Columbia Public Service Commission, as part of a policy of educating the average citizen about energy, to require all bills to be written using a common measurement.

Clearly, there will be problems. BTU is a measure of the quantity of energy. There are qualitative measurements as well. Electricity, for instance, is a superior form of energy in certain applications, such as driving electric motors, and one could not substitute heat energy and do this efficiently. It is also true that electricity currently is generated in power plants where two-thirds of the total energy is rejected as waste heat. It is necessary to take into account the primary energy used in the conversion process as well as the final energy used. (Of course, if this were the case, it is necessary also to take into account the different efficiencies of fossil-fueled-heating and hot-water systems versus electric systems within the building envelope. Gas furnaces, for example, have efficiencies of 70-75%, while electric resistance heating has efficiencies of 100% within the house.)

The issue of efficiencies, and the quality of energy, will have to be dealt with in any citizen-education program. These are better discussed, we believe, when there is a common measurement, or a common basis. When people realize that the calories and the kilowatt hours and the BTUs they consume are all energy, and that energy can come from similar fuel sources, whether it be fossil-fuels, nuclear, or solar energy, then energy planning is greatly simplified.

**An Energy Competition:**

One of the best means for both gathering data and developing energy awareness, is through a friendly competition among neighborhoods. The neighborhood which conserves the most energy, either through conservation or solar energy efforts, would be awarded a cash prize, based on the amount of energy conserved. The cash award would go to the Advisory neighborhood Commission (ANC), to be used for operating community projects, voted on by the entire community.

The details of such a competition -- and the criteria for comparison among neighborhoods -- must still be worked out. At first glance, it appears that, in the initial years, rental buildings should be excluded, because those who rent have less control over their energy use than those who own. (But the city can, through legislative remedies or new regulations, help renters to reduce energy costs.)

The city might begin such a program with single-family dwellings. There are 100,000 single-family dwellings in the District of Columbia. By assuming that these are divided equally among the 35 Advisory Neighborhood Commissions, there would be 2,857 in each neighborhood. Sixty percent of these are owner-occupied, bringing the total involved in the competition to 1,714 within each neighborhood.

The average energy consumption of a single-family dwelling in the District is 82,000 BTU's per square foot. The average size is 2,000 square feet. Thus, 1,714 single-family dwellings would, on the average, consume 281 billion BTU's per year (in energy consumed within the boundaries of the building). The first 10% of energy savings is relatively easy to achieve, and receives no award. Two neighborhoods receive cash awards. The amount of the award is equivalent to the cost of 25% of the BTU's saved above the initial 10% savings, converted into current dollars.

Using the above example, and assuming that the neighborhood achieved a 20 percent energy savings, the first 10 percent is not counted in the cash award. The neighborhood would be credited with a total of 28 billion BTU's in savings. Assuming a $5 per million average cost, this comes to $140,000. Twenty-five percent of this is equal to $35,000. This money would be awarded to the Advisory Neighborhood Commission for use in operating programs established by vote in community assembly meetings.

Obviously, there are issues which must be clarified in the planning of this kind of competition. For example, is it desirable to equate electrical energy and thermal energy? Electricity generated outside the home loses two-thirds of the energy to waste heat. Therefore, by saving a BTU of electricity, actually about 3 BTU's in energy are saved to the total system, whereas a savings of one BTU of natural gas, given the 60 percent efficiency of many natural gas appliances, would save the equivalent of only about 1.5 BTU's.

What approach is necessary to deal with the fact that some neighborhoods are already reasonably energy-efficient, and possibly are starting from a lower energy base than others? Are percentages useful as the basis for these competitions, or should a base case be established for the entire city and awards given for those who dip below the average base?

Would it be desirable to base the competition on all the single-family dwellings in the area, even though only a few participate in the program? One might establish a minimum percentage of homes participating in order to make the neighborhood eligible, possibly 20 percent. The cash awards could be based on total number of structures, or total number of square feet, participating.

The National Energy Act requires the utility companies to maintain monthly records for each customer, and upon request, to provide a comparison of usage in the current year with that of the year before, normalized for differences in degree days. Both WGL and PEPCo can break out records by geographic area. It is less clear whether they can differentiate between records on the basis of single-family dwellings. It is likely that fuel-oil dealers may have problems in geographically separating similar relevant data. The collection of data presents no problem if the individual household is maintaining records, for they can examine monthly bills. However, if aggregate totals are to be gained, the utility companies and the fuel oil dealers' records would be relied upon.

