Making the Polluter Pay:
The Case for a Minnesota Carbon Tax

DAVID MORRIS

December 1991

INSTITUTE FOR LOCAL SELF-RELIANCE

Environmentally Sound Economic Development

The Institute for Local Self-Reliance (ILSR) is a nonprofit research and educational organization that provides technical assistance and information on environmentally sound economic development strategies. Since 1974, ILSR has worked with citizen groups, governments and private businesses in developing policies that extract the maximum value from local resources.

Institute for Local Self-Reliance
1313 5th Street SE, Suite 306
Minneapolis, MN 55414
Phone: (612) 379-3815
Fax: (612) 379-3920
www.ilsr.org

MAKING THE POLLUTER PAY:
THE CASE FOR A MINNESOTA CARBON TAX

The term "sin taxes" is well-know. For years it has been used to describe taxes on liquor and tobacco and gambling. Recently we have broadened the definition to include environmental sins as well. We are increasingly taxing environmentally immoral behavior in a variety of ways and for a variety of purposes. Concerns about a new kind of environmental pollution—global warming—have spurred several countries to impose a tax on carbon emissions. A modest Minnesota carbon tax could raise sufficient revenue to finance two important pollution reducing strategies: the creation of a homegrown renewable energy industry and a dramatic expansion in energy conservation programs for low income households.

Classifying Environmental Taxes

Generally, environmental sin taxes can be divided into four categories based on their objective.

1. Taxes designed to raise revenue to compensate for the costs of disposal.

These charges usually dedicate revenues derived to pay for the costs associated with waste disposal. Minnesota's landfill and hazardous waste taxes fit this definition.[1]

2. Taxes designed to change behavior.

These charges are usually very high and are often accompanied by regulations requiring the end to the specific behavior or the phaseout of the use of the particular material. The taxes are used to accelerate a phaseout.

The Clean Air Act, for example, phased out the use of most CFCs by the year 2000 and at the same time imposed a tax of $l.37 per pound for virgin CFCs. Recycled CFCs were exempted from the tax. This tax was about twice the going price. The tax rises to $3.10 per pound in l995 and to $4.90 by l999, in effect, lifting the price of CFCs six fold.[2]

The Minnesota Groundwater Protection Act of l989 prohibited the use of once-through water systems in the Twin Cities after 2010 and immediately raised the price of using once-through water 200 fold for commercial users and 50 fold for non profits and schools.[3]

3. Taxes designed to finance measures to increase consumption.

This is the odd fellow in the bunch and stands out as a contradiction to the overall purposes of environmental taxes. There is only one such tax to my knowledge—the gasoline tax—and I include it because it garners the lion's share of revenues and because in many states gasoline taxes can be spent only for the purpose of encouraging the increased consumption of gasoline. Minnesota's gasoline tax, by Constitutional amendment, must be spent only on building and maintaining roads or to encourage the consumption of gasoline by off road vehicles.[4] In fiscal year l989 Minnesota raised $454 million from this tax.

4. Taxes designed to finance measures that reduce consumption.

Until relatively recently, most environmental sin taxes were used to clean up after the fact, but a growing number of taxes are now used to reduce the level of sinning in the first place.

In 1989, Minnesota extended the 6.5 percent sales tax to garbage services and in l990 raised $24.3 million. A portion of this money has been used to finance recycling and waste minimization programs and to provide loans and grants for recycling businesses.

In l987, by initiative, Californians approved Proposition 99, The Cigarette and Tobacco Products Surtax. The initiative imposed an additional 25 cent tax over and above the existing tax of l0 cents per pack. It went into effect January l989 and, in l990 raised $543 million. These funds have been used to fund very aggressive public education programs, and nicotine addiction treatment programs, as well as to pay for the health costs related to tobacco use.[5]

