Peer Review:

North Carolina Energy Scenario Economic Impact Model[1]

December 2007

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Introduction

The North Carolina Energy Scenario Economic Impact Model (NC-ESEIM) was developed to quantify the potential impacts on the state economy of major energy policy initiatives designed to reduce greenhouse gas emissions.

Unfortunately, the model has serious flaws that undermine its ability to forecast how changes in energy policy will impact wages, Gross State Product, and the number of jobs, in North Carolina. This peer review summarizes the NC-ESEIM, explains the flaws in the model, and provides suggestions of what would need to be done to create a reliable model.

Our comments are based on secondary sources (Ponder and Tiller 2007, Tiller (undated), and Rose and Wei 2005), as we did not have direct access to the model or the underlying code. A companion briefing paper presents a broader critique of the policies proposed to reduce emissions of greenhouse gases.[2]

The model

The NC-ESEIM was developed by Skip Laitner in 2005 and reviewed by Adam Rose and Dan Wei in the same year.[3] In 2005 it was used to measure the economic impact of establishing a state-level "Public Benefit Fund" to support energy-saving measures, and to examine the impact of state renewable portfolio standards (which would mandate that an increasing share of electricity come from renewable sources). In 2007 it was used by researchers at Appalachian State University to measure the economic impact of 31 policy options developed by the Center for Climate Strategies (CCS) for the North Carolina Climate Action Plan Advisory Group (NC-CAPAG). A similar model has been applied to a comparable set of policy options in several other states, including Arizona, Colorado, Florida, Iowa, Michigan, Ohio, and Texas.

Suppose a state government were to tax electricity sales enough to raise $1 million for a "Public Benefit Fund" whose proceeds would be used to fund a demonstration project showing how to achieve energy conservation. How might one measure the impact of such a measure? This is the type of question that the NC-ESEIM is designed to answer.

To be able to say more, some further assumptions are needed. Suppose, for now, that the demonstration project spawns three conservation projects of comparable size that are privately financed. This will raise private investment by $3 million, pushing up the demand for wood and cement and steel, which in turn will raise the demand for chainsaws and clinker and iron ore, in a chain of "indirect" effects that work through to most of the sectors of the state economy. Meanwhile, the workers on the new private projects will spend some of their new income locally, raising demand for goods and services in a chain of "induced" effects. If there is some initial slack in the economy, the indirect and induced multiplier effects can be expected to increase the number of jobs and boost incomes.

This is the classical "multiplier analysis" treatment of an investment. But the NC-ESEIM model has been designed to address energy issues, and there are two further considerations: first, the private investments lead to savings in the quantity of energy used (and imported), and this leaves residents with more money

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[2] *North Carolina Climate Action Plan Advisory Group Recommended Mitigation Options for Controlling Greenhouse Gas Emissions*, (Beacon Hill Institute: Boston, December 2007) available upon request

[3] Skip Laitner is a Visiting Fellow and Senior Economist at the American Council for an Energy-Efficient Economy. Dan Wei is part of "the CCS [Center for Climate Strategies] team" that has developed policy options for climate mitigation in North Carolina.

to spend on other items, which in turn boosts Gross State Product. Second, power generating costs change over time (at fixed annual rates, depending on the fuel). Indeed, the model assumes that the cost of producing electricity from renewable sources (e.g. wind, biomass, hydropower), which starts high, falls below the cost of generating electricity from conventional fuels, by 2016.

Although this sketch captures the essence of the NC-ESEIM, the actual model is of course more complete and complex. In its original form, it was used in 2005 to analyze the effects of:

(i) introducing renewable portfolio standards, which mandate that a rising share of electricity production come from renewable sources; and

(ii) establishing a Public Benefit Fund that would spend on public education, demonstration projects, and research and development; and would provide low interest revolving loans, as well as grants and tax credits. These would be geared mainly to improving energy efficiency in the residential, commercial, and industrial sectors.

The original model traces the effects of these policies through an input-output table with 20 sectors.

The results of the base Public Benefit Fund case are shown in Table 1 (from Rose and Wei). The model shows a small drop in employment in the first year (before energy savings kick in), but a rise in jobs and wage payments thereafter; GSP also falls initially, then rises, and drops again after 2016, when falling electricity prices (due to low-cost generation from renewables) reduce the amount of dollars received by the local utility sector, and because "the revenue losses in utility sectors outweigh the gains in other sectors" (Rose and Wei, p.8).

