



The Economic Effects of Proposed Cap-and-Trade Legislation on the State of Pennsylvania

THE BEACON HILL INSTITUTE AT SUFFOLK UNIVERSITY

8 Ashburton Place Boston, MA 02108

Tel: 617-573-8750, Fax: 617-994-4279

Email: bhi@beaconhill.org, Web: www.beaconhill.org

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President Obama and several members of Congress have proposed legislation to reduce greenhouse gas (GHG) emissions in the United States. The Waxman-Markey Bill currently before Congress would bring GHG emissions, and hence carbon emissions, below 2005 levels in steps – 3% below those levels by 2012, 20% by 2020, 42% by 2030, and 83% by 2050.

Waxman-Markey would create a “cap-and-trade” system, under which U.S. producers would receive tradable permits to emit greenhouse gasses. Producers buying the permits would, in effect, pay a tax for the privilege of emitting greenhouse gasses currently emitted without charge. The resulting “carbon tax” would have an effect on production and employment similar to an explicit excise tax on production.

In this report, the Beacon Hill Institute (BHI) uses two computer modeling capabilities to estimate the economic effects of this tax on the Pennsylvania economy. The first of these is the “DICE” (Dynamic Integrated Model of Climate and Economy) model developed by William Nordhaus of Yale University.¹ The second is the Beacon Hill Institute STAMP® (State Tax Analysis Modeling Program). We used the DICE model to estimate the implicit carbon tax that Waxman-Markey would impose on U.S. producers and the STAMP model to estimate the resulting effects on the Pennsylvania economy.² Table 1 displays the results.

Table 1: The Economic Impact of Waxman-Markey on Pennsylvania (2009 \$)

Cost of Carbon	2020	2050
Equivalent Carbon Tax (current \$/metric ton)	92.66	714.00
Total net cost to Pennsylvania (\$ billions)	6.45	55.34
Economic Variables		
Total Employment (Jobs)	-47,549	-480,852
Gross Wage Rate (\$/person/year)	-297.59	-2,551.72
Investment (\$ millions)	-671.19	-5,755.21
Real Disposable Income (\$ millions)	-5,536.03	-47,469.36
Tax Revenues		
State Funds (\$ millions)	-574.96	-4,930.40
Local Funds (\$ millions)	-396.09	-3,396.40
Total Funds (\$ millions)	-971.09	-8,326.80

We find that the cap-and-trade system would impose a tax of \$92.66 per metric ton of carbon in 2020 in order to reach the 20% emissions reduction goal. The cost of carbon would rise to \$714 in 2050 to reduce emissions by 83% below 2005 levels. These carbon taxes would cost the residents of Pennsylvania \$6.45 billion dollars in 2020 and \$55.34 billion by 2050 through increased energy prices.

¹ William Nordhaus, 2008, *A Question of Balance*, Yale University Press.

² For a description about the model see www.beaconhill.org.

These increased energy prices would inflict significant harm on the Pennsylvania economy. The state economy would shed 47,549 jobs by 2020 and 480,852 by 2050. The decrease in labor demand, as seen in the job losses would cause gross wages per person to fall by \$297.59 per capita annually by 2020 and \$2,551.72 by 2050.

The job losses and price increases would combine to reduce real incomes as firms, households and governments spend more of their budgets on energy and less on other items, such as home goods, entertainment and clothing. As a result, real disposable income would fall by \$5.536 billion per year by 2020 and \$47.469 billion by 2050. Furthermore, annual investment in the state would fall by \$671 million by 2020 and \$5.755 billion by 2050.

State and local government tax collections would also suffer from the economic damage. By 2020, the state of Pennsylvania can expect annual tax revenues to fall by \$575 million, while local governments would lose \$396.1 million in tax revenue, for a combined state and local revenue loss of \$971.09 million. By 2050, the state and local government tax revenue losses would swell to over \$8.326 billion, with the state losing \$4.93 billion and local governments losing \$3.396 billion.

Table 2: Effects of Waxman-Markey on Energy Prices in Pennsylvania

Energy Source	2008 Retail Price	Energy Price Increases	
		2020	2050
Gasoline retail price (\$/gal)	2.74	0.29	1.94
Natural gas residential price (\$/'000 cu ft)	16.24	1.75	10.66
Electricity retail price : natural gas (¢/kWh)	12.06	1.11	7.64
Electricity retail price : coal (¢/kWh)	12.06	2.48	16.93
Coal, bituminous, market price (\$/ton)	40.8*	40.63	277.89
Coal, lignite, market price (\$/ton)	14.89*	71.69	490.29

*2007 national price

Table 2 shows how cap-and-trade would affect energy prices in Pennsylvania. The policy would push up the price of gasoline by 29 cents/gallon by 2020 and by \$1.94/gallon by 2050, and would raise the retail price of electricity produced from natural gas by 1.11 cents/kWh by 2020 and 7.64 cents/kWh by 2050. Electricity produced from coal would experience a 2.48 cent/kWh increase by 2020 and a 16.93 cent/kWh increase by 2050. Additionally, bituminous coal would increase in cost by \$40.63 /ton by 2020 and \$277.89 /ton by 2050, while lignite coal would increase by \$71.69 /ton by 2020 and \$490.29 /ton by 2050.

Conclusion

Cap-and-trade is aimed at reducing the consumption of fossil fuels by increasing their prices and thus, in turn, the prices of energy and of all goods and services. A cap-and-trade proposal such as Waxman-Markey would therefore inflict large negative impacts on the economy of Pennsylvania. The state would experience significant declines in employment, wages, disposable income and investment upon implementation of the policy.

