

ENERGY CONSERVATION

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ABSTRACT

This paper is an attempt to quantify the potential energy savings from a comprehensive national program of energy conservation. Included are measures to reduce oil consumption in transportation, freight movement, resource recovery, appliances and home standards, industry and electric utilities and the computed figures of potential energy savings for each of the strategies proposed. The end result is a reduction in energy consumption in the period 1980 to 1985 of approximately 6 million barrels a day—the same amount as our current imports.

This paper demonstrates that by using our resources more efficiently, we need not sacrifice our standard of living, although we may change the arbitrary indices of that standard.

Preamble

This nation is now engaged in a long predicted struggle for survival. It centers around our wanton use of energy and other irreplaceable natural resources. This excessive use, well beyond that of any other people on earth, lies at the root of our present economic dilemma. High cost energy has become the indispensable ingredient of our production, our transportation, our educational and health care operation and virtually every aspect of our lives.

Misuse has meant injury to our air, water and land; abandonment of old energy conserving cities in favor of energy intensive suburbs, and waste of our limited material resources. Imported energy materials are increasingly costly as oil producers raise their prices to take advantage of our dependence and to preserve their own futures. This places severe strains on our economy and on our capacity for independent foreign policy.

In face of this, there has been little in the way of definitive programs to deal with the problem on either a short or long term basis. Three basic pro-

grams have been put forth. The first and most widely publicized is that of the President's. Its basic principles are:

1. A tax on petroleum but none directly on gasoline.
2. Relaxation of environmental standards.
3. Voluntary agreement to improve auto efficiency.
4. Rapid development of off shore oil, coal and the nuclear breeder-reactor.
5. Conversion of power plants from oil to coal and rapid construction of nuclear plants.
6. Continuation of the auto-based economy.

The second program which has been advanced by a coalition of business leaders led by Paul Peterson, is basically similar except that it advocates a gasoline tax in place of the petroleum tax. More recently a variety of programs centering more directly on a gradual energy conservation program have come forward from the Congress.

The current crisis will be either the opportunity to readjust our modes of life, production and transportation to ones which are both more economical in energy use and environmentally sound, or merely the continuation of search for new sources (at the expense of environmental regulations) to satisfy an unabated energy demand. It is vital that we take this opportunity to define a better energy program. The basic tenets of our program are as follows:

1. Use of energy is a determining factor in our society; thus both the executive and legislative branches of government should reorganize to provide central coordination of energy programs.
2. All national programs should give first priority to making cities more attractive places to live and work. By any account, cities are the most useful social and energy-saving instruments we have.
3. Tax programs should be directed to areas where conservation can occur and will occur without major social and economic hardship.
4. Based on these considerations, a tax on all fuel is an impossible proposition since it cannot discriminate as to the social value of the end use. It is uniquely destructive of urban housing and the urban middle class.
5. Any tax program should be progressive rather than regressive.
6. The first step should be a concerted effort towards sound energy utilization rather than new source development to provide time for the wisest choice of new energy technologies.
7. Development of new sources should focus on those with modest environmental consequences such as solar energy and use of refuse as fuel.
8. *Emphasis should be given in national policy to the following principles:*
 - *Densification of existing and new urban centers, excluding high density urban centers;*
 - *Halting suburban sprawl and encouraging efficient land use management;*

- Expansion of multi-family housing;
 - Expansion of mass transit facilities;
 - Tax systems to encourage conservation;
 - Preservation of wilderness and open space;
 - Use of total energy systems.
9. Energy conservation programs will increase employment. Since most increases in energy use per unit of end product results from substituting energy intensity for labor intensity, reversing the energy pattern will result in additional employment. Any dislocations created by these policy changes must be dealt with forcibly. If we reduce automobile production, it is vital that we convert that production capacity to new products, modify assembly line procedures to a more human pace, or at the very least move those workers into new areas. We are not short of things to do. For example, our need for homes easily exceeds 2.4 million units per year. Filling that demand alone would absorb a substantial percentage of the unemployed labor force. Over the past twenty years, we have permitted our infrastructure to decline while spending our money on disposables and luxuries. We must change that, but in changing we must stimulate new employment opportunities.
 10. Our program is directed at a substantial reduction in overall costs. The President's program, based on Project Independence, has an estimated capital cost of several hundred billion dollars and an immediate cost in taxes of \$50 billion per year.
 11. Our goal is to reduce the energy consumption through the period 1980-1985 by six million barrels a day (about the amount of present oil imports).