In l987, Iowa passed the Groundwater Protection Act which imposes a tax of 1/10th of l percent on gross sales for pesticides at the retail level, and 1/5th of l percent of gross sales on the manufacturers of pesticides. It also imposes a 75 cents per ton tax on nitrogen fertilizer. These

three taxes raise about $2 million a year. Thirty five percent goes to the Leopold Center for Sustainable Agriculture at Iowa State University to promote economic and environmentally sustainable agriculture.[6]

All the taxes discussed so far are levied on the basis of weight or volume, not on the basis of pollution(although if waste itself is considered pollution, then waste based fees might be viewed as a pollution tax). In l990, the California legislature passed a literal pollution tax to encourage efficient cars.[7] The program would have imposed a heavy tax on gas guzzlers and provided rebates on gas sippers, but the tax was based on the grams of pollutants emitted per mile. The bill was vetoed by the Governor.

The Clean Air Act of l990 allows states to impose a charge per ton of regulated pollutants in order to finance the regulatory program. The Minnesota legislature in l99l authorized such charges to cover "direct and indirect costs...to develop and administer" the program. Presently, the Minnesota Pollution Control Agency is imposing a charge of $7-9 per ton on l990 emissions, and will be establishing final rules by the end of l99l that will probably lift the fees to near the $25 per ton level specified in the federal law.[8] These fees will be imposed on stationary, not mobile sources. The Clean Air Act expressly prohibits fees on carbon monoxide emissions.[9]

Internalizing the Costs of Pollution in Utility Planning

Public Utility Commissions in an increasing number of states are taking into account environmental costs when evaluating utility investment plans. Half a dozen states have quantified the costs of pollutants. Staff estimates of costs range from 1.2 to 8.6 cents per kWh, depending on the type of plant and the type of fuel. No regulatory commission has imposed the full environmental cost on its utilities. New York State has estimated, for planning purposes, a 1.4 cent environmental cost of coal fired power plants, New Jersey a 2 cent cost and Nevada a 3 cent per kWh cost.[10]

In 1991, the Minnesota legislature required the Public Utility Commission to include environmental costs when comparing the costs of alternative energy sources. It is unclear whether the PUC will take into account all environmental costs, including global warming. A January 31, 1991 "Open Letter to the Managers of the U.S. Utility Industry" from the National Association of State Utility Consumer Advocates declared, "Utility resource planning that does not account for emissions of carbon dioxide and other greenhouse gases is both harmful to the environment and fiscally irresponsible...Failure to realign resource planning and investment...will leave those responsible subject to prudency challenges if identified risks and alternatives are not responsibly addressed."

The justification for internalizing environmental costs in utility planning is that these are real costs imposed on society. However, because of the narrow regulatory jurisdiction of state utility commissions, these costs are being taken into account only for the planning of future power plants. They are not being imposed on current electric generation. This means that utilities are receiving accurate price signals to guide their own future investments, but business, government, and households are buying an underpriced commodity in the present and thus are not encouraged to make their own investments in improving energy efficiency.

Using Emission Offsets to Reduce Pollution

The Clean Air Act of l990 capped various power plant emissions. It also contained specific transportation fuel requirements in areas that exceeded specified carbon monoxide and also ozone levels. States were given the opportunity of allowing transportation fuel suppliers to trade pollution allowances, and utilities were given that right under the federal act. Trading emission offsets is justified on efficiency grounds. If utility A can reduce sulfur emissions below targeted levels at a lower cost than utility B can reduce sulfur emissions to targeted levels,

then it is cheaper for utility A to do so and to sell its pollution savings to utility B at a price that is above utility A's cost of pollution reduction but is below the cost to utility B of meeting targeted levels.