**Organizational Structure for Energy-Related Services in the District of Columbia**

Since the District of Columbia is treated by the federal government as both a city and a state for purposes of funding, it will receive a higher per capita portion of available national energy funds than comparable jurisdictions. A great deal of funding will be coming into the District in the future years for energy-related programming, including almost a million dollars for low-income energy conservation grants, about half a million dollars for energy planning and research, and several million dollars for audits of public buildings, schools, and hospitals, and several hundred thousand dollars for an Energy Extension Service.

Such programs, if coordinated, can reinforce one another. If uncoordinated, the effectiveness can be considerably reduced. The Municipal Planning Office (MPO), and the D.C. Energy Task Force of the Transition Teams, recommended the creation of a single Energy Office at the executive level. Although the functions of the Office were not detailed in these recommendations, it would seem likely that the following tasks would be assigned to it:

1) Audits of public and private buildings
2) Research and recommendations for legislative initiatives
3) Low-income weatherization programs
4) ) Economic development
5) ) Grant-making
6) Consumer protection
7) Public education and citizen outreach
8) Data collection on current and projected energy consumption
9) Research and development

Given the variety of existing institutions in the District, it is suggested that such an office coordinate with, and use, these delivery mechanisms while performing many of these functions.

Audits of public buildings, and research and recommendations for legislative initiatives, are best done in-house. The Department of General Services is already undertaking audits of several schools in the District, and the Municipal Planning Office is collecting data on existing energy programs in various parts of the country. The development of these skills in-house will also be useful in evaluating the reasonableness of future code changes, or the potential for certain conservation efforts.

Maximum use should be made, however, of District-based energy firms performing the audits for the private sector. These firms can be trained by the in-house staff, use the public buildings as a basis for such training, and then branch out to the city as a whole.

The low-income weatherization program is currently operated by the United Planning Organization (UPO). Under the regulations of the U.S. Department of Energy, the funds used (constituting a majority of the total funds dispensed in the coming year) can only be used for grants. Under Community Service Administration (CSA) regulations, such funds can be used as well as no-interest or low-interest loans. An evaluation should be undertaken as to whether it is more efficient to use existing minority, small business firms to do the weatherization work, or whether it should be done by a separate agency involved chiefly in the delivery of services to low-income populations. Using small business firms might enable the job-training aspects of the program to meld with future employment possibilities much more closely than has been the case in many other programs around the nation. UPO would continue to administer the program, and a small in-house staff should be available to do audits for low-income people, and to provide assistance for those who want to do their own weatherization jobs. The creation of self-confidence, and an awareness of energy among the low-income population, and the potential for stretching out the dollars by allowing these people to use their labor instead of hiring professionals, should be encouraged.

Economic development activities could be the province of a separate corporation or can be part of the energy office. The city might want to imitate the development of policies of the city of Hartford, Connecticut, or the solar activities of the Tennessee Valley Authority. The District could establish a municipal corporation, linked to the Energy Office, but independent of it, which would catalyze additional financing from local financial institutions, and would purchase in bulk, reselling equipment at wholesale prices with a small markup to individual residents within the District.

The city already purchases fuel oil in bulk, and the potential for a 20 percent price reduction through cooperative purchasing seems quite likely. An even greater reduction could be possible through the bulk purchase of such items as storm windows or insulation. These products would, of course, have to conform to the highest manufacturing, and federal specifications.

The bulk purchase of 500-1,000 solar systems by TVA has resulted in a price of $2,000 per system installed, including a large backup tank and off-peak devices, as well as the solar collectors and controls. This compares favorably to current individual prices of about $2,500 in D.C. for solar systems with neither extra storage tanks nor off-peak controls. The municipal corporation could put solar within the reach of more city residents.

This corporation would, in combination with the energy office, work on bringing together the financing aspects of commercializing conservation and solar. A survey of the largest banks in the District of Columbia found that none were including energy as a factor in considering mortgage loans. Thus, the traditional formula of principal, interest, taxes and insurance (PITI) has not yet been changed by District banks, although there are banks and savings-and-loan associations in the nation which are not only crediting energy costs, but are giving differential interest rates for energy-efficient automobiles, homes, and appliances. This is the case even though energy costs can already be about 15 percent of the mortgage payments, higher than the payment for insurance and possibly more than that of taxes. The corporation staff would work in educating mortgage loan officers on the need to integrate energy expenditures in residential and commercial appraisals.

