

FOIA MARKER

**This is not a textual record. This is used as an
administrative marker by the William J. Clinton
Presidential Library Staff.**

Collection/Record Group: Clinton Presidential Records
Subgroup/Office of Origin: Council of Economic Advisers
Series/Staff Member: Michele Jolin
Subseries:

OA/ID Number: 23919
FolderID:

Folder Title:
Partial Staff Only Review Docs - [Climate Change] [3]

Stack:	Row:	Section:	Shelf:	Position:
S	21	1	11	2

Review of DOE Labs Study

Unspecified Policies:

- *No Program Descriptions:* The authors do not estimate the costs or even describe the programs necessary to stimulate the adoption of the new energy-efficient technology they find could reduce emissions of approximately 200 million metric tons of carbon equivalent (MMTCE) by 2010. These reductions correspond to about ½ of the reductions needed to attain 1990 levels by 2010. In the absence of cost estimates this information is of little use in the evaluation of alternative policy options.
- *Costs of Programs:* Given reasonable assumptions, government programs may cost many tens of billions of dollars per year above the costs of existing programs to reduce 200+ million tons of carbon. The marginal cost of emissions reductions, including the cost of the government program, is likely to greatly exceed the permit price. As a result these programs may be less cost-effective than a cap-and-trade emissions control program.
- *Luck:* The transportation sector requires “luck” in terms of technological innovation to achieve the projected emissions reductions. Without a permit price, this luck appears likely only through stringent standards, such as increasing CAFE.

Overestimates Reductions/Underestimates Costs:

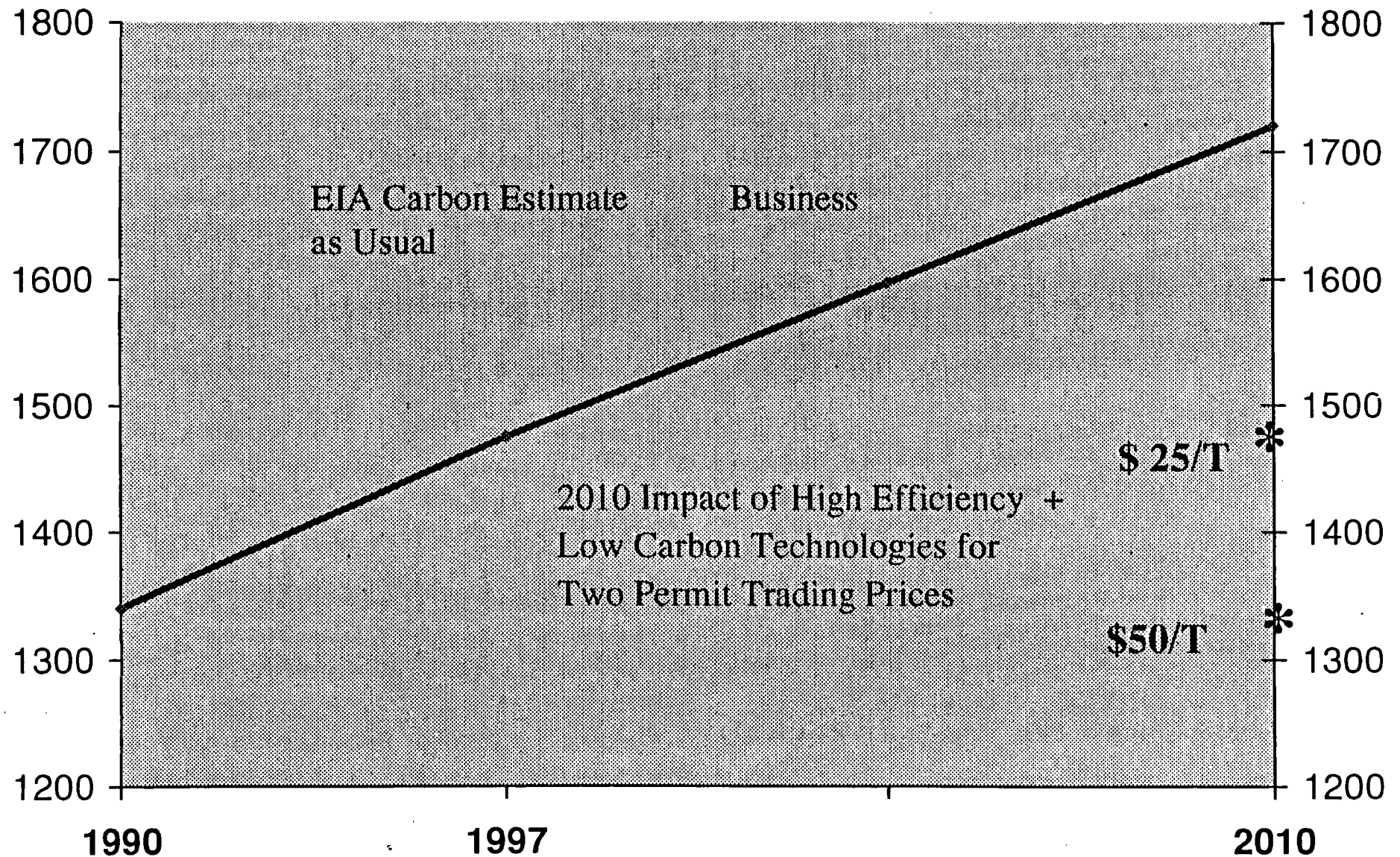
- *Behavioral Changes Ignored:* The analysis appears to ignore the behavioral changes that offset the energy efficiencies promised by the new technologies. For example, more efficient windows lead to houses with more glass, and more efficient cars lead to more vehicle miles traveled. Thus these innovations offer real value to consumers, but smaller energy savings than engineers forecast.
- *Cost Effectiveness Calculated Using Average, Not Marginal Prices:* Many of the innovations in electrical use appear to be assumed to be cost effective based on an assumption of average, not marginal electricity prices. The marginal prices may be half as much as the average prices.
- *Price Declines Resulting from Reductions in Energy Demand Are Not Taken into Account:* The study assumes a 12% decrease in energy use, but does not account for this effect on price when calculating cost effectiveness for energy efficient technologies.
- *Study Double Counts Emissions Reductions Occurring Under Business-As-Usual:* The labs study double counts 22 MMTCE in reductions in the efficiency case that will occur under the business-as-usual case.
- *Interactions Ignored, Double Counting “Likely” in Utilities Sector Analysis:* The double counting of dispatching and retooling coal plants to natural gas results in about 9 MMTCE of overestimated reductions.
- *Industry Sector Analysis Ignores the Costs of Accelerating Retirement.*