The Chicago Board of Trade will begin trading "cash forward" pollution contracts in l993 and are currently requesting permission of the Commodity Futures Trading Commission to establish a continuing "futures" market, permitting anyone to gamble on emissions rights in standardized 25 ton allotments up to 3 years in advance. The value of saved pollution is estimated to be around $400 a ton of sulfur dioxide at the start of trading.[11]

The Sacramento Metropolitan Air Quality Management District has proposed the nation's first formal air permitting rule that would allow stationary sources to utilize offsets obtained from mobile sources and transportation control measures. Rule 206 proposes that adding clean fuel vehicles, or other forms of emission reduction strategies like telecommuting could be used by stationary polluting sources as offsets in the same manner as offsets from shutdown or modification of other stationary sources.[12]

The Clean Air Act reportedly allows utilities to use investments in energy conservation and renewable energy programs to offset pollution.[13]

The Twin Cities exceeds EPA ceilings on carbon monoxide emissions. That means that after November 1992 gasoline sold in the Twin Cities must contain minimum levels of oxygen during the winter. The Minnesota legislature in 1991 extended the oxygenate requirements so that in 1995 oxygen will be required year round in the Twin Cities and in 1997 year round statewide. Minnesota has the authority to develop a method of trading oxygenate allowances, but is not planning on doing so. Virtually all transportation oxygenated fuels will be ethanol. Therefore the administrative costs would outweigh any economic efficiency such a system might achieve.

Carbon Taxes

Many industrialized countries have established carbon dioxide reduction goals. Usually these are in the range of a 20 percent reduction below l988 emissions levels by the year 2005.[14] However, most observers believe that a 50 percent reduction in human generated carbon dioxide emissions is needed to eliminate global warming.

To change consumer and investor behavior, most economists believe that a carbon tax in the range of $90-100 per ton will be needed.[15]

PRICE IMPACT OF CARBON TAXES

Unit	$10/Ton	$100/Ton
Barrel of Oil	$1.00	$10.00
Ton of Coal	$6.00	$60.00
1000 Cubic Ft. of Natural Gas	$0.15	$1.52
Gallon of Gasoline	$0.02	$0.20
kWh(Coal Fired)	$0.003	$0.03

A number of studies have evaluated the macro economic impact of a tax of such a magnitude, with varying results. Most estimate a 1-3 percent reduction in GNP.[16] However, these studies do not assume offsetting tax reductions elsewhere in the economy, nor do they assume that the money raised would be directed toward improving efficiency.[17]

The World Resources Institute argues that the current taxes on capital and labor undermine efficiency. A tax on capital raises the cost of capital and thus discriminates against technological innovation. A tax on labor raises the cost of labor and thus may lower employment. "Unlike many other sources of federal revenue, a carbon tax would generate overall economic efficiency gains, regardless of how the revenues from the tax are used."[18] A recent report by several national environmental organizations calculates a 70 percent reduction in carbon emissions by the year 2030 with a net economic savings to the economy of $2 trillion.[19] In 1987 the German Bundestag estimated

that $160 billion in investments would be necessary by 2005 to meet a 25 percent reduction in CO2 levels by that year, excluding investments in what was then East Germany, and that the investment would be substantially offset by reduced energy needs.[20]

These studies assume that market forces will catalyze investments in energy efficiency, that is, higher carbon taxes will lead to higher efficiency investments. However, investments in fuel switching(e.g. to natural gas or nuclear power) might also occur.

If a carbon tax were used to raise revenue money dedicated to financing efficiency improvements and renewable fuels, a lower tax might achieve the same objective. Physicist Jose Goldemberg, Brazil's Secretary of Science and Technology calculates that a worldwide carbon tax of just $l per barrel of oil, $6 per ton of coal, would generate more than enough revenue to finance fuel saving and fuel switching measures to renewable alternatives to reduce global warming.[21]

Aside from the question on the macro-economic impact of a carbon tax is the question of its impact on competitiveness. European energy taxes traditionally are lower on industries, especially industries in export sectors, and fall most heavily on automobiles and households. Interestingly, Minnesota imposes energy taxes in a somewhat similar manner. Energy taxes on fuels sold to manufacturers or agriculture producers are exempt, except for heating and lighting. Minnesota exempts from taxes process steam and electricity used to drive industrial motors.[22]

Several nations have already imposed modest carbon taxes. Finland's is $6.25 per ton of carbon.[23] The Netherlands' carbon tax is $11.40 per ton.[24]