This corporation could also develop mechanisms for leveraging existing federal and local financing programs for solar and energy conservation. Its job would be to help the consumer and other small business persons' to stretch their energy dollar.

There are a number of mechanisms for financing conservation and solar programs (see above, Chapter 3). It is also possible to develop a tax specifically oriented to energy financing. In California, there is a small kilowatt-hour tax which finances the California Energy Commission. A tenth-of-a-penny tax on existing electrical consumption in the District (excluding the United States Government), would bring in $4.3 million based on 1977 energy costs. Such a special-purpose tax, however, would be unprecedented in the District, which has a policy whereby into the general fund. Gasoline taxes, for example, go into the general fund. An energy tax of this kind should have a strict limitation on overhead. It would not be used to staff an energy office or conduct research. These could be accomplished with federal money appropriated for that purpose. Rather, the fund could be used for three purposes: finance, demonstration and small grants programs. Approximately $2 million could be used to finance energy-related activities, coupled with other District monies. $1 million dollars could be used for demonstrations of new technologies and systems (e.g., fuel cells, cogeneration systems, combination thermal and electric systems), possibly in combination with federal demonstration monies. The remainder could be useful as a small grants program.

Each of these suggested programs is already being utilized by selected state governments and some city governments. For example, Seattle's municipally-owned utility makes conservation grants to neighborhood residents. Montana has a small grants program for renewable energy sources. California, New York, Montana, Illinois, and several other states have established research and demonstration funds. The small grants program would be a means for tapping into the creativity of small groups, individual investors and designers, small businesses, and professional engineering and architecture societies. The District of Columbia could develop guidelines based on the experiences of the appropriate technology grants program funded by the Board of Regents in California and operating out of the University of California at Davis, or the program in Montana, or the National Center for Appropriate Technology grants program, or the U.S. Department of Energy small grants program.

Consumer protection on energy-related matters should be an important function of the Energy Office. New guidelines on insulation and wood stoves, performance standards for solar systems, operating information from manufacturers or independent testing laboratories, should be available to District residents.

The District would have to decide whether it wants to develop a seal-of-approval process, or only relay information from independent testing agencies and professional standard setting societies. An interesting variation is the program of Southern California Edison, in which private businesses install solar energy systems but SCE guarantees the work, servicing the systems for the consumer. The city could establish a similar mechanism. One possibility might be to rely on the water department's expertise in doing this. In the city of Santa Clara, California, the water department, not he city-owned electric company, leases and installs solar systems. Whatever the mechanism, there must be a place that District residents can go to get accurate, unbiased information on the bewildering proliferation of energy-related products. Without it, consumer acceptance and trust will be slow in developing.

Data-gathering on current and projected energy trends should be done by the staff of the Energy Office, in association with the Council of Governments (COG), the Municipal Planning Office, and related offices. Legislative initiatives should also be developed in-house, although initiatives will be developed, as well, by the city council staff.

The public education programs and citizen outreach will be the backbone of the successful implementation of this program. The soon-to-be--created Energy Extension Service should have two levels of operations. One is a central-core facility which provides backup information. This can be a consortium of existing universities professional engineering firms and the public school system. A coordinating committee of citizen organizations and small businesses. could play a direct advisory role in the process.

There is, for instance, an experiment in progress concerning the viability of community input into planning and decisions on energy matters. In the fall of 1977, the D.C. government Office of the People's Counsel received notice of a grant award from the Office of Consumer Services of the U.S. Department of Energy. The grant was awarded to the People's Counsel to implement the formation of a community-based citizens advisory committee for whichever community information purposes which this group might deem relevant to the citizenry of the District. Additionally, the People's Counsel was to conduct five studies on various aspects of the social and financial costs of electrical conservation measures.

Initially, letters requesting nominations for a preliminary steering committee were sent to 600 community leaders engaged in activities of interest groups, citizen groups, governmental entities, commercial users, Advisory Neighborhood Commissions, political interest groups, labor organizations, church groups and members of the community at large. An avalanche of nominations quickly returned and the next step was to choose a small cadre of the most informed community leaders to whittle the list down to a manageable size and to contact the nominees. Within a few weeks, this Herculean task was completed and a 40--member steering committee was formed to hammer out bylaws, a structure and a name for this group.