Transportation

Directly, transportation consumes a major portion (25 per cent to 30 per cent) of our nation's energy supply. Furthermore, it is a demand sector which can easily be shifted since more efficient use of our existing systems, expanded use of low energy demanding alternatives such as public transit and rail are all consistent with a healthy economy and environment.

PEOPLE MOVEMENT

There are several alternatives to reducing gasoline use. They are:

1. High gasoline tax
2. Rationing
3. Allocation
4. Increased automobile fuel efficiency
5. Transfer to travel demand to mass transit

The study by Rand which is the basis of our proposal indicates that (1) a high gasoline tax can be very effective in reducing demand, (2) a high tax on automobiles will not be effective in reducing gas consumption but will reduce car demand and create severe unemployment, (3) a decrease in effectiveness of a gasoline tax will occur as time goes on due to increasing income and inflation and this can be compensated for by mandating high efficiency automobiles. Such a program is feasible without sacrificing emission standards. The basic data are shown in Tables 1 and 2.

Table 1. Impact of Tax on Gas Consumption

<i>Tax (in cents)</i>	<i>% Reduction</i>	
	<i>1980</i>	<i>1985</i>
15	16.2	13.6
30	33.8	25.0
45	40.5	34.5

Table 2. Increase in Car Mileage Through Design

<i>Features</i>	<i>% Increase mpg</i>	
	<i>Full Size</i>	<i>Subcompact</i>
Radial Tires	7	5
Minor Aerodynamics	6	7
Major Aerodynamics	7	13
Aluminum Construction	15	20
CVT	27	32
No Trunk	20	—
TOTAL	56	58
Urban Car—2 passenger	75%	
1 passenger	108%	
Elimination of air conditioning and fast acceleration—	130%	

The major question will be the utilization of monies from the program. This utilization is shown for 1976 when the tax is 10¢/gallon and 1980 when the tax is 45¢/gallon. It should be noted that the basic uses of the monies will be:

1. rebates to rural areas through transportation stamps;
2. rebates to poor Americans in transportation stamps;
3. public transit subsidies directed towards free public transit;

4. public transit construction (in addition to current plans and programs);
5. energy conservation tax credits;
6. clean energy research and development (solar, wind, etc.);
7. upgrade rail freight system.

<i>Program Item, as numbered above</i>	<i>Billions of Dollars/Yr.</i>	
	<i>1976</i>	<i>1980-5</i>
1.	2.8	10.5
2.	2.5	10.0
3.	1.0	7.5
4.	3.0	4.0
5.	0.5	3.0
6.	0.3	2.0
7.	0.9	2.0
TOTAL TAX YIELD	\$11.0	\$41.5
residue for other social programs		\$ 2.5

These results are then projected from the Rand reports in Table 3.

Table 3. Gasoline Demand Reductions

<i>Policy</i>	<i>Barrels per Day</i>	
	<i>1980</i>	<i>1985</i>
Mandate high mpg and gasoline tax	1,300,000	1,800,000

CONGRESSIONAL ACTION

1. Mandate a new gasoline tax starting at 10¢/gallon in 1975 and rising to 45¢/gallon in 1980 and declining to 10¢/gallon in 1990.
2. Use gasoline tax revenues to improve mass transit, develop clean energy sources, encourage energy conservation and provide rebates to poor and rural Americans.
3. Establish a federal excise tax on inefficient new automobiles from 1976-1979, using EPA mileage data with a current charge of \$200/mpg for each mpg under 15 mpg for that automobile model.
4. Mandate new car efficiencies of 21 mpg in 1980 and 38 mpg in 1985.
5. Use tax monies to improve and expand transit and rail service in rural areas.