There is, moreover, no offsetting benefit to the other states that would offset the harm suffered by Pennsylvania. In other analyses, we have shown that Waxman-Markey would inflict harm on the U.S. economy as a whole equivalent to what it would inflict just on the state of Pennsylvania.³ No proposal to institute cap-and-trade should go forward without regard to these findings.

Methodology

To reduce GHG emissions, a cap-and-trade system seeks to change the behavior of economic agents such as producers, consumers and governments. It does so by changing the incentives, both negative and positive, faced by all three when consuming GHG producing energy.

BHI deployed the DICE model developed by William Nordhaus of Yale University to estimate the carbon tax needed to achieve the GHG reduction mandated by Waxman-Markey. We then used these results to calculate the effects on fossil fuel prices that would result from reducing GHG emissions and to measure the effects on the economy of Pennsylvania. Although full details of the DICE model are set out clearly in Nordhaus (2008), and the computer code is freely available, it is useful to sketch the essential components here.

The model consists of 19 dynamic equations, and rests on 44 non-trivial parameters. The objective is to maximize the present value of the utility that consumers get over time from consumption. Emissions of CO₂ accumulate in the atmosphere and the oceans, and these accumulations reduce output via a damage function. Spending on emissions abatement is costly, and so there is a tradeoff: more abatement eats into consumption directly but limits damage by avoiding further warming that would indirectly have cut consumption. In principle there is a level and time pattern of emissions reductions that maximize utility, which is referred to as the optimal path. This may be compared to the “baseline” case of no emissions controls for 250 years.

The model allows one to specify abatement targets – for example, a maximum allowable rise in global temperature, or a maximum atmospheric concentration of CO₂, or a given proportionate reduction in emissions. The model then determines how much to save and invest, and how much to spend on abatement. It also generates the carbon taxes that would be needed to yield these outcomes efficiently. We used the results of the DICE model to calculate the changes in fossil fuel prices that would result from reducing GHG emissions and to measure the effects on the economy of Pennsylvania.

³ We will provide the results on request.

The cap-and-trade policy would increase the price of energy, and subsequently goods and services. Standard economic theory shows that price increases of a good or service leads to a decrease in overall consumption, and consequently a decrease in the production of that good or service. This is especially true in periods of economic decline as we are now facing. As producer output falls, the decrease in production results in a lower demand for labor. We assume that the federal government opts for the free permit model under its cap-and-trade program and thus foregoing a substantial amount of revenue.

BHI utilized its STAMP (State Tax Analysis Modeling Program) model to identify the economic effects and understand how they operate through a state's economy. STAMP is a five-year dynamic CGE (computable general equilibrium) model that has been programmed to simulate changes in taxes, costs (general and sector-specific) and other economic inputs. As such, it provides a mathematical description of the economic relationships among producers, households, governments and the rest of the world. It is general in the sense that it takes all the important markets, such as the capital and labor markets, and flows into account. It is an equilibrium model because it assumes that demand equals supply in every market (goods and services, labor and capital). This equilibrium is achieved by allowing prices to adjust within the model. It is computable because it can be used to generate numeric solutions to concrete policy and tax changes.⁴

BHI calculated the impact of the fossil fuel price increases on the price level for each of the (27) sectors of the economy within the STAMP model. Using the Energy Information Agency's (EIA) national data on GHG emissions by the residential, commercial, industrial and transportation sectors; we allocated the national emissions to the STAMP sectors.⁵ We then used data from the U.S. Census Bureau's Economic Census as a proxy for the size of each industry in each state relative to the national data.⁶ We applied the cost of carbon, adjusted to be equivalent to 3.67 metric tons of CO₂, to GHG emissions in each sector, which gives us our total cost to the economy. We converted these price increases in dollars into percentage changes based on the annual value of production in each sector.

We simulated these changes in the STAMP model as a percentage price increase on fuel to measure the dynamic effects on the state economy. The model provides estimates of the proposals' impact on employment, wages and income in Pennsylvania. Each estimate represents the change that would take

⁴ For a clear introduction to CGE tax models, see John B. Shoven and John Whalley, "Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey," *Journal of Economic Literature* 22 (September, 1984): 1008. Shoven and Whalley have also written a useful book on the practice of CGE modeling entitled *Applying General Equilibrium* (Cambridge: Cambridge University Press, 1992).

⁵ U.S. Department of Energy, Energy Information Agency, *American Energy Outlook 2009*, Table 18: Carbon Dioxide Emissions by Sector and Source, Internet, available at www.eia.doe.gov/oiaf/servicerpt/stimulus/excel/aeostimtab_18.xls.

⁶ 2002 Economic Census, Summary Statistics by 2002 NAICS, United States, Internet, available at <http://www.census.gov/econ/census02/data/us/US000.HTM>.

place in the indicated variable against a “baseline” assumption about the value that variable for a specified year in the absence of the cap-and-trade policy.

The Beacon Hill Institute at Suffolk University in Boston focuses on federal, state and local economic policies as they affect citizens and businesses. The institute conducts research and educational programs to provide timely, concise and readable analyses that help voters, policymakers and opinion leaders understand today's leading public policy issues.

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**THE BEACON HILL INSTITUTE
FOR PUBLIC POLICY RESEARCH**

**Suffolk University
8 Ashburton Place
Boston, MA 02108**

Phone: 617-573-8750 Fax: 617-994-4279

bhi@beaconhill.org

<http://www.beaconhill.org>