On February 1, 1978, the final draft of the bylaws were ratified by the steering committee and the Consumers Utilities Board (C.U.B.) was launched. Most of the members of the steering committee. chose to join the new Board and officers were elected. Three standing committees were organized: the Special Projects Committee which was to deal with the "housekeeping" details attendant upon such an organization; the Consumer Education Committee to advise and aid the community education staff person to plan and implement a viable community education program; and the Technical Studies Committee which, after a number of meetings with experts to delineate the various technical aspects of the studies, devised a suitable RFP an one of the studies and served as technical advisors to the rest of the Board. In addition, due to the enthusiastic response of the community to active participation on this Board, a subsidiary group, called the Citizens Advisory Group (C.A.G.) was proposed and a mechanism for membership on the C.U.B. drawn from this group was devised.

While the final report of the first year's activities of the C.U.B. has yet to be produced, it is obvious that the level of interest in such activities is high in the community. It is also obvious that the complexities of the electrical conservation can be sufficiently outlined to the citizenry to enable them to make intelligent decision for the community on such matters.

The second level is community-based outreach. Given the relatively low level of funding expected for the Energy Extension Service, it might be best initially to divide the city into four quadrants, and establish an energy office in the middle of each quadrant. This office would be a part of an existing facility (e.g., library, school, church, neighborhood association, advisory neighborhood commission). It would provide funds and technical assistance for audits, would gather data for the neighborhood competition, would disseminate information on energy-related issues, and would serve to interface between individual and city agency.

Probably the best facilities for citizen outreach would be the public library and the school systems. Initially, one or two libraries within a quadrant could be selected as the energy information base. Each library would have a small reference section on energy materials. The bulk of the city's energy information would be available at the Martin Luther King Central Library, in either the Science and Technology section, or the Washingtonian section.

The branch libraries would house demonstrations of conservation and solar devices. Probably the best way to do this would be to use some of the energy money to retrofit solar hot-water systems on the libraries and to have the District vocational training schools build scale models of conservation and solar devices.

In addition, there could be a computer terminal in these libraries. The terminal could be used to access existing programs which can be used to give people an idea of things like the cost, payback period, and energy savings of various conservation alternatives -- and the amount of energy and payback period gained from solar systems. In addition, the terminal can be used for bibliographic retrieval of energy-related data. Such retrieval is extremely relevant to D.C. branch libraries, for the items accessed can usually be found in existing libraries for those interested in pursuing an energy issue in more depth. Current research on community energy systems, on legislation related to energy, or on federal energy programs and appropriation levels, can already be accessed through these terminals.

A part of the extension system may be used to orient curricula in schools to energy awareness. This would not be at the expense of undermining current proficiency levels. As mentioned in the introduction, trigonometry can be learned as well when sizing a solar collector as when doing abstract examples in the back of a textbook. Shop classes can build insulating window shades for low-income dwellings as easily as they can build furniture or other ornamental devices -- and students can learn the same construction techniques from such exercises. One may want to coordinate activities with the university professional levels with the public elementary and. secondary school programs in developing these kinds of programs. In the energy field, the tens of thousands of school-age children, the school buildings themselves, and the faculty's experience and talents could be considered important resources in both education and development strategies.

In all branches of the District government incentive programs related to energy conservation can be devised. Fairfax County offers cash awards for conservation in the public schools. It would be feasible to permit those schools which reduce energy consumption by more than 10% to have the surplus continue into their general budgets for use as the faculty and student body sees fit. The same tactic would be possible for the library system. A workable formula might be that such energy savings, translated into current energy costs, would be maintained in the budget for two years after the savings have been achieved.

The public education program will be most useful, if experience around the nation is an indicator, when it stresses self-reliance rather than conservation. As was mentioned in the introduction to this report, people are not highly motivated to save energy because of too many global shortages. In general, individuals do not modify or change their behavior because of planetary concerns. Nor do most people conserve because of potential pocketbook savings. A survey of existing District buildings found that none had installed flow restrictors in shower heads, even though the payback period is a matter of months.

However, self-reliance is a powerful motivator. For people with a solar energy system, for example, every BTU saved is one more BTU gained toward independence.

Thus, the public education program should promote the concept of the community as a producer of energy, not just a consumer, and of self-reliance as a goal. One aspect of this may be to adopt the solar energy index now being used in several weather forecasts, developed by the International Business Systems (IBS). This index gives the amount of solar energy that fell per square foot that day, or the percentage of hot water usage which a family of four could garner from an average-sized collector on a given day. It could become as integral a part of the weather forecast as the daily high- and low-temperatures, the relative humidity, the air quality index (AQI), and the comfort index.

