SO, THE WORLD IS GETTING WARMER: WHAT NOW? NEW LITERATURE ON ELECTRIC SECTOR OPTIONS AND THE COST OF CLIMATE CONTROL LEGISLATION

*Jonathan D. Schneider**

While the nation heatedly debated the science behind anthropogenic global warming, quieter work was being done on the range of options available to address the issue and the associated cost. Assuming, as now seems to be the case, that there is a political consensus that warming for which we are responsible is under way, the obviously ensuing questions are what we can do about it, and how much it will cost. These issues are particularly acute for the electric industry, which is responsible for roughly forty-two percent of the nation's CO2 emissions.[1]

Activity in this area has quickened in the last two years, and we now have relatively comprehensive visions of generation alternatives, undertaken by the Electric Power Research Institute (EPRI)[2] and McKinsey & Company (McKinsey).[3] One can draw from this literature a sense of cautious optimism that the technology to address global warming is either available to us or within reach. Yet, the technical challenges are daunting, the cost is substantial, and the economic impact will, in all probability, be distributed unevenly throughout the economy.

With respect to costs, both EPRI and McKinsey have taken a stab at estimating the economic impact of the anticipated change in generation resources. In addition, , a slew of recent studies have been undertaken analyzing the impact on the GDP of the Waxman-Markey bill.[4] Good work synthesizing (and criticizing) the studies has been done recently by the Congressional Research Service, leading to the conclusion that decisions regarding climate control legislation are unlikely to be made on the basis of reliable evidence of its cost.

I. WHAT CAN BE DONE?

With its *Prism/Merge Analyses*, EPRI has meaningfully revised the greenhouse reduction targets initially studied in 2007. In 2007, EPRI's analysis of the electric industry's available options for addressing global warming was

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* Partner, Stinson Morrison Hecker, L.L.C., Washington, D.C. Special thanks to Brett Postal, law clerk, Summer 2009.

1. U.S. ENVIRONMENTAL PROTECTION AGENCY, (EPA), INVENTORY OF U.S. GREENHOUSE EMISSIONS AND SINKS: 1990 – 2007, ES-6. (EPA 2009), available at http://epa.gov/climatechange/emissions/downloads09/InventoryUSGhG1990-2007.pdf.

2. EPRI's initial work in this area, *The Power to Reduce CO2 Emissions; The Full Portfolio,* was first released in the summer of 2007. EPRI's *Prism/Merge Analyses, 2009 Update,* updates this work.

3. *See* MCKINSEY & CO., REDUCING U.S. GREENHOUSE GAS EMISSIONS: HOW MUCH AT WHAT COST (Dec. 2007) [hereinafter, *McKinsey Report*].

4. American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009) [hereinafter, *Waxman-Markey bill*].

aimed at meeting a gross reduction in annual CO2 emissions by the U.S. electric sector of forty-five percent by 2030, relative to estimates in the Energy Information Administration's (EIA's) 2007 *Annual Energy Outlook* (AEO) Base Case. Though the forty-five percent figure seems significant, the EIA Base Case through 2030 showed steadily increasing annual emissions associated with the U.S. electric sector, rising to roughly 3.3 gigatons tons per year, up roughly 1gigaton from 2005 levels. The result was that EPRI's 2007 study targeted a relatively modest reduction in current emission levels. By comparison, the Waxman-Markey bill calls for economy-wide Greenhouse Gas (GHG) reductions of forty-two percent below 2005 levels by 2030, and eighty-three percent below 2005 levels by 2050.[5] Those targets are more in line with the fifty percent reduction in global emissions by 2050 to which the G8 committed at the summit in Helligendamm in 2007, and are consistent with the seventy-six percent global reduction by 2050 targeted in the *Stern Review*.[6]

Clearly, EPRI's 2009 *Prism/Merge Analyses* respond to new political reality and reflect a heightened sense of urgency. Looking ahead to 2030, EPRI's analyses target a forty-one percent reduction in annual CO2 emissions by the U.S. electric sector relative to 2005 levels, and a fifty-eight percent reduction relative to 2005 emissions, if reductions due to electric transportation and electro-technologies are included. EPRI President and CEO Steve Specker's presentation "Creating Our Future: *Meeting the Electricity Challenge"* makes it clear that EPRI's revised approach is designed to address the goals articulated in the Waxman-Markey proposed legislation.[7]

How these goals can be met is obviously the central question. EPRI answers in two ways: with and without a commitment to the development of new processes for (a) carbon capture and sequestration; (b) advanced nuclear reactors; and (c) plug-in electric vehicles. EPRI's analysis makes it plain that the more economical and more efficacious choice will involve our collectively banking on these new technologies, investing in what it refers to as a "Full Portfolio" of options for addressing carbon reduction. EPRI's comparison of our current generation mix and what it believes will be an economically optimal mix is as follows:

5. *Id*.