The European Community is discussing a carbon and energy tax beginning at $3 per barrel and rising to $10 in the year 2000. The imposition of this tax has been delayed pending resolution of a dispute regarding the method of application.[25]

A Minnesota Carbon Tax

In 1988, Minnesota generated 24.4 million tons of carbon, equivalent to 89.5 tons of CO2. Imported electricity, accounting for about l7 percent of all electricity consumed in the state, if included, would increase the generation to 27 million tons of carbon.[26]

MINNESOTA EMISSIONS OF CARBON IN 1988 BY SECTOR
(1000 tons)[27]

Sector	Emissions	Percentage
Residential	2,833.1	11.6%
Commercial	1,901.1	7.8
Industrial	2,751.6	11.3
Agricultural	733.5	3.0
Transportation	7,755.1	31.8
Electric/Steam	8,447.8	34.6
Total	**24,422.7**	**100%**

The Department of Natural Resources has recommended a carbon tax of 55 cents per ton dedicated to tree planting. This would generate $13.5 million a year.[28]

The proposed tax is a major step in the right direction and would constitute the nation's first CO2 tax, but it also has several drawbacks.

The proposed tree planting program would have a negligible impact on CO2 emissions. The financing is sufficient to plant 108,000 trees per year, 1.08 million over ten years. Over a 40 year period, these trees would sequester "substantially less than one percent of the total emissions".[29] This assumes no growth in emissions over the next 40 years, although growth has occurred in the l980s because of an expansion of coal fired electricity generation.

A substantially greater CO2 reduction would occur if the trees were planted in a way that reduces energy consumption by surrounding homes. Trees can shade windows, thus reducing air conditioning bills, can provide windbreaks, and can reduce the overall urban heat island effect. Such add-on savings can increase by 3-15 times the carbon dioxide reduction impact of tree planting.

In some instances, trees planted in Minnesota might pay for themselves through energy savings alone. Thus the carbon benefits would be, in effect, free. Based on its own experience, the Osage Municipal Utility in Iowa in 1990 began giving away trees to urban dwellers who plant them in locations that reduce household energy bills.

However, no utility savings are likely from trees planted in the northern portion of Minnesota.[30] If the Minnesota tree planting program is designed to maximize carbon dioxide sequestration and to minimize cost, it would tend to be restricted to southern, urban areas.

The second problem is that the CO2 tax as now conceived is dedicated only to tree planting. This violates the least cost energy principle that is only now, after a long battle, becoming an integral part of utility regulation. Least cost planning in the utility field means that utilities should invest in the least expensive way to meet a customer's need for heating or cooling, for mechanical power, or for lighting. It means that power companies should not continue the traditional practice of dedicating revenues from customers solely to building and maintaining power plants. Minnesota's CO2 tax will be breaking new ground. It should adopt right from the beginning criteria compatible with least cost principles.

Planting trees may be a worthwhile strategy for absorbing carbon already in the atmosphere. Extensive experience shows that improving energy efficiency is widely applicable as a relatively low cost carbon reduction option. A review of conservation programs in the Midwest, Northwest and New York States found the average cost of reducing carbon emissions to be $23.17 per ton.[31] (Assuming a coal fired power plant, this translates into a cost of saved electricity of less than a penny a kilowatt hour). This seems a very low figure and probably reflects initial utility investments with very short paybacks. Conservation measures that cost less than 3 cents per kilowatt hour, more reflective of the cost of significant efficiency programs, translate into a cost of saved carbon of $100 per ton.

Tree planting may be competitive with more direct energy efficiency measures. The estimates are highly variable. In Minnesota, the cost per ton of saved carbon from tree planting ranges from less than $10 a ton to over $420 a ton in central and southern Minnesota. In northern locations, the cost per ton of carbon saved could exceed $8,000 a ton.[32] Estimates from elsewhere in the country vary from $55-120 per ton of carbon sequestered for tree planting.[33] It should be pointed out that if a least cost principle were used for carbon reduction that, one German company has devised a heat battery which warms car engines and heaters just 30 seconds after startup. By eliminating cold starts the device cuts CO2 emissions in half and reduces wear on engine. For $500, Saab-Scandia and VW plan to install the battery as an option on cars. The cost of saved carbon of this device is about $l35 per ton.