6. Retain clean air goals as presently mandated and accelerate development of alternative engines and control systems.
7. Establish a national land use planning program by encouraging state and regional actions.

GOODS MOVEMENT

About one-third of out total transportation demand is lodged in goods movement, much of it truck and air. We need to improve our rail system, halt the rapid growth in air freight and develop more efficient trucks and trucking practices (goods consolidation). *If we make the following assumptions shown below:*

	<i>Increase in Goods Movement</i>	<i>Shift From Truck To Rail</i>	<i>Shift From Air To Ground</i>	<i>Increase In Truck Efficiency (High Efficiency Engines, Truck Consolidation)</i>
1980	12%	15%	20%	5%
1985	25%	30%	30%	10%

then we will produce the following savings:

1980	180,000 barrels per day
1985	320,000 barrels per day

CONGRESSIONAL ACTION

1. Mandate truck mileage standards.
2. Substantially improve rail freight movement system.
3. End the Highway Trust Fund.

Resource Recovery

A substantial energy drain occurs in this country because products are designed to be thrown away. Our refuse, on a per capita basis, is double that of other countries. Recapture of these materials will have a substantial positive impact on our energy picture. If we assume a national returnable bottle bill, together with a national program to establish resource recovery centers, we can make a substantial reduction in energy demand. If we assume (1) 70 per cent of the 125×10^6 million tons is recoverable; (2) 20 per cent will be in the recovery system by 1980; (3) 80 per cent by 1985; (4) refuse will grow at a rate of 2 per cent per year; (5) we will save 0.74 barrels per ton of refuse in reclaimed material (iron, aluminum, glass); (6) 1.19 barrels per ton of refuse in actual fuel recovered, then we project the following savings as shown in Table 4.

Table 4. Energy Savings in Resource Recovery
(barrels per day)

<i>Item</i>	<i>1980</i>	<i>1985</i>
Bottle Bill	100,000	103,000
Material Recovery	40,000	75,000
Fuel	125,000	275,000
TOTAL	265,000	450,000

CONGRESSIONAL ACTION

1. Mandate Resources Recovery Bill.
2. Mandate Returnable Bottle Bill.
3. Adjust freight rates and tax structures to favor recycled materials.

Appliance and Home Standards

Many of our appliances as well as residential and commercial space have been designed for a cheap energy era. Mandatory standards, new building codes and tax credits provide substantial gains. Many existing buildings can have their energy use reduced by 25 per cent or more, while new building design can save 50 per cent at modest costs. Here we will assume consumption levels developed by Project Independence for housing and commercial space of 22.358 quad Btu/yr in 1980 and 26.760 quad Btu/yr in 1985 as a base and 19.121 quad Btu/yr in 1973 (assuming \$11/bbl oil). Here are the practices we advocate and their results.

1. Mandatory insulation standards for homes with 10 per cent energy reduction by 1980 and 20 per cent by 1985, excluding low cost measures.
2. Mandatory insulation standards for new commercial space with a 10 per cent energy reduction by 1980 and 20 per cent by 1985, excluding low cost measures.
3. Tax incentive and subsidy programs to encourage upgraded insulation, ventilation, lighting and heating in existing residential and commercial building.
4. Low cost measures such as thermostat setback will save 3.0 quad in 1980 and 2.8 quad in 1985.
5. Save 0.25 quad in 1980 and 0.4 quad in 1985 in water heating.
6. Increase refrigerator/freezer efficiency and save 0.36 quad in 1980 and 0.86 quad in 1985.
7. Increase air conditioner efficiency and save 0.3 quad in 1980 and 0.5 quad in 1985.
8. Electric ignition will save 0.1 quad in 1980 and 0.17 quad in 1985 with

other appliances and improved furnace operation will save 0.8 quad in 1980 and 1.2 quad in 1985.