6. The Stern analysis provides a synthesis of literature identifying a CO2 atmospheric stabilization target of 450 to 500 ppm in order to avert an average increase in global temperatures of more than 2 degrees Celsius, a target that would call for a 70% reduction in current emissions by 2050. NICHOLAS STERN, THE ECONOMICS OF CLIMATE CHANGE (The Stern Review 2006).

7. Steven Specker, Creating Our Future: Meeting the Electricity Technology Challenge, 2009 Summer Seminar, EPRI (Aug. 3-4, 2009), at 4, *available at* www.mydocs.epri.com/docs/SummerSeminar09/Specker09SumSem.pdf [hereinafter, *Specker Seminar*].

EPRI's Full Portfolio Analysis

Resource	2009[8]	2030 (Full Portfolio)
Coal	53%	28%
Coal CCS[9]	0%	10%
Petroleum	1%	0%
Natural Gas	15%	11%
Gas CCS[10]	0%	2%
Nuclear	21%	28%
Hydro	7%	6%
Renewables	4%	15%

If investment is not made in new nuclear technology and construction, and in carbon control and sequestration (in what is referred to as the "Limited Portfolio" scenario) EPRI's vision of what will be required to meet the forty-one percent abatement target is dramatically different, and calls for: (1) the elimination of coal as a generating resource; and (2) the expansion of natural gas to fifty percent of the nation's generating resource base. EPRI estimates that the average cost of electricity under its optimal scenario will increase by fifty percent by 2030 to accomplish national objectives, and by ninety percent in the Limited Portfolio scenario.

EPRI's Full Portfolio approach is substantially similar to the approach identified in the McKinsey Report for its mid-range of abatement potential by 2030. McKinsey's mid-range economy-wide abatement vision specifies abatement of 3 gigatons of carbon annually (economy-wide), on an anticipated base case for 2030 of 9.7 gigatons annually.[11] McKinsey's generation mix, placed alongside EPRI's is as follows:

Resource	McKinsey 2030	EPRI Full Portfolio 2030
Coal	33%	28%
Coal CCS[12]	9%	10%
Natural Gas	9%	13% (with and without CCS)
Nuclear	24%	28%
Renewables	23%	21% (including hydro)
Other[13]	2%	

8. Drawn from Energy Information Administration. EIA, ANNUAL ENERGY OUTLOOK 2009 REFERENCE CASE (2009), *available at* http://www.eia.doe.gov/oiaf/servicerpt/stimulus/index.html.

9. Coal with carbon capture and sequestration technology (CCS).

10. Natural Gas with carbon capture and sequestration technology.

11. *See McKinsey Report*, *supra* note 4, at 7, 17.

12. Coal with carbon capture and sequestration technology.

13. Includes geothermal, waste, and pumped storage.

Looking ahead to 2050 (the targeted horizon for the Waxman-Markey legislation), EPRI's prognostication regarding the electric sector's response is less definitive, though the general anticipated direction is clear. If advanced nuclear power (and new construction) and CCS remain unavailable (the Limited Portfolio), EPRI sees:

- No place for coal-fired generation;
- Reliance on natural gas resources for roughly 30% of the nation's generating capacity;
- Increasing reliance on solar energy and biomass (presumably in the Southeastern U.S.);
- Increasing reliance on demand reduction techniques to reduce total consumption by roughly 20% below levels that would enable the nation to meet emission targets under the Full Portfolio approach to meeting the Waxman-Markey targets.

Under the Limited Portfolio approach, EPRI estimates an average increase in electric rates of rates of 170% (2007 dollars) vis-à-vis the reference case for that year (no emissions targets) , while the increase is projected to be 80% under the Full Portfolio setting.[14]

The EPRI and McKinsey analyses have profound policy implications. One is that we have an enormous stake riding on the successful development and implementation of carbon sequestration techniques. EPRI's analysis makes it clear that if the Waxman-Markey targets are to be met, our ability to use coal as a generating resource to any extent after 2030 depends on our ability to implement CCS technology. It is worth emphasizing that being able to rely on coal on an ongoing basis for electric generation presents enormous advantages, if it can be squared with environmental objectives. Principal among coal's selling points is that it is a resource we control, and a key piece of such energy independence as we have. This is particularly important to the extent the transportation sector is converted from its reliance on petroleum to electricity. That transformation presents an enormous opportunity to strike a blow for energy independence and carbon reduction, but the incremental demand clearly underscores the need for the use of all available resources. As well, the ability to use coal as part of our generation mix will substantially ease the potentially disparate geographic impact of climate control legislation when one considers areas not blessed with substantial wind or solar resources.