Any outreach program must rely heavily on those most skilled and experienced in popularizing messages: the artists. It is hoped that a consortium of artists from different fields would be an integral part of the outreach program. It is suggested that, initially, the city establish an awards program for energy education on the concept of energy self-reliance. An award of $200 to be won on a basis of effectiveness by ten groups of artists who articulate an initial concept paper, or design, or script, may be useful. The groups contacted for participation would include photographers, theatre players, songwriters and players, graphics people, comic book illustrators, and writers. Each different art form could be used.

Obviously, there are very complicated issues which must be worked through in developing the organizational structure and functions of the energy office. However, it appears clear that a fragmented program will deliver services inefficiently, may be redundant, and could easily bog down in mutual suspicions and confused lines of authority. On the other hand, a program based on citizen participation, which catalyzes existing sectors combining professional energy expertise with neighborhood and small business knowledge and initiative, can work best.

# CHAPTER 6

## A Look At the Future

We are living through an era of transition in the way we view and use energy. The basic assumptions that shaped the rules of the energy game for two generations have changed. Until 1970, the last unit of energy produced was less expensive than the one before. We believed in an inexhaustible supply of cheap energy. Rate structures encouraged consumption, rewarding those who used the most by charging them the least. Promotional campaigns encouraged consumption. Respected professionals equated spiralling energy demand with the economic health of the nation, measuring BTU's per Gross National Product (GNP) as an index of prosperity.

After 1970, that last unit of energy became more costly than the one before. By the late 1970's, the marginal cost of energy had become two, three, even five times more expensive than the historic cost. No longer could we base future pricing policies on past costs.

Simultaneously, the time required to bring new energy sources on-line increased. As power plants grew larger, and mines and wells went deeper, their construction time lengthened, and their aggravated environmental impact required time-consuming review processes. It now requires about a decade from the time a nuclear power plant is planned to the time it generates electricity. This long lead-time, particularly in this era of rapid inflation, leads to construction cost overruns, hut, of more importance, it requires energy companies to he able to predict demand accurately far into the future.

This was a simple task in the halcyon days of the 1960's, when demand predictably grew at a high rate. Utilities planned for the worst (i.e., most rapid growth in demand) and, even if their projections were exaggerated, few complained since construction costs were low, and energy prices were lower still. The 400% crude-oil increase in 1973, and the rising prices of all energy sources thereafter, forced consumers and industry to take conservation measures seriously. Demand is no longer growing at historic rates and utilities, especially electric utilities such as PEPCo, are saddled with excess capacity, This excess capacity adds to the consumer's utility bill, which breeds consumer dissatisfaction.

These developments led the nation to reevaluate its use of energy. Conservation and efficiency have become the new watchwords. Rate structures are undergoing a dramatic revision, redesigned to encourage conservation, not consumption. National policy now encourages the use of smaller power plants, which can come on-line rapidly, and therefore reduce the vulnerability to rapid changes in demand. These are called "load-following" plants. Power plants that generate electricity are now trying to capture and use the two-thirds of the energy which is rejected as heat. Industries which generate high-temperature steam are devising ways to use part of it to generate electricity. The concept of cogeneration, producing both heat and electricity simultaneously, has come of age.

These new concepts reinforce the growing awareness of the importance of dispersed energy generation. A recent article in the Electric Power Research Institute Journal described the potential of the new fuel-cell technology, which can come on-line rapidly, is more efficient than current fossil-fuel generators, and produces reject heat appropriate for making steam or hot water.

> Therefore, cogeneration with fuel cells is a definite possibility for utilities interested in supplying district heat or industrial process heat. Since fuel cells can be sited close to population centers, the reject heat can be delivered economically to the user...
>
> Since fuel cells have no combustion cycle, emissions other than carbon dioxide, air, and water are minimal. Those that do occur originate mainly in the power plant's fuel processor $SO_x$ emissions will be less than 0.045 g (0.0001 lb.) per million BTU and $NO_x$ emissions less than 9 g(.02 lb.) per million BTU if petroleum or clean coal-derived fuels are used -- at least an order of magnitude below federal standards. Other good neighbor characteristics: the fuel cell power plant is expected to be quiet and will not need makeup or cooling water.[1]

Fuel cell technology may be commercially feasible by the early 1980's. However, the dynamics of changing rate structures and the new concept of cogeneration is already changing the relationship between producers and consumers of energy.