9. Wide use of solar energy will save 0.1 quad in 1980 and 0.5 quad in 1985.
10. Commercial use other than space heating will save 0.3 quad by 1980 and 0.8 quad by 1985.

Thus, we find the total savings from Housing and Commercial sectors in Table 5.

Table 5. Savings from Housing and Commercial Sector

	<i>1980</i>	<i>1985</i>
1. Residential heating/cooling (new & old)	1.00	2.10
2. Commercial heating/cooling (new & old)	0.25	0.60
3. Low-cost measures	3.00	2.80
4. Water heating	0.25	0.50
5. Refrigerator/freezer	0.36	0.86
6. Air conditioner	0.50	0.80
7. Electric ignition	0.10	0.18
8. Miscellaneous	0.80	1.20
9. Solar heat	0.10	0.50
10. Commercial systems	0.30	0.80
11. Lighting/ventilation	0.40	0.80
TOTAL	7.06	11.14
Increase due to growth	3.24	7.64
<i>Net reduction</i> (quadrillion Btu's)	3.82 quad	4.50 quad
Barrels per day	1,800,000 bbl/day	2,110,000 bbl/day

LEGISLATIVE ACTION

1. Tax incentives to property owners to reduce energy loss and upgrade heating and air conditioning equipment.
2. Tax subsidy to low income property owners to reduce energy loss and upgrade heating and air conditioning equipment.
3. Mandated standards for major appliances.
4. National fuel use standards for buildings, based on reductions for existing levels.
5. State and local adoption of new energy conscious building codes.
6. National tax incentives and development program to encourage solar energy heat recovery and heat pumps.

Industrial Sector Conservation

Industry has a great capacity to respond to economic incentives. Recent improvements in energy efficiency have already resulted in higher electrical rates. Since the improvement is already on the order of 10 per cent, the projections in Table 6 may be conservative.

Here we will use the following baseload conditions from Project Independence:

1973	23.994 quad/yr
1980	28.819 quad/yr
1985	36.102 quad/yr

Table 6. Projected Savings by Industrial Sector
(quad/yr)

<i>Industry</i>	<i>Savings (including growth)</i>	
	<i>1980</i>	<i>1985</i>
Steel	1.0	1.4
Petroleum	0.6	1.1
Plastics	0.5	0.8
Food Processing	0.5	0.8
Paper	0.4	0.6
Cement	0.2	0.4
Aluminum Production	0.2	0.4
Agriculture	0.4	0.6

This projects to the following values assuming \$11/bbl oil (also from Project Independence).

1973	24 quad/yr
1980	26 quad/yr
1985	28.7 quad/yr

If a major government effort including (1) tax incentives, (2) major R&D programs, and (3) energy budget for major industries such as suggested in the Project Independence report, substantial energy demand reductions would occur as shown in Table 7.

Table 7. Major Program Energy Savings

	<i>1980</i>	<i>1985</i>
Energy R&D	0.75	1.50
Energy Budget	3.0	7.3
Investment credit	1.0	1.9
Total	4.75 quad	10.7 quad

Thus the net savings (including growth) would be 2.75 quad in 1980 (1,290,000 barrels per day) and 6.0 quad (2,820,000 barrels per day) in 1985.

LEGISLATIVE ACTION

1. Investment tax credit/subsidy/tax on fuel options to industry for energy conservation actions.
2. Controls over long-term energy use by 10 major energy industries, including approval of an energy budget.
3. Institution of national energy conservation research and development program.

Electrical Energy

It is important to note that substantial improvements in overall fuel use can be gained through more efficient use of fuel in the generating cycle.