It bears pointing out that effective, large-scale CCS implementation appears to be a realistic aspiration, but it is clearly not a done deal. In a report issued June 19, 2009, the Congressional Research Service observed that while the technology exists for capture and removal of eighty to ninety-five percent of CO2 from point sources, it is untested on larger generating stations and costly. Moreover, better processes are in the research phase, and the challenges posed by the transportation and sequestration of the gas have not yet been met.[15] On the uncertainty regarding transportation and storage, the report concludes: "A large pipeline infrastructure for transporting CO2 could be very costly, however, and considerable uncertainty remains over how large quantities of injected CO2

14. Relative to 2007 costs, in constant dollars, EPRI's Steve Specker indicates that the average cost of electricity under the Limited Portfolio would increase 210%. Specker Seminar, *id.*, p. 21.

15. PETER FOLGER, CRS REPORT FOR CONGRESS: CARBON CAPTURE AND SEQUESTRATION (CCS), (Cong. Research Serv., June 19, 2009) [hereinafter, *CRS on CCS*].

would be permanently stored underground. To help resolve these uncertainties, DOE has initiated large-scale CO2 injection tests in a variety of geologic reservoirs that are to take place over the next several years."[16]

With respect to carbon capture, CRS reports that meaningful work is underway, but substantially more must be done if the technology is to be commercially viable. CRS indicates that the technology in the most advanced stage of development (post-combustion capture) is also the most expensive, and would add sixty to seventy percent to the cost of electric generation, even before transportation and sequestration are considered.[17] Moreover, the technology has yet to be applied to larger generating stations.[18]

The EPRI and McKinsey analyses also underscore the importance of a hard-headed debate over the future of the nuclear industry. Like coal-fired generation, nuclear power offers support for energy independence, and is available in parts of the country bereft of substantial wind and solar resources. Without a doubt, the environmental community in the United States has not generally reconciled itself to a nuclear future for the electric industry. But, the key question is whether nuclear energy may ultimately be seen to be the lesser of environmental evils, a conclusion to which the EPRI and McKinsey studies certainly seem to point.

Finally, the EPRI and McKinsey studies counsel strongly for viewing climate strategy as a multifaceted effort, presenting a problem for which there is no single magic bullet. Given the attention devoted to wind resources, it would probably surprise the general public to know, for example, that EPRI and McKinsey both target the resource to satisfy only fifteen percent of energy needs in 2030, while the American Wind Energy Association itself is pressing for not more than twenty percent penetration by that time frame. This resource is critical, but it is not a panacea.

II. WHAT WILL IT COST?

The questions what carbon abatement will cost, and what impact that cost will have on the U.S. economy have triggered vigorous debate, and no conclusive answers. In figures that are provided without the benefit of supporting analysis, EPRI estimates that the total cost per U.S. household, of CO2 emissions constraints between now and 2050 will be $16,300, on a cumulative net present value basis (in 2000 value), if the Full Portfolio approach is employed. That cost escalates to $28,400, if the Limited Portfolio is used.

The McKinsey Report estimated that through 2030 (and adjusting for efficiency-inducing investments that pay for themselves) the cost of net new investment would be $1.1 trillion. Putting that figure in perspective, McKinsey comments that it comprises roughly 1.5% of the total $77 trillion in investment

16. *Id.* at 1.

17. *Id.* at. 5 – 7, 17 – 18. CRS cites MASS. INST. OF TECH., THE FUTURE OF COAL: AN INTERDISCIPLINARY MIT STUDY (2007) for cost estimates, noting that the cost of retrofitting such stations could increase the cost of generation by 220 – 250%.

18. How the cost of CCS might be distributed has been given little consideration. Section 114 of the Waxman-Markey bill would authorize the creation of a Carbon Storage Research Corporation, chartered to establish and administer a program to accelerate the commercial availability of CO2 capture and storage. The legislation would authorize the corporation to levy an assessment on distribution utilities for all fossil fuel-based electricity delivery to retail customers.

anticipated in the U.S. economy over this period.[19] This net figure reflects the additional capital required to generate "clean" megawatts, over what was required before abatement requirements, and is therefore presented as a loss to economic productivity.[20]

What these figures really mean to us with respect to the net impact on total Gross Domestic Product between now and 2050 is exceedingly difficult to say. This is made abundantly clear in a comprehensive review by the Congressional Research Service (CRS), published September 14, 2009, of a slew of recent studies of the economic impact of the Waxman-Markey bill.[21] The studies reviewed by CRS, and the projected negative impact on GDP per capita, as reported by CRS, are as follows:[22]