Traditionally, large energy users received dramatic price breaks. Partially, this practice is based on the costs of delivering energy to these consumers. However, the roots of the practice go back to the days when Samuel Insull, President, Chicago Electric Company,was trying to develop the first modern electric utility. His was the task, not only of encouraging the use of electricity, but of making the case for monopoly. For, in his time, the streetcar companies and the larger apartment buildings had their own power plants. He had to convince them of the economics of disbanding their own operations, and joining in a wider grid system. He could accurately point to the economies of scale associated with larger power plants, and with serving great numbers of customers. He also developed a rate structure that was enormously favorable to these large users. Never the bashful person, he would give lectures with such titles as, "Sell Your Product at a Price Which Will Enable You To Get a Monopoly".[2]

These promotional rate structures may now be disappearing. Already flat-rate, and even inverted-rate structures are appearing throughout the country. Section 111(d) of the Public Utilities Regulatory Policies Act of 1978 requires all state regulatory commissions to consider seriously a phasing-out of promotional, declining, and other rates for electricity which encourage consumption and do not reflect the cost of service.

In addition, national policy now encourages on-site energy generation. Section 301 of the Energy Tax Act provides for an additional 10% investment tax credit for cogeneration facilities. The Power Plant and Industrial Fuel Use Act, Section 212, prohibits the use of natural gas or petroleum in new boilers, but provides for a possible exemption for cogeneration facilities. This could be quite important for those areas, such as Washington, D.C., which will in the middle 1980's be forced to comply with the requirements of the Clean Air Quality Act of 1977.

The Public Utilities Regulatory Policies Act, Section 210, requires that, within a year after the date of enactment, the Federal Power Commission prescribe rules to encourage cogeneration and small power production. These rules will require electric utilities to offer to:

1) sell electric energy to qualifying cogeneration facilities and qualifying small power production facilities; and
2) purchase electric energy from such facilities.

Such rates must be (Section 210 (b)) 1)..."just and reasonable" to the "electric consumers of the electric utility, and in the public interest"; and 2) ..."shall not discriminate against qualifying cogenerators or qualifying small power producers".

Indeed, the Act goes even further, requiring the Federal Energy Regulatory Commission to undertake an intensive examination of the issue of scale with respect to power generation. Section 209 (2) (E) of the Act requires the Commission to examine "the cost-effectiveness of adding a number of small, decentralized conventional and non-conventional generating units rather than a small number of larger generating units with a similar total megawatt capacity for achieving the desired level of reliability". Although the requirement is not directed at state public service commissions, such an examination applied to the District of Columbia, would inevitably mean community-based power systems.

Recently, the increasing attractiveness of cogeneration has led to some fascinating permutations and combinations of interrelationships between utility and on-site producers. Some utilities are beginning to join partners with industrial users. The publicly-owned Eugene Water and Electric Board joined with the Weyerhauser timber company in a contractual arrangement.

The utility installed, owns, and operates the turbine generator on leased land within the mill site and also pays for certain modifications to the existing boiler facilities. The utility's generator buys the excess heat generated in the timber facility, thereby providing an important cash flow for Weyerhauser and low-cost energy generation capacity for EWEB. The director of operations and engineering at EWEB is satisfied:

> We are now going out to help our customers save energy. We quite frequently introduce one company to another. A typical example would be a refrigeration plant located just across the alley from a warehouse and office building that is electrically heated. The waste heat from the refrigeration plant now is used as heat in the warehouse and offices. Sure, we lose revenue on the displaced heating, but it does meet tre test, 'will it save energy in the Northwest'?[3]

In Cambridge, Harvard University approached Boston Edison to form a similar arrangement. Boston Edison refused. Harvard then decided to go ahead with its own plant and requested backup rates from Boston Edison, and sales arrangements for its excess energy. Boston Edison again refused. As a result, the Medical Area Service Corporation was established by twelve institutions engaged in medical, educational and charitable functions. It will operate a total energy plant providing electricity, steam, chilled water, and solid waste incineration for MASCO members. Boston Edison will lose approximately $3 million a year in gross revenues because of the new private energy plant.

A 50-year-old office building at 11 West 42nd Street in Manhattan is in the process of uncoupling from Con Ed. The building will use eight 700 kilowatt diesel generators, each about the size of a panel truck, and a storage capacity of 100,000 gallons of No. 2 diesel fuel. The utility company itself predicts that one-third of Manhattan's office buildings could currently do the same and save money, reducing by 5% the overall power demands on Con Ed and necessitating a 3% overall rate increase to make up for lost revenues.