Recommendations

Minnesota should impose a carbon tax designed to raise revenue rather than to change behavior. A reasonable tax might be $6 per ton, in line with taxes already imposed by European governments, although lower than those proposed by the European Commission. Such a tax would raise the cost of energy by 1.85 cents a gallon on gasoline, less than a fifth of a cent per kilowatt hour on electricity, and 10 cents per thousand cubic feet of natural gas. To maintain the competitiveness of exporting industries, and in keeping with current practice here and in Europe, the tax should not be imposed on fuels used for industries and agricultural enterprises engaged in export.[34]

Assuming a 27 million ton overall carbon emission level, and subtracting for industrial and agricultural use, a carbon tax at this level would generate about $150 million a year. Assuming an average cost of saved carbon of $100 a ton, this investment, if fully applied to energy efficiency, would reduce carbon emissions by 1.5 million tons a year, a little over 5 percent of l988 emissions.

The revenue generated from the carbon tax should be

used for two primary purposes: to jump start a renewable energy industry in Minnesota and to reduce energy consumption by low income residents. One might ask why the money should not be used to further general conservation programs. The reason is that these programs should be financed through least cost planning techniques. Minnesota's Public Utility Commission, in theory, has adopted least cost planning in its resource planning process although Minnesota utilities have a long way to go before they are fully invested in cost-effective conservation programs. Least cost planning requires utilities to invest in the lowest cost way to meet existing and new demand for energy services and in most cases energy conservation is the preferred least cost strategy.

But least cost planning tends to place low income and renewable energy programs at the bottom of the resource planning hierarchy because both tend to have long paybacks. Low income conservation programs find it difficult to compete with commercial efficient lighting programs. Renewable energy technologies find it difficult to compete with existing power plants or gas fired cogenerators.

Yet there is a moral and ethical reason for us to invest in low income energy conservation programs and an economic development and environmental protection reason for us to invest in renewable energy programs.

With respect to low income programs, poorer households tend to inherit the hand-me-downs of society, the used houses, used cars, used refrigerators. Because of improved regulations in the past 15 years, the newest generation of houses and cars and appliances are much more energy efficient than their predecessors. Thus low income people tend to inherit a physical stock that is the most expensive to operate. Low income households often have to choose between heating and eating and often as their financial desperation increases the public sector steps in to pay their energy bills or other bills. Therefore it is appropriate to target low income households for energy conserving investments.

There is another reason to focus on low income households. A carbon tax is a sales tax and as with all sales taxes, it is a regressive tax. Low income households spend a greater percentage of their revenue on energy than higher income households. Therefore as a matter of fairness, low income energy conservation programs should be a priority target for carbon tax generated revenues.

A $6 per ton tax on carbon would translate into an increased tax of $43.12 per low income household in Minnesota.

THE IMPACT OF A $6 PER TON CARBON TAX ON LOW INCOME HOUSEHOLDS

Fuel	Annual Consumption	Additional Tax
Gasoline	655 gallons[35]	$12.12
Electricity	7505 kWh[36]	$15.00
Natural Gas[37]	160 MCF[38]	$16.00
Total		**$43.12**[39]

These estimates may be high. One third of low income households, for example, do not own cars and thus their gasoline consumption would be lower than that given above. The electricity figure is for a typical household while low income households tend to use less electricity. The electricity figure assumes coal fired electricity, but 40 percent of Minnesota's electricity is generated by non-coal fuel sources.

Assuming 514,000 low income households in Minnesota, the amount generated by a $6 per ton carbon tax from low income households throughout Minnesota would be $22.16 million.[40] If 50 percent of the carbon tax revenues were used for energy conservation programs it would amount to $75 million. Thus the low income community would receive an annual net benefit of about $53 million.