Study	**Projected GDP Impact**
Environmental Protection Agency[23]	Over (-) 1.2% by 2050
Energy Information Administration[24]	Up to (-) .8% by 2030
National Black Chamber of Commerce[25]	Up to (-) 1.5% by 2050
Heritage Foundation[26]	Up to (-) 2.7% by 2030
American Council for Capital Formation/ National Association of Manufacturers[27]	Up to (-) 1.7% by 2030
Massachusetts Institute of Technology[28]	Up to (-) 1.8% by 2050[29]

The CRS Report makes a most persuasive case that relying on any of these figures, and trying to compare them, is a dicey matter. The reasons are:

- The estimated GDP impacts over the studied period are vastly overshadowed by GDP growth during this period. All studies presume that GDP will roughly double during this period, but varying assumptions regarding the exact growth rate exceed the difference between the affect of Waxman-Markey exhibited in the studies.

19. *McKinsey Report*, *supra* note 4, at xiii.

20. MCKINSEY & CO., THE CARBON PRODUCTIVITY CHALLENGE: CURBING CLIMATE CHANGE AND SUSTAINING ECONOMIC GROWTH 17 (June, 2008).

21. LARRY PARKER & BRENT YACOBUCCI, CLIMATE CHANGE: COSTS AND BENEFITS OF THE CAP-AND-TRADE PROVISIONS OF H.R. 2454 [hereinafter, *CRS Report*].

22. *Id*. at 37, at fig. 8.

23. U.S. ENV'T. PROT. AGENCY, EPA ANALYSIS OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009; H.R. 2454 IN THE 111TH CONGRESS (June 23, 2009).

24. ENERGY INFO. AGENCY, ENERGY MARKET AND ECONOMIC IMPACTS OF H.R. 2454, THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009 (August 4, 2009).

25. CHARLES RIVER ASSOC., IMPACT OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009 (H.R. 2454) (May 2009).

26. DAVID KREUTZER, KAREN CAMPBELL, WILLIAM BEACH, ET. AL., THE ECONOMIC CONSEQUENCES OF WAXMAN-MARKEY; AN ANALYSIS OF THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009 (August 5, 2009).

27. AMERICAN COUNCIL FOR CAPITAL FORMATION, NATIONAL ASSOCIATION OF MANUFACTURERS, ANALYSIS OF THE WAXMAN-MARKEY BILL "THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009" (H.R. 2454) USING THE NATIONAL ENERGY MODELING SYSTEM (NEMS 2009).

28. SERGEY PALTSEV, ET AL., THE COST OF CLIMATE POLICY IN THE UNITED STATES, MIT Joint Program on the Science and Policy of Global Change, Report No. 173, Appendix C: Analysis of the Waxman-Markey American Clean Energy and Security Act of 2009 (H.R. 2454) (2009).

29. Figures are approximated based on the CRS graphic representation at Figure 10 (p. 8) of the report.

- The studies do not control for varying assumptions regarding generation alternatives to meet carbon controls, and the cost and efficacy of available technology.
- The studies do not separate abatement cost from GDP impact.
- Technological advances in efficiency in energy consumption and production are unpredictable over this period, and may overshadow the negative impact of carbon control.[30]

Finally, the CRS report notes that none of the studies purport to place a value on measures that effectively address climate change. To put it another way, the studies place no value on averting the cost of grappling with uncontrolled climate change. If one has confidence in the science supporting the theory of anthropogenic global warming, and in our ability to avert potentially catastrophic increases in global temperature, the economic (not to mention the human) impact of doing so may very well dwarf the GDP discussion framed in these analyses.

III. WHAT NOW?

The EPRI and McKinsey studies provide cogent templates for the direction the electric industry must take if Waxman-Markey or some similar legislation is passed. It seems fairly plain that using a "Full Portfolio" of available technology, and technology still under development but within reach, is essential. The studies emphasize how critical it is for the nation to commit itself to a crash program for developing and implementing CCS technology. The dramatically higher cost of retrofitting facilities[31] makes it clear that there is no time to waste in this area.

With respect to the cost of this exercise, the CRS Report calls into serious question whether reliable data is within our grasp. The Report's observation that GDP growth substantially overshadows all estimates of compliance costs provides some comfort that the economy is large enough to absorb this task.

30. This summer's estimate by the Potential Gas Committee apparently showing dramatic increases in natural gas reserves as a result of new technology for extracting gas from shale is a potential case in point. *See:* http://www.nytimes.com/2009/06/18/business/energy-environment/18gas.html. Other candidates for technological breakthroughs include new solar technologies, electric storage techniques and advanced biofuels.

31. *See supra*, note 17.