It should also be noted that increases in electrical energy demand have already been accounted for in other calculations. Thus, we are looking at three programs to reduce fuel demand:

1. District steam from combined cycle plants
2. Peak time pricing and rate financing for urban areas
3. Higher efficiency fossil fuel plants through natural replacement
4. National power grid

We calculate each as the following (quad/yr):

	<i>1980</i>	<i>1985</i>	
District steam/combined cycle	0.1	0.2	(10)
Peak time pricing	0.1	0.2	(5)
Higher efficiency	0.7	1.1	(9)
Total	0.9 quad	1.5 quad	
Barrels per day	420,000 bbl/day	700,000 bbl/day	

FEDERAL ACTION

1. Mandate adjustments in rate structure by state PSC or nationally.
2. Prohibit hookups to buildings with extensive energy uses.
3. Mandate a national power grid.
4. Tax incentives to encourage efficiency improvements.

Summary

The following is a summary of projected reductions in barrels per day through this proposed energy program:

<i>Program</i>	<i>Barrels Per Day</i>	
	<i>1980</i>	<i>1985</i>
1. Automobile/Mass transit	1,300,000	1,300,000
2. Freight movement	180,000	320,000
3. Resource recovery	265,000	450,000
4. Appliance and insulation	1,800,000	2,110,000
5. Industrial	1,290,000	2,820,000
6. Electric Utilities	420,000	700,000
Total	5,255,000	7,650,000

Economic Impact

The economic impact of this program is substantial and complicated. Further studies are necessary. However, we are really talking about a shifting in jobs and monies rather than an elimination; thus, the government should enter the private sector to soften the blow.

GASOLINE TAX

Impact on economy—This allocation will have, according to the Rand report, no impact on automobile sales but will reduce secondary employment (e.g., gas station employees).

Car costs (new efficiency cars)—New car costs are expected to be 10-20% lower. This will save the consumer perhaps \$3-6 billion per year.

RESOURCE RECOVERY

The resource recovery construction program will amount to about \$10 billion.

CONSUMER COSTS

Appliances—Assuming 10% increase in sales price,

Air conditioners	\$100 million/yr	Dryers	\$ 50 million/yr
Refrigerators	50 million/yr	Pilot lights	600 million/yr (at
Televisions	50 million/yr		\$20 each & 10-year conversion)

Dwelling units—\$.50/sq ft for upgrading residential units. Thus, the total cost, assuming 1,000 sq ft per dwelling unit and 70,000,000 units, will amount to \$35 billion total construction cost.

Commercial units—\$1/sq ft for upgrading commercial units. It is safe to assume 10,000,000,000 sq ft of commercial space with a total cost of \$10 billion.

Industrial costs—It seems as though the industrial costs will amount to \$200 million per year. This will either be paid out of government tax credits or subsidies or by the consumer. The research and development program will be part of the overall program discussed above.

Utilities—To move efficiencies from 10,500 to 9,000 Btu/KWH will require replacing older 13,000 Btu/KWH units with 9,000 Btu/KWH units. At \$300/KW, this will amount to \$18 billion capital. Furthermore, the proposal for district steam will amount to another \$15 billion.

BIBLIOGRAPHY

- Dubin, Fred S., P.E., personal interview.
Environmental Protection Agency, Division of Solid Waste Management, personal interview.
Federal Energy Administration, Project Independence Report, November 1974.
Fourth Sink Management, Inc., *Report to Speaker Stanley Steingut*, 1975.
Office of Emergency Preparedness, "The Potential for Energy Conservation: A Staff Report," October, 1972.
Rand Corporation (Sorrel Wildhorn, B. K. Burright, J. Hennis and T. F. Kirkwood), "How to Save Gasoline: Public Policy Alternatives for the Automobile," R-1560-NSF, October, 1974.
Rickles, Robert N., "Energy Impact on Housing Markets," 1974.
Shreve, Norris, *Chemical Process Industries*, McGraw-Hill, Inc., 1955.