The actual benefit would be greater because the money would lower energy use over 10-25 years. A $2,000 investment per household would generate heat, electricity and water savings of $100-200 per year or more.[41]

Moreover, as these savings are realized, the impact of the carbon tax is proportionately lowered.

Low income energy efficiency programs in Minnesota currently serve about 20,000 homes per year, although by far the largest amount of spending comes from the 10,000 homes served by the weatherization program.[42] At current rates, the weatherization program would need 50 years to serve all low income households. To date the low income energy efficiency programs have found it difficult even to keep up with the increased number of households in need.

Assuming a $2,000 investment per home, the $75 million from the carbon tax would serve 37,500 homes per year. In addition to existing low income programs, this would allow the entire low income household population to be served within about 10 years. This would allow for Minnesota to finally finish the job begun in the late 1970s.

A portion of the carbon tax revenues should also be used to finance renewable energy sources. A sole focus on demand reduction is not a long term solution, since economic growth will eventually overcome efficiency improvements. Substituting low or non carbon dioxide emitting fuels is the long term solution.

Minnesota is rich in renewable resources. Its wind speeds are high and reliable and its land area is abundant for growing biomass. Direct sunlight also could be a longer term renewable energy fuel. Minnesota currently spends more than $6 billion for energy every year; 90 percent of its fuel is imported. Substituting homegrown fuels for imported fuels and creating a homegrown renewable energy industry are thus in the long term interest of Minnesota. In 1991 renewable energy technologies generate electricity at a modestly higher price than conventional technologies, assuming the environmental costs of conventional technologies are ignored. Yet it makes sense, as a component of a state economic development strategy, that Minnesota invest now in a renewable fueled industry in order to become a leader in this increasingly important sector in the early part of the next century. Carbon tax revenues can be used to offset the higher prices of renewable fuels today in order to jump start an industry whose prices will be competitive within 5-10 years and which may become an important element in Minnesota's export sector for years to come.

NOTES

1. Landfill Taxes. Minnesota Statutes. Section 115A.923. Enacted in 1989. Initial 50 cents per cubic yard tax boosted to $2 per cubic yard in l990. $3.06 million raised in fiscal year l988, $2.8 million in l989, $3 million in l990. Hazardous Waste Generation Tax. Minnesota Statutes. Section 115B.22. Enacted in 1983. Long term containment without treatment is taxed at a rate of 32 cents per gallon of liquid or $32 per cubic yard of solid. Long term containment after treatment is taxed at l6 cents per gallon of liquid or $l6 per cubic yard of solid. Land treatment is taxed at $32 per cubic yard. Other treatment is 8 cents per gallon of liquid waste or $8 per cubic yard of solid waste. Collected $l.36 million in fiscal year l988, $749,000 in l989, $553,000 in 1990.

2. Public Law 101-549.

3. The Act, administered by the Division of Waters of the Department of Natural Resources, requires that a conversion plan be submitted by users by January l, l992. The once-through systems must be converted within the design life of the equipment based on the ASHRAE service life for primary system components. This ranges between l9-24 years and l990 is used as the base year to determine the remaining service life for a system. Once-through water for heating and cooling systems for commercial users is $200 per million gallons with no maximum fee. The fee for non profits and school districts is 5 cents per l000 gallons until l993($50 per million gallons), rising to l0 cents in l993 and to l5 cents in l997. The current fee for water not appropriated for once through systems or for other uses is $50 for up to 50 million gallons, or $l per gallon and rises to a maximum of $4.50 per million for use above 400 million gallons, according to the Division of Waters.

4. Minnesota Constitution. Article XIV. Section 5. Amended in l924. Not all of the funds must be used for roads. It is estimated, for example, that 1.5 percent of the gasoline purchased was used by boats that made no use of the roads, .75 percent was purchased by snowmobilers, and .15 percent by all terrain vehicles. Therefore equivalent percentages of the highway fund is allocated to expenditures for increasing the consumption of gasoline by these users(e.g. building snowmobile paths or aiding the expansion of water sports).