Table 1. Effects of an NC Public Benefit Fund for energy conservation on jobs, wages and Gross State Product, as projected by the NC-Energy Scenario Economic Impact Model

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Jobs	-73	212	2,300	1,463	1,838	1,869	2,012	2,371	3,234	3,752	4,255	3,277	3,753	4,152	4,656	5,137
Wages ($m, 2000 prices)	-2.3	3.1	64.4	35.5	43.7	41.6	43.0	51.3	74.1	87.5	100.7	67.3	80.2	90.5	105.0	119.3
GSP ($m, 2000 prices)	-4.2	-5.9	98.3	34.0	32.8	14.1	0.8	-1.2	12.5	13.3	14.0	-63.9	-83.5	-69.8	-68.4	-67.0

Source: Rose and Wei (2005), p.11.

In the 2007 simulations based on the model, researchers at Appalachian State University found that a raft of 31 policy measures would, collectively, increase employment in the state by about 23,500 annually (equivalent to 0.54% of current employment), boost income by just over $1 billion per year, and raise Gross State Product by $1.47 billion (or by 0.39% of current GSP).

Flaws

The model is so flawed that its results are not credible. There are four serious problems – apart from the lack of documentation and public access to the model – which are listed here and discussed in further detail below.

1. The use of a multiplier analysis is not appropriate in a full-employment context.
2. The model does not allow the changing price of electricity to affect production or determine the price deflator (inflation) component of Gross State Product (GSP), with the ultimately nonsensical result that GSP is projected to rise when electricity is produced inefficiently (more expensively), and to fall when electricity is produced with higher efficiency (less expensively). If this were true, we should welcome higher energy prices and high inflation because it increases nominal GSP.

3. The assertions about what determines investment – the key driver of this input-output model – are too optimistic.
4. The assumptions about the evolution of energy costs over time are implausible.

Problems (1) and (2) could be remedied with the use of a computable general equilibrium model (as noted by Rose and Wei, p.5), while the issues raised in (3) and (4) could be addressed on the basis of a wider review of the available literature.

Flaw 1. Multipliers

It is appropriate to count the full multiplier effects of additional spending only if an economy initially has significant amounts of underused resources – spare industrial capacity, for instance, or a high level of unemployment. Under such circumstances, an additional $10 of spending will increase the demand for inputs (the indirect multiplier effects) and put spending power into the hands of workers (creating induced multiplier effects), so employers will hire more workers and use their machines more intensively.

However, in an economy with full employment, hiring someone for a new job essentially means bidding someone away from another job, so that the net effect on incomes and output is minimal.

By counting all the multiplier effects, the preliminary simulations undertaken by the Appalachian State University team are implicitly assuming that there is consistently expected to be slack capacity in the North Carolina economy over the coming decade, and that one could hire an additional 23,500 people in the state without any effect on the output of other sectors in the economy (Ponder and Tiller 2007). This is not plausible. The unemployment rate in North Carolina stood at 4.8% of the labor force in October 2007, statistically indistinguishably from the national rate of 4.7%, and a rate that indicates that there is little underused capacity in the state. For the full multiplier effects to apply one would have to assume that the state were in perpetual recession though 2020!

Flaw 2. Lack of price feedback

The NC-ESEIM model does not include a mechanism whereby a change in the price of electricity feeds into the cost of producing goods and services in the state. Furthermore, the simulations report measures of wage income and of Gross State Product (GSP), but they are nominal rather than “real” values because they do not adjust for the changes in the cost of living that would be expected if the price of electricity were to change.

These are not esoteric points. Consider the case of the introduction of a Renewable Portfolio Standard (RPS); under the NC-ESEIM model, the cost of producing electricity would rise until 2016, after which it would fall because the cost of renewables-based electricity would, it is assumed, drop below the cost producing electricity from fossil fuels. Economic logic dictates that if one does not take the value of greenhouse gas reductions into account (which the model does not), the introduction of the RPS should first reduce real GSP (because one is generating some energy inefficiently) and then raise real GSP (because technological change has reduced the cost of producing energy).

Yet the NC-ESEIM model does not show this! Instead, it projects rising GDP throughout the 2006-2020 time horizon, with a *smaller* net gain in GSP after 2016 (when renewables have become especially efficient).

Flaw 3. Determinants of investment

If state government spends a million dollars on a program designed to leverage private investment in order to conserve energy, how much additional private spending is likely to occur, and how much energy will be saved? The key relevant assumptions made by the NC-ESEIM model are set out in Table 2.