Georgetown University is already in the midst of planning an energy self-reliant campus. Under arrangement with PEPCo, it will generate electricity, and be interconnected to the electrical grid system. Ultimately, when several campus buildings are generating electricity, Georgetown University could provide power to surrounding Georgetown in the event of an area-wide power failure. According to one Washington Post story, "Georgetown envisions a day, possibly even within the next decade, when it will be self-sufficient in energy, a sort of campus space capsule on Georgetown's hill"[4]

The issue of scale is already intruding on the public consciousness. As on-site power generation becomes more common, the issue arises at which point it should be publicly regulated. The Public Utilities Regulatory Policies Act defines a small power producer as one primarily engaged in generating or selling electric power, who produces less than 80 megawatts of electricity from solid waste or renewable resources. If using fossil fuels, one can produce up to 30 megawatts and be exempt from state utility regulations, Federal Power Act, and Public Utilities Holding Company, if the Secretary of Energy determines that this is necessary in order to carry out the objectives of the Act.

In California, state legislation AB 2046 would exempt cogeneration plants greater than 50 megawatts (MW) from certain site certification procedures and would shorten the licensing procedures from 36 months to 18 months. Already, such plants with capacities up to 50 MW are exempted from state regulations.

As cogeneration becomes more economically attractive, the scale at which the units can be effectively used will decline as well. One simulated study was done in 1977 of a 50-house neighborhood in Ames, Iowa.[5] The average residence was 1,200 square feet. The power plant was located in the center of the block. Using a diesel generator, the total cost of the system, including piping, etc. was $437,000 or about $8,500 per dwelling. The estimated annual fuel savings were more than 15%. The total energy system was slightly less expensive to the customer when compared to a customer using only electricity, but when compared to residences that used both gas and electricity, the modular total energy system customers would have energy bills twice as large.

If such systems do begin to become operational, they must be designed to match the end-use requirements as much as possible. Cogeneration systems have different thermal and electrical outputs. Steam turbines produce a much greater portion of total energy as heat than as electricity, while diesel generators can produce up to 40% of the total output as electrical energy. There is a certain latitude in choosing the type of energy to be used for certain purposes. Cooking, for example, can be accomplished either by electric or gas ranges. Space heating can utilize steam or electricity. Steam-driven clothes dryers, vapor compressors, and small, absorption-type air conditioners are technically feasible as well.

Regarding community energy systems, the interrelationship of individual action to system costs is perceived more directly. The individual who purchases a $125 window air conditioner which he turns on during the hottest summer hours, may be adding thousands of dollars in peak-power costs to the electric utility. Currently, loadlevelling is an important aspect of many utility operations. Utilities, such as the municipally-owned company in Burbank, California, have installed devices in offices and factories which cut off electricity to certain machinery for a few minutes an hour during peak times. In Washington, D.C., one major owner of apartment buildings is installing electronic control systems in 27 buildings in the District and Virginia, some separated by as much as three miles, in order to reduce demand charges. It is estimated that his investment will be repaid in less than 18 months. In Georgia, the Georgia Power Company is in the process of linking 50,000 households in the same fashion. Such load-levelling can be an important component of community energy system designs.

The technology of on-site generation is still new, and although current technology appears to work best with at least 50 households linked together, the scale might be reduced in the near future. The Total Energy Module (TOTEM) system of FIAT motors is a converted FIAT model 124 auto engine which provides heat and electricity for four houses.[6] It is not marketed as a stand-alone system, but there are those who are trying to modify it so that there is adequate storage capacity for it to become a very small cogenerating total energy system. It is so heavily insulated against noise that FIAT says it is no more noisy than a typical gas furnace.

By the middle 1980's, solar energy may become economically viable as a total energy system. It must be remembered that the commercial applications for solar energy are less than three years old. There is an extraordinary developmental process fermenting in the field. New advances, and new technologies, are now being demonstrated which show great promise for community energy systems.