5. The breakdown of surtax revenue distribution is as follows: 20 percent to health and education services, 35 percent to hospital services, 10 percent to physician services, 5 percent to research, 5 percent to public resources, and 25 percent unallocated. The revenues are dropping 3 to 3.5 percent per year as cigarette smoking goes down.

6. Sixty five percent goes to demonstration projects as well as to the testing and closure of public and private wells, and to research the health effects of contamination. This portion might be viewed as similar to the landfill tax in Minnesota. An upcoming report by Iowa State reveals that in recent years, Iowa's use of pesticides has been below that of surrounding states.

7. California State Senate Bill No. 431.

8. Conversation with Greg Pratt, PCA senior scientist. November 25, 1991.

9. Clean Air Act. Title V. Section 502.3b(ii). Regulated pollutants are SO2, NOx, particulate matter, lead and hydrocarbons. Only sources that generate more than l0 tons per year of a given pollutant are included. The PCA is presently unclear whether state legislative language would permit it to impose fees on carbon monoxide emissions from stationary sources. It will likely request a modification of the language in the next session to enable it to do so. Conversation with David Thornton, Chief of Air Quality Division, PCA.

10. David Morris, et. al., *Getting the Most from Our Materials.* Institute for Local Self-Reliance. Washington, DC. 1991.

11. *New York Times.* July l7, l99l. Richard Sandor, Executive Managing Director of Kidder, Peabody & Company told the Times the price could not rise above $2000 a ton because utilities have the option of exceeding the legal emissions and paying a fine of $2000 a ton.

12. *California Environmental Insider.* October l5, l99l.

13. *Public Power.* July-August l99l. Estimates vary from $300 to $800 per ton.

14. Karen Schmidt, *Industrial Countries' Responses to Global Climatic Change.* Environmental and Energy Study Institute. July l, l99l.

15. The Congressional Budget Office's Natural Resources and Commerce Division used economic models assuming a carbon tax phased in over l0 years, beginning at $l0 a ton in l99l and rising to $l00 a ton in l988 dollars by the year 2000. Taxes at this level might stabilize carbon dioxide emissions 6 percent below to 5 percent above l988 levels. Washington Post National Weekly Edition. October 1990.

16. *Washington Post National Weekly Edition.* October 1990. Cites CBO study concluding that GNP in year 2000 would be l percent lower because of a $l00 a ton carbon tax. Alan Manne of Stanford and Richard Richels of the Edison Electric Institute assume that a much higher tax would be needed to make the transition and calculate that the reduced productivity would reduce GNP by 3 percent or $300 billion a year. New York Times. October 3, 1990.

17. The studies disagree on the impact on energy efficiency of the tax itself. The Environmental Protection Agency says that energy conserving technologies would permit Americans to roll back carbon emissions at a continuing sacrifice of l percent of GNP, but that assumes that the amount of energy required to generate one dollar of GNP fell by l.5 percent annually. Others think this is too high. Manne and Richels, for example, assume that gains in energy efficiency would be 1/2 percent per year.

18. Roger Dower and Robert Repetto, *Use of the Federal Tax System to Improve the Environment,* U.S. House of Representatives. Committee on Ways and Means. Long Term Strategy Hearings on the Environment. March 6, l990.

19. *Americas Energy Choices: Investing in a Strong Economy and a Clean Environment.* Alliance to Save Energy, American Council for an Energy-Efficient Economy, Natural Resources Defense Council, Union of Concerned Scientists. October 1991.

20. Karen Schmidt. *Op Cit.*

21. *Technology Review.* November-December l990.

22. The use of fuels and electricity for home heating is also exempt from taxes. If a home uses natural gas for heat, the gas consumed from November through April is not subject to tax. The same is true if a home uses electricity for heating. Fuel oil, coal, and wood are not taxed because they are assumed to be used for space heating. Carolyn Carlson. Minnesota Department of Revenue. Tax Research Division.