So, for instance, when the state spends $1m on demonstration projects, it is assumed in the model that residential investment on conservation will rise by $3m. It is assumed that the private investment will be recouped in 5.07 years, as a result of the reduction in energy costs.

The assumptions are optimistic. For example, private commercial and residential investment in energy conservation is assumed to pay back the original investment in less than two and a half years; if the investment lasts for ten years that represents a generous 38% rate of return. One might legitimately ask how many unexploited opportunities such as this are still available. (If there are, count us in, we're interested!)

Public education is assumed to be particularly effective; every dollar spent is expected to save at least two dollars in energy, a handsome annual rate of return of no less than 100%.

Table 2. Assumptions used in the NC-ESEIM model about the effect of additional state spending, related to energy conservation, on private investment and on energy savings

		State spending of $1m spawns private investment of ($m):	… and annual energy savings, per dollar of state spending, of ($):	Memo: Energy savings payback period (years)
Demonstrations	Residential	3.0	0.59	5.07
	Commercial	2.0	0.85	2.35
	Industrial	1.0	0.44	2.26
Grants	Residential	2.86	0.56	5.07
	Commercial	2.63	1.12	2.35
	Industrial	2.63	1.16	2.26
Loans	Residential	5.56	1.10	5.07
	Commercial	5.56	2.37	2.35
	Industrial	7.41	3.28	2.26
Research & Development			2.0	0.50
Public Education	Residential		3.0	0.33
	Commercial		2.0	0.50
	Industrial		2.5	0.40

Source: Rose and Wei (2005).

We do not wish to imply that state spending to encourage conservation would have no effect on investment or energy savings, but we do wish to suggest that the gains are being oversold here; a similar point has been made by Paul Joskow and Donald Marron (1992), and is still relevant.

Flaw 4. Energy cost assumptions

Technological improvements have gradually reduced the real cost of producing electricity out of a given quantity of conventional fuel such as coal, natural gas, oil, or uranium. Similar technical improvements are reducing the cost of producing electricity from wind, biomass (such as wood), methane (from landfills), and from the sun (photovoltaics and other systems), but most of these renewable technologies are still significantly more expensive than the conventional sources.

The idea behind a Renewable Portfolio Standard (RPS) is to require a larger and larger share of electricity to come from renewable sources. Such a standard would not be needed if renewable technologies were already cheaper.

But the NC-ESEIM assumes that, from 2016 onwards, electricity from renewable sources ("green electricity") will become less expensive than that from conventional fuels **because of the North Carolina renewable portfolio standards**. If the reduction in the cost of green electricity is not due to the renewable portfolio standards, then the effects of such a cost reduction cannot be attributed to the RPS, and any simulation that assumes this would be incorrect – which would imply that the analysis of the effects of the RPS should end in 2016, at which point the program has reached the end of its useful life.

But if the North Carolina RPS causes lower costs for green electricity, how is the mechanism supposed to work? It is not credible that the learning by doing that would take place just in North Carolina would be enough to have a discernible impact on the cost of green electricity there, *relative to an appropriate counterfactual* under which the cost of green electricity might fall anyway. The NC-ESEIM model assumes a learning rate – i.e. a rate at which production costs fall over time – that is constant over time for each type of electricity generation; it appears that the learning rate is permanently higher for renewable energy sources, but it is far from clear why this should be so.

Conclusion

It is not straightforward to analyze the economic impact of state policies that are designed to reduce greenhouse gas emissions. The North Carolina Energy Scenario Economic Impact Model (NC-ESEIM) represents a serious and concerted effort to measure the relevant effects on jobs, incomes, Gross State Product, and energy use.

But the results of the NC-ESEIM model are not compelling, for the reasons we have set out in this note. By using a demand-driven input-output analysis at its core, the model assumes that the state economy has slack capacity; and it lacks an adequate mechanism for energy prices to feed back into measures of real incomes or investment decisions. These could be addressed by developing a computable general equilibrium model in which prices are allowed to adjust, but such models are themselves complex and difficult to construct. The NC-ESEIM also makes unduly optimistic assumptions about the future course of cost reductions in the production of energy from renewable sources, and is too sanguine about the potential for state spending to trigger private investment, and influence individual behavior, in energy conservation.

We are just beginning the great debate about the extent to which, and how, state governments should pursue policies to reduce greenhouse gas emissions. Appropriate formal models to measure the economic impact of such policies will have an important role to play in this process, but it is essential that such models be credible and testable. The NC-ESEIM model falls short of this standard.

References

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