The Five Lab Study

- Five National Labs Assess Potential of Energy Technologies to Reduce Carbon Emissions
 - LABS: Lawrence Berkeley, Oak Ridge, Argonne, Renewable Energy, Pacific Northwest
 - Externally Peer Reviewed: U.Tenn, Monsanto, EPRI, GRI, Harvard, NAS, Stanford (Huntington), UNC (Link), and UCSB (DeCanio)
- Assumes
 - Expanded Technology Strategy (R&D and Diffusion)
 - Carbon Dioxide has a price and is traded

Lab Study Results

US Carbon Emissions in MMTCE



Low-Carbon Technologies

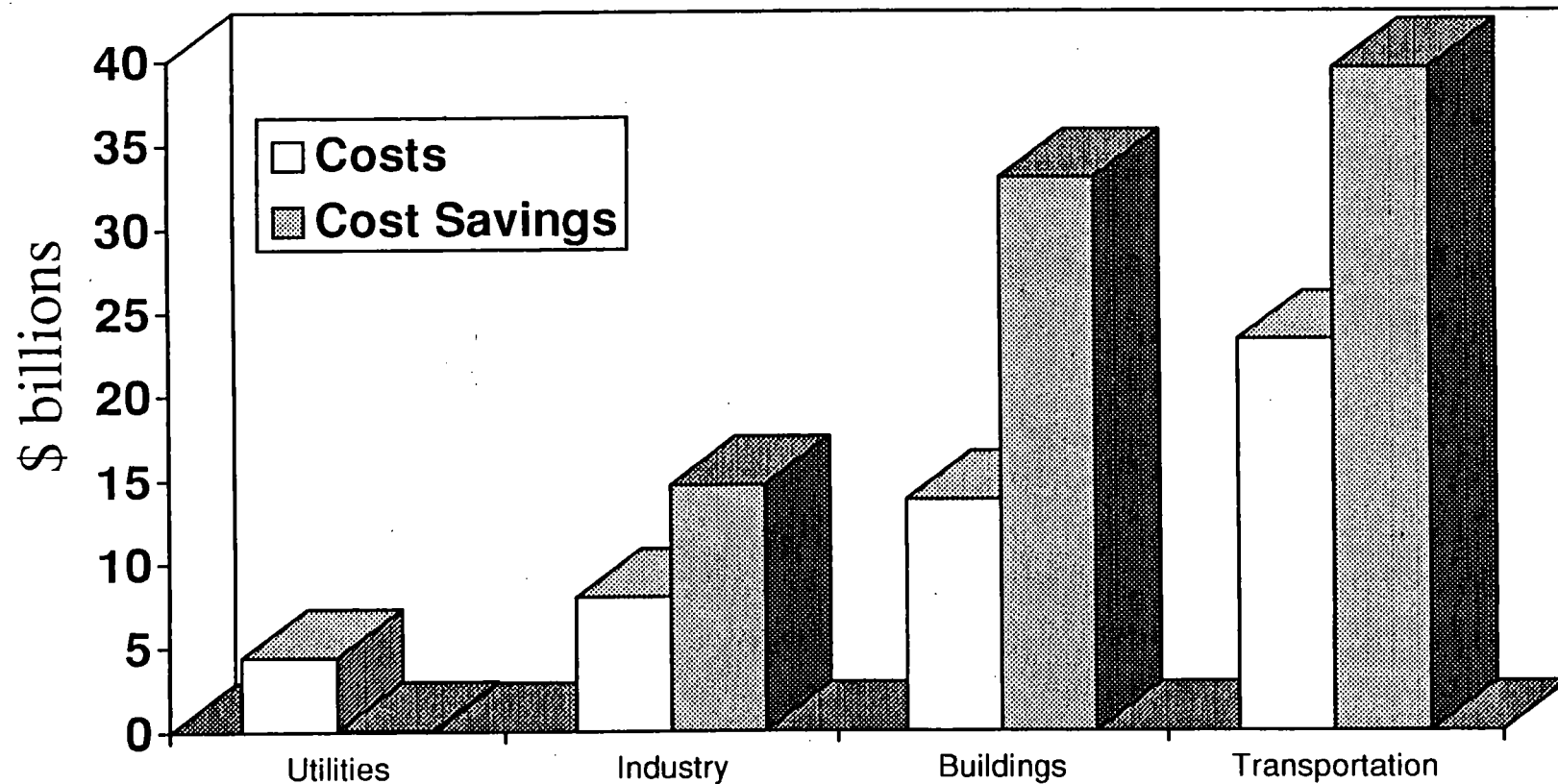
Technology	Cost to Generate *cents/kWh	Incremental Cost \$/ton Carbon	Carbon Reduction Potential (MMT)
• Utilities			
– Carbon Dispatch	--	\$30	55
– Gas Repowering	2.5 - 3.2	\$30	40 (24-83+)
– Biomass co-firing	2.7 - 3.2	\$38	17 (16-24+)
– Wind	2.5 - 3.5	\$42	7 (6-20+)
– Other	--	\$25	9 (7-12)
• Industry			
– Advanced Turbine	2.5 - 3.5	\$40	17 (15-26)
– Industry Specific	--	\$40	14 (13-16)
• Buildings			
– Fuel Cell	5.0 - 6.0	\$30	3
• Transportation			
– Non-corn Ethanol	--	--	16
Total (rounded)			180 (160-250)

*Average costs as of 2005

Energy Efficient Technologies

Technology	Carbon Reduction Potential (MMT)
- Utilities – Generation Efficiency - Industry – R&D and Diffusion - Buildings – Standards and Diffusion - Transportation – Passenger Cars – Light Trucks – Heavy Trucks – Aircraft	8 51 59 28 28 14 14 200 (7-13)
Total (rounded)	200

Business and Consumer Annual Costs and Cost Savings in 2010



FAX

5 tabs

Date: August 12, 1997Number of pages including cover sheet: 1 letter
add
From

	Name	FAX Number	Phone Number
To:	Jeff Frankel	395-6947	
	Jay Shogren	395-	
From:	David Wilcox	202-622-2633	2-2200

REMARKS: ☐ Urgent ☐ For your review ☐ Reply ASAP ☐ Please comment

Attached are partial comments. Having an advance look may be useful.

AUG-11-1997 14:11

CEA

P.002/011

Wilcox

MEMORANDUM

TO: Jay Shogren

FROM: Joe Aldy and Quindi Franco

DATE: August 11, 1997

RE: Review of DOE Labs Study, June 10 Draft

We provide an assessment of *U.S. Carbon Reductions by 2010 and Beyond: The Potential Impact of Energy-Efficient and Low-Carbon Technologies* (DOE Labs Study, June 10 draft). The report identifies carbon reductions and their associated costs in the buildings, industry, transportation, and electric power sectors under two hypothetical climate policy scenarios. The study finds that, with unspecified "very aggressive policies" and a \$50/ton permit price, carbon emissions can be stabilized at 1990 levels by 2010. ~~In reviewing the report, we believe it is beneficial to highlight several limitations of the study.~~ ^{should be highlighted} First, the authors do not ~~provide~~ ^{describe} descriptions of the government programs ~~necessary to stimulate the necessary technology adoption to reduce emissions of 180 million metric tons of carbon equivalent (MMTCE).~~ Based on the actual history of CCAP, we estimate the costs of government programs to achieve these reductions could total \$45 billion (1995\$), depending on the form of the marginal cost curve. We annuitized this figure and found that government programs could cost \$1.1 billion annually into perpetuity. These are costs in addition to existing program costs to improve energy efficiency technology development and adoption. Second, the analyses across sectors are not integrated. Therefore, the penetration rate of energy efficient technologies may be overestimated because the separate sectoral analyses do not account for declines in fuel prices. Third, the industry sector analysis ignores the costs of accelerating capital retirement, ~~resulting in either an overestimate of reductions or an underestimate of costs.~~ Fourth, the transportation sector requires "luck" in terms of technological innovation to achieve the projected emissions reductions. Fifth, the utilities sector analysis resulted in double counting of emissions reductions. ~~These examples of the qualifications can provide additional insight into the projections of emissions reductions and costs.~~ Upon receiving the final version of the report and documentation of the analyses, we will update this review.

Overview of Report

The Labs Study estimated the carbon emissions reduction opportunities available through technology development and adoption and fuel switching. The Study employs the Energy Information Administration's 1997 baseline (AEO97) for the buildings and industry sectors. For the transportation sector, the authors changed the AEO97 assumption of increasing fuel efficiency in automobiles to constant fuel efficiency. For the utility sector, the baseline was modified to reflect a fully competitive bulk-power market in the year 2010. Discharge.

Doesn't the analysis also ignore implementation costs?

I find this extremely small
(yes)

shutdown, repowering, and new construction decisions were optimized to select the amount of capacity that minimized the cost of the power-supply system, plus the cost of unserved energy. Compared to AEO97, the final baseline has slightly lower energy prices, larger electricity sales, and a greater share of gas generation. The study provides emissions reductions from this baseline for two scenarios: 1) "efficiency" and 2) "high efficiency/low carbon" over the period 1998-2010. The study describes neither the policies necessary to achieve emissions reductions nor the costs of federal programs for these scenarios, only their outcomes: increased adoption rates and better technologies.

Efficiency Scenario

This case assumes that all technologies adopted are at zero or negative net cost to the user given more aggressive federal policies to stimulate development and diffusion of energy efficient technologies. The Study estimates that 120 MMTCE will be reduced at negative net cost in this scenario. None of these reductions occur in the utility sector as a function of fuel switching or technology adoption to increase combustion efficiency.

With more electricity and more gas generation and more gasoline consumption, aren't we consuming a lot more energy in the baseline? Does this make sense with lower prices?

High Efficiency/Low Carbon Scenario

This case assumes a "greater commitment" to reduce emissions through federal policies, in concert with state and private activities and a \$50/ton permit price that stimulates low carbon technologies (read: primarily fuel switching). The policy is announced in 2000 and the policy's restrictions are phased-in through 2010. There is an assumed announcement effect (although an ARE is not specified), increased domestic and international R&D in low-carbon technologies, and a "change in psychology". The Study estimates reductions of 180 MMTCE from the baseline through energy efficient technology adoption at negative net cost (see high efficiency without low carbon technology in chart below). The carbon permits will yield an additional 150-200 MMTCE of reductions through low-carbon technology adoption. Given that these occur at a permit price of \$50/ton, the Study estimates the upper limits of these costs to be \$10 billion per year in 2010.

Carbon Emissions (MMTCE): 1990 - 2010

1990	2010 Baseline	2010 Efficiency	2010 High Efficiency (w/o Low Carbon Tech)	2010 High Efficiency/Low Carbon
1340	1720	1600	1540	1340 - 1390

Review

The Lab Study employs several important assumptions in the analyses. Learning about these qualifications can enhance one's understanding of the estimates regarding cost-effectiveness and

discuss
~~emissions reductions in this study. We present several of the most significant assumptions and discussions of their impact below.~~

The Study Does Not Specify Policies to Achieve Carbon Reductions

"Cost effectiveness is improved because R&D, in combination with increased deployment efforts, result in declining capital costs. We do not specify the policies, economic conditions, or exogenous events that could precipitate such changes" (p. 1.4).

The entire study is premised on two sets of undefined policies: an "aggressive" or "invigorated" public sector effort to stimulate energy efficient technology adoption (efficiency case) and a "very aggressive" public sector effort to stimulate technology development and adoption (high efficiency/low carbon case). The only specific policy instrument mentioned in the report is a \$50/ton tradeable permit. The study ~~makes vague references to policies and only provides details~~ *merely asserts that* these unidentified policies would result in: 1) "better technology" (p. 1.5); 2) "higher penetration rates" (p. 1.6); 3) "changing the capital recovery factor [in industry sector] from 33% to 15%" (p. 4.8); and 4) "technological breakthroughs" (p. 5.3). These policy effects would result in reductions of 180 MMTCE for "free": firms and individuals receive energy cost-savings in excess of technology adoption and implementation costs.

I thought these were ignored?
The report specifically states that the efficiency case reduces, but does not eliminate, market barriers (p. x), and that implementation costs are ignored (p. xvi). ~~First, we will discuss the implications of reducing market barriers, and then we will address the cost issue.~~ "Market barriers" can occur in well-functioning, but occasionally complex, private markets. Information is fully transmitted among all those in the market, although some information may seem incomplete to non-participants (read: policy or market analysts). A person addresses all real costs, but these costs can go undetected by analysts, hence the term "hidden costs". For market barriers, private costs match social costs, and resource allocation is efficient. Policy intervention to eliminate a market barrier cannot make society better off and usually makes society worse off, regardless of the implementation mechanism.¹

may help
The economics literature has identified several barriers that explain the slow rate of technology adoption: 1) qualitative attributes differ across technologies; 2) private attributes of information; 3) private discount rate diverges from social rate; and 4) heterogeneous usage levels.

Incident • *Energy efficiency is not the only thing that matters to consumers.*
~~Qualitative attributes of technologies can affect adoption. Consumers of technology prefer technologies because of a set of characteristics, not just energy efficiency.~~ For example, some technology consumers may purchase a product with a lower efficiency than another product because the former is more reliable than the efficiency-superior product.

¹ In contrast, policy intervention to eliminate a market failure (such as carbon emissions) may make society better off, depending on the costs of the intervention.

- New technologies may be costly to integrate with existing ones. Until private attributes of information include the tasks of learning how a new technology works with one's existing suite of technologies and identifying technology suppliers. Transaction costs exist with these tasks. If opportunities for economic gains in supplying this information exist, one would expect arbitrage to occur where middlemen consultants would assess the needs of potential adopters and match them with the appropriate suppliers. ^{all components of a complex system are fully depreciated} it may make sense to replace an energy-inefficient component with another likewise-inefficient component.

(No) The social discount rates to evaluate new technologies may not fully capture the uncertainty and risks faced by individuals and firms. These private actors may use a much higher discount rate reflecting the uncertainty of future energy prices, the reliability of the technology, the irreversibility of a technology investment, and the constraints on their ability to borrow capital.

If investment is irreversible, social = private, doesn't it?

Heterogeneous use of energy-intensive technology can affect who benefits from efficiency investments and who does not. ^{just because} If a technology is cost-effective on average, it does not mean that it is cost-effective for individuals who do not use much energy. ^{all} Those who may use the device less intensively may find it optimal to purchase a less efficient model.

These four types of market barriers illustrate the economic behavior that explains the apparent under-adoption of energy efficiency technology (the "efficiency gap"). These barriers clearly demonstrate the difference between the technological maximum adoption (which only assumes technology costs) and the economic maximum adoption (which assumes total costs). A set of climate change policies to stimulate technology adoption could increase efficiency, but only because they also decrease the effect of a market failure (carbon emissions). Social welfare is improved because the net benefits of indirectly fixing the market failure exceed the costs of removing the barriers. If carbon emissions are appropriately priced (assuming in this case that \$50/ton is the correct carbon price), a policy to remove a barrier (e.g., lower the capital recovery factor from 33% to 15%), will generate negative net benefits. High adoption rates will be realized once prices rise enough for some technologies to clear the barriers.

Could more some of this to previous page.

From the literature on market barriers, we know that the costs of reducing barriers are greater than their benefits. In this case, the authors of the Labs Study do not provide an estimate of the costs to government to ^{of lowering} lower market barriers to achieve these substantial reductions (and they only provide benefits in terms of projected emissions reductions). We ~~calculated~~ ^{estimated} the costs of emissions reduction programs based on the government's experience with the Climate Change Action Plan (CCAP). CCAP promotes carbon reductions through a broad array of voluntary programs that stimulate "cost-effective" technology adoption by private firms.

^{reducing emissions} Participation by a firm in a CCAP program implies that carbon is reduced and the firm gains financially. CCAP received appropriations totaling \$494 million (1995\$) during the FY95-FY97 period. During this period, the Department of Energy and the Environmental Protection Agency can account for reductions of 14 MMTCE (see attached table). Each ton of carbon reduced in CCAP cost the federal government, on average, \$35.29 (1995\$) over this three year period. Assuming a flat marginal cost curve (MC = AC of CCAP), to reduce 180 MMTCE beyond the baseline, the government costs of the unidentified policies in the Labs Study would

² Note that CCAP efforts are incorporated in the AEO97 baseline.

I think stocks & flows are confused here.

Need footnote questioning why any govt action is required to attain truly "cost effective" reductions.

attaining the 180 MMTCE reduction per year

^A exceed \$6.3 billion. To account for the opportunity cost of capital through time, we annualized this value and found that government costs would run about \$150 million annually into perpetuity. ~~However,~~ ^{It is as if almost surely the case} the marginal costs of technology adoption in the efficiency and high efficiency/low carbon scenarios are ~~definitely~~ ^{definitely} higher than the average cost of 14 million metric tons reduced in the baseline scenario, ~~especially as more and more efforts to reduce emissions are undertaken.~~ ^{aggregant costs could be much higher.} Assuming that costs increase 10% for every 10 million metric tons of carbon reduced, then the government cost would total \$16.1 billion (~~annuity of \$375 million~~ ^{per year}). This is a slowly increasing marginal cost curve given baseline assumptions of gains in energy efficiency. Assuming that costs increase 20% for every 10 million metric tons of carbon reduced, then the cost to government would exceed \$45.2 billion (~~annuity of \$1.1 billion~~). (see attached chart).

The Sectoral Analyses Are Not Integrated

"The model runs for each of the three end-use sectors were not integrated and therefore may overstate the effects of technology penetration. In an integrated modeling effort, fuel prices might fall as consumption declines, resulting in less penetration of energy-conserving technologies" (p. 1.1).

The analyses of the various sectors assume that the reduction of 180 MMTCE occurs through energy efficient technology adoption without any price effect. This implies that, with government programs, private agents will adopt technologies because the benefits (energy cost-savings) exceed the costs of adoption. The authors claim that these reductions occur at zero or negative net costs. By failing to account for the effect of decreased energy demand due to energy efficiency technology adoption, some of those adoption decisions that occur on the margin would no longer generate positive net benefits for private consumers. The Labs Study indicates that energy consumption will decline from the baseline by 11.6% under the high efficiency/low carbon case (p. xi). This decrease in demand should result in a decrease in the price of energy, and cause some energy efficient technologies to become unattractive to private agents.

In addition, the absence of an integrated analysis precludes an assessment of the economy-wide effects of a tradeable permit system. As previous studies have indicated, the nature of the permit allocation (e.g., grandfathering, auction, or a hybrid) and the characteristics of the revenue recycling (e.g., various adjustments to existing taxes) can affect economy-wide investment. Understanding the effects on investment is instrumental in assessing the likelihood of success of these scenarios, given that they rely on substantial R&D and technology adoption.

The Industry Sector Analysis Ignores the Costs of Accelerated Retirement

"When the economic losses of accelerated retirement are accounted for this means that, at the margin, all investments are not likely to be cost effective at our assumed 15% CRF [capital recovery factor]. Since we do not have a model to

¹ We employed a 7% discount rate to calculate the annuities in this paper.

account for this potential early retirement and the economic losses, we must caveat our estimates of investment and net costs. ...the investment cost may be understated by the amount of loss due to any early retirement that may occur" (p. 4.15).

This assumption implies that one of three results should be accounted for in the analysis. First, the projected emissions reduction should be revised downward, because the assessment of the industry sector overestimates technology adoption by ignoring these costs. Second, the cost of reducing emissions, if the reduced carbon from this sector remains constant, should increase, with some technology adoption decisions occurring at positive net costs. Third, if the authors maintain the same costs and emissions estimates, then the costs of government programs to somehow force down the CRF from 33% to 15% would increase.

The Transportation Sector Requires "Luck" to Achieve Carbon Reductions

"[B]ecause the [transportation sector] outcomes postulated in the high efficiency/low carbon scenario require technological breakthroughs, they require a certain degree of luck to be achieved by 2010. There are no credible methods to accurately gauge the probability of such breakthroughs — we believe they stand a decent chance of occurring with an intensification of research efforts, but we stop short of claiming they are a likely outcome of such an intensification" (p. 5.3).

Note that this statement includes two qualifications: luck on top of intensified research efforts. To achieve just the efficiency level of emissions reductions for this sector (73 MMTCE), these intensified research efforts may require two to ten times existing funding on transportation (p. 5.3). To gain a sense of the magnitude of what such an increase in funding might be, consider that the Partnership for a New Generation of Vehicles (PNGV) alone is funded at the federal level at \$263 million. Private sector costs of participating in the PNGV are in addition to this large sum. Further, the estimates of costless (on net) carbon reductions relies on a series of tenuous assumptions: commercial development of the fuel cell for passenger cars, commercial availability of cellulosic ethanol (and the elimination of the ethanol excise tax exemption), and an apparently arbitrary 30% reduction in costs for "certain key technologies" (p. 5.24). These technologies are not identified, and the report does not provide documentation for the NEMS model runs conducted for the transportation sector.

Interactions Ignored, Double Counting "Likely" in Utilities Sector Analysis

"Chapter 7 considers other electricity supply technology options, including: converting coal-based power plants to natural gas; cofiring coal with biomass; efficiency improvements in generation and transmission and distribution systems; extending the life of existing nuclear plants; increasing generation and capacity of existing hydropower plants; and constructing new powerplants using advanced coal technologies. Each of these options is assessed independently. Thus,

interactions between the options are not taken into account, and the possibility of double counting is therefore likely" (p. 7.1).

The emissions reductions in the electricity sector come from two sources. First, utilities undertake fuel switching at the \$50/ton permit price through carbon-ordered dispatching. Second, utilities modify their capital stock through several technology options such as those listed in the above quotation. As electricity production moves away from coal in the first analysis, fewer and fewer plants (and therefore potential emissions reductions) will be available for conversion to natural gas or cofiring with biomass. The second set of analyses were "static" and did not optimize unit/plant production cost, dispatch, or system load. Conversations with one of the co-authors (Stanley Hadley of Oak Ridge National Laboratory) indicate that 10 GW of coal-to-gas conversions (approximately 9 million tons of carbon reductions) were double-counted.⁴

Furthermore, the analysis of specific options did not examine the effect of increasing fuel prices (from gas demand due to coal-to-gas repowering). Given the range of assumptions considered in the study, the authors actually estimated that repowering coal plants for natural gas could result in carbon reductions between 5 million and 269 million tons (p. 7.2), depending on the gas/coal price differential, the cost of carbon, and the costs of sulfur dioxide and nitrous oxide emissions. This is quite a substantial range. The Labs Study estimates that natural gas consumption will increase 14% to 191% above 2010 baseline consumption. However, the DRI 1.25 run in the IAT report indicates a 16% decline in natural gas consumption, while the SGM run resulted in only a negligible decline and Markal-Macro generated a 6% increase in natural gas consumption. These three models indicate that a non-integrated analysis that does not account for the price change in natural gas may overestimate natural gas substitution for coal and emissions reductions from fuel switching.

⁴ Hadley noted that a subsequent draft of the report should address at least some of the double counting, but he did not provide details.

Summary of Greenhouse Gas Emissions-Reduction Actions

Million Metric Tons of Carbon Equivalent

Source: U.S. Climate Action Report—1997

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
Residential & Commercial Sector Actions		26.9	10.3	--
New	Rebuild America	2.0	1.6	--
1 and 2	Expanded Green Lights and Energy Star Buildings	3.6	3.3	--
3	State Revolving Fund for Public Buildings	1.1	Terminated	
4	Cost-Shared Demonstrations of Emerging Technologies	3.8	0.0	--
5	Operation and Maintenance Training for Commercial Building Facility Managers and Operators			
6	Energy Star Products	5.0	4.3	--
7	Residential Appliance Standards	6.8	0.2	--
8 and 11	Energy Partnerships for Affordable Housing	4.4	0.4	--
9	Cool Communities			
10	Update State Building Codes			
New	Construction of Energy-Efficient Commercial and Industrial Buildings		0.1	--
New	Superwindow Collaborative		0.0	--
New	Expand Markets for Next-Generation Lighting Products		0.2	--
New	Fuel Cells Initiative		0.0	--
Industrial Sector Actions		19.0	4.8	--
12	Motor Challenge	8.8	1.8	--
13	Industrial Golden Carrot Programs	2.9	Merged Into Action 12 Terminated	
14	Accelerate the Adoption of Energy-Efficient Process Technologies			
15	Industrial Assessment Centers	0.5	CCAP Component Terminated	
16	Waste Minimization	4.2	2.1	--
17	Improve Efficiency of Fertilizer Nitrogen Use	2.7	0.8	--
18	Reduce the Use of Pesticides			
Transportation Sector Actions		8.1	5.3	--
19	Cash Value of Parking	6.6	4.6	--
20	Innovative Transportation Strategies			
21	Telecommuting Program			
22	Fuel Economy Labels for Tires	1.5	0.7	--
Energy Supply Actions		10.8	1.3	--
23	Increase Natural Gas Share of Energy Use Through Federal Regulatory Reform	2.2	Terminated	

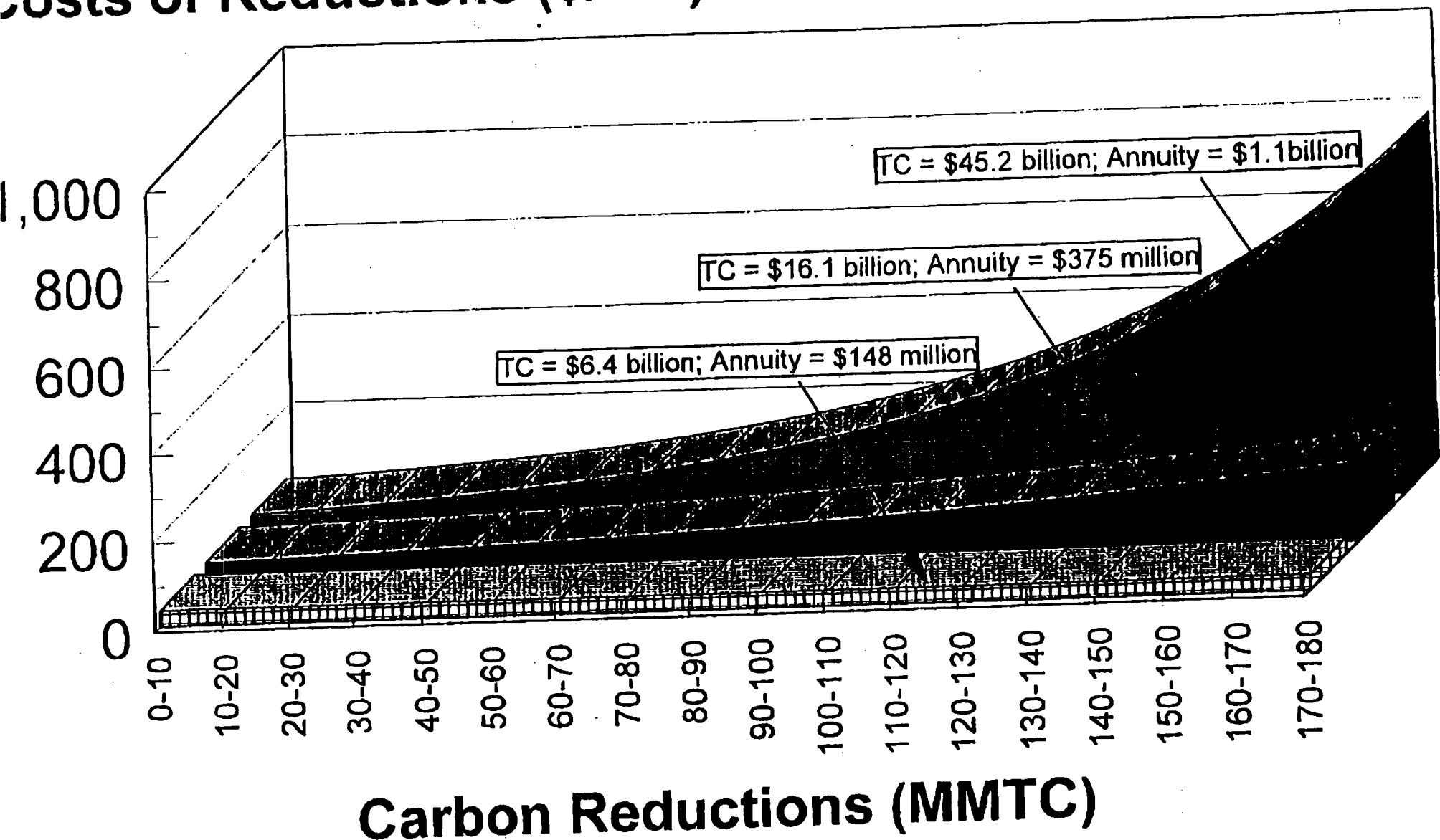
AUG-11-1997 14:15

CEA

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
24	Promote Seasonal Gas Use for Control of Nitrogen Oxides	2.8	0.5	--
25	High-Efficiency Gas Technologies	0.6	Terminated	
26	Renewable-Energy Commercialization	0.8	0.3	--
27	Expand Utility Integrated Resource Planning	1.4	Terminated	
28	Profitable Hydroelectric Efficiency Upgrades	2.0	0.0	--
29	Energy-Efficient Distribution Transformer Standards	0.8	0.5	--
30	Energy Star Distribution Transformers			
31	Transmission Pricing Reform	0.8	Terminated	
New	Green Power Network	Not included	0.0	--
Land-Use Change & Forestry Actions		10.0	2.4	--
43	Private Depletion of Nonindustrial Private Forests	4.0	Terminated	
44	Accelerate Tree Planting in Nonindustrial Private Forests	0.5	0.4	--
16	Waste Minimization	4.2	2.0	--
9	Expand Cool Communities	0.5	To be determined	
Methane Actions		16.3	15.5	--
32	Expand Natural Gas STAR	3.0	3.4	--
33	Increase Stringency of Landfill Rule	4.2	6.3	--
34	Landfill Methane Outreach Program	1.1	1.9	--
35	Coalbed Methane Outreach Program	2.2	2.6	--
36	RD&D for Coal Mine Methane	1.5	Terminated	
37	RD&D for Landfill Methane	1.0	Terminated	
38	AgSTAR Program	1.5	0.3	--
39	Ruminant Livestock Efficiency Program	1.8	1.0	--
Actions to Address Other Greenhouse Gases		16.3	25.4	--
17	Improved Fertilizer Management	4.5	5.3	--
40	Significant New Alternatives Program	5.0	6.4	--
41	HFC-23 Partnerships	5.0	5.0	--
42	Voluntary Aluminum Partnership	1.8	2.2	--
New	Environmental Stewardship Initiative	Not included	6.5	--
Foundation Actions			11.3	--
	Climate Wise	Not estimated	1.8	--
	Climate Challenge	Not estimated	7.6	--
	State and Local Outreach Programs	Not estimated	1.9	--
Total GHG Emission Reductions From CCAP		108.6	76.0	14.0

Data is not readily available for cumulative emissions reductions for many CCAP programs. Emissions reductions of about 5 MMTCE can be attributed to DOE's CCAP programs. EPA's Office of Air and Radiation is responsible for emissions reductions of about 9 MMTCE through their CCAP programs.