Already the concept of district heating using solar energy has been suggested. Researchers at Lawrence Berkeley Laboratory conceive of a series of collectors which would heat a large water supply which would be used to supply space and water heating by traditional district heating methods. Their calculations for San Francisco are:[7]

| | |
|---|---|
| Population | 677,000 |
| Solar Resource | 0.16 MMBtu useful heat/ft $^2$ |
| Collector Requirements (Range) | 24.5-52.7x10$^6$ft$^2$ |
| Storage Requirements<br>4 days hot water backup*<br>no space heating backup* | 190,000-271,000 gal |
| *Backup to be provided by bioconversion (methane). | |

> Storage facilities could be located either at central location with a backup heating system, or dispersed along the District's loop, depending upon which proved the most efficient in conjunction with the collection system organization. Basements of community facilities such as schools, churches, and libraries could provide relatively large spaces for storage. Location of storage tanks beneath street intersections has been proposed by some.[8]

In Palo Alto, California, the city-owned utility is designing what it calls a "mini-utility", where a square block of residential units use solar energy converted by collectors located over a nearby central collector and storage area. With an overall density of about parking lot. In San Bernardino, California, ten houses surround a 12,000 people per square mile, Washington, D.C. is one of the most densely populated cities in the nation. Certain downtown neighborhoods, such as Adams-Morgan[9] have as many as 45-50,000 people per square mile. Thus, the space factor is of crucial importance in evaluating the portion of our energy that solar energy can provide.[10]

It is clear that it is not at all inevitable what the future will be. In some cases, the straightforward economics, or hardware systems, will dictate the types of energy delivery systems, and therefore the organizational structures surrounding it. In most instances, the decisions comprise tradeoffs, and these tradeoffs must take into account the type of energy system which the people in Washington, D.C. desire. The choices are not unlimited, but they vary sufficiently that the first responsibility of the city government would be to educate its people on the complex issues of energy generation and consumption, and the alternatives as it sees them. Through this process of citizen involvement, public education, and debate, and with an awareness of new technical developments, Washington, D.C. can become an important working laboratory for energy self-reliance.

## Chapter 6: Footnotes

1. Electric Power Research Institute Journal, November 1978, page 7.

2. Sheldon Novick, The Electric War: The Fight Over Nuclear Power, Sierra Club Books, 1976, page 132.

3. Herbert H. Hunt, Director, Operations and Engineering, CoGeneration - Eugene Water and Electric Board, page 2.

4. Washington Post, January 11, 1979.

5. Raymond E. Opila, Minimum Load Requirements for Economic Residential Total Energy Systems in Northern Climates, Master of Science Thesis, Iowa State University, Ames, Iowa, 1978.

6. TOTEM - Total Energy Module, brochure; FIAT Motors of North America, Inc., Montvale, New Jersey, 1977.

7. Distributed Energy Systems in California's Future, Volume 2, September 1977, Lawrence Berkeley Laboratory-6831,page 132.

8. Ibid.

9. See Stephen R. Pace, Solar Energy As An Alternative Residential Energy Source in Washington, D.C., 1976.

10. See Appendix G for analysis of solar energy use in dense residential areas.

# Explanatory Notes on BTU's [1]

A BTU, or British Thermal Unit, is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. For example, our tapwater enters the house at about 55 degrees Fahrenheit. Hut showers require water at a temperature of about 120 degrees Fahrenheit (although most people set their thermostats at 140 degrees). This means that the temperature ought be raised 65 degrees to meet the requirements of a hot shower. A gallon of water weighs about 8.3 pounds. An average shower requires about 10 gallons. Therefore, the amount of BTU's required for a hot shower is:
8.3 x 10 x 65 = 5,395 BTU's

A cubic foot of natural gas contains about 1,000 BTU's. A gallons of gasoline contains 120,000 BTU's. A kilowatt hour(KWH) of electricity contains about 3,413 BTU's. Therefore, a hot shower would require about 5 cubic feet of natural gas, 1/25 of a gallon of gasoline, and a little less than 2 kilowatt hours of electricity.

The average car achieves an energy efficiency of 14 miles per gallon. The average car averages 1.4 riders. Therefore, the BTU's required per passenger mile is 120,000/14 = 8,571/1.4 = 6,122 BTU's per passenger mile.

There are 4 BTU's in a calorie. A non-athletic person weighing about 150 pounds can manage a leisurely speed of 11 miles per hour on a 10-speed bike. That person will need to add about 1,500 calories to his diet for each five hours during which
he cycles, or about 300 calories per hour. Since one gallon of gasoline equals about 30,000 calories (120,000/4), using the comparable measurement of one gallon, the bicycler would use only one gallon per 1,100 miles.

[1]For reference and additional information, see Gil Friend and David Morris, Kilowatt Counter, Alternative Sources of Energy, Inc., 1975.

# Appendices

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