23. Karen Schmidt, *Op. Cit.*

24. Dower and Repetto, *Op. Cit.*

25. In their discussions, the ministers agreed to exempt energy intensive industries from the tax, and were split on the division between energy and carbon. According to published reports, the Environmental Commissioner wants a quarter or less of the tax to be based on carbon content, preferring to concentrate on promoting energy efficiency through higher energy taxes. The Energy Commissioner wanted half or less of the tax to be based on energy production, preferring to speed up the switch to low carbon sources. It is also true that a tax on carbon favors nuclear power, which has more supporters in the energy department than the environmental department. See for example, *New Scientist.* October 5, 1991.

26. *Carbon Dioxide Budgets in Minnesota and Recommendations On Reducing Net Emissions With Trees.* Report to the Minnesota Legislature. Minnesota Department of Natural Resources. Division of Forestry. Saint Paul, Minnesota. January 1991.

27. *Ibid.*

28. *Ibid.*

29. *Ibid.* p. 74. There appears to be a typographical error here. The amount of carbon sequestered should be one half million to one million tons, not one half billion to one billion tons. The actual percentage sequestered over a 40 year period is equal to about 1/10 of l percent of the CO2 generated during that time inside the state.

30. *Ibid.*

31. Daniel Dudek, A. LeBlanc and P. Miller. *CO2 and SO2: Consistent Policy Making in a Greenhouse.* Environmental Defense Fund. January l990. p. 9.

32. *Carbon Dioxide Budget in Minnesota. Op. Cit.*

33. See Richard L. Ottinger, David R. Wooley, et. al. *Environmental Costs of Electricity.* Oceana Publications. New York. l990. pp. 165-191.

34. Electrical use for industrial purposes accounts for about one-third of total electric consumption. *Minnesota Energy Data Book, 1960-1986.* Minnesota Department of Public Service. Industrial use for process steam has not been calculated.

35. Average fuel efficiency in 1990 was 16.5 miles per gallon and average annual vehicle miles driven was 10,800. Minnesota Department of Transportation.

36. *Northern States Power Company. 1991 Annual Report.*

37. Non-electric.

38. The average household gas usage for Northern States Power Company customers in 1991 was 122 MCF. *1991 Annual Report.* The average usage for Minnegasco customers was 130 MCF in 1991. Personal conversation with David Kostik, Minnegasco. December 1992. The Center for Energy and the Urban Environment estimates their Operation Insulation participants used 149 MCF for a homeowner occupied unit and 190 MCF for a rental unit. Conversation with energy auditors working at the Neighborhood Energy Consortium resulted in estimates of 160 MCF per house.

39. This figure is close to the $29.25 per year additional expenditures estimated for households below 100 percent of the poverty line in the U.S. by the Department of Energy for a $6 per ton carbon tax. *Studies of Energy Taxes.* Energy Information Administration. Department of Energy, Washington, D.C. April, 1991.

40. The official poverty level for a household of four is $13,950. There were 369,292 Minnesota households below $14,999 in 1989. *Income and Poverty Status in 1989.* 1990. There were 658,426 households with incomes under $24,999 per year. We do not at this time have a good breakdown of number of persons per household and income levels. Therefore we have used a household figure between the $14,999 and $24,999 income levels to come up with the 514,000 figure.

41. The Center for Energy and the Urban Environment estimates a retail rate of $4.16 per MCF, and 15 percent savings on their Operation Insulation program for major insulation jobs. The Energy and Environment Resource Center pilot project on savings related to water efficiency investments(e.g. reduced water, sewage and electric bills for hot water) found savings of over $100 per year.

42. *Minnesota Energy Programs. A Report to the Legislature. Minnesota Department of Public Service.* February 1990. These are 1989 figures. The Weatherization Program completed about 10,000 homes and spent $19 million, for an average cost per home of $1,900. The Conservation Improvement Gas program served about 8,200 homes and spent $1.46 million, for an average cost per home of $180. The Conservation Improvement Program for electricity savings served 1,600 homes and spent $562,000 for an average cost per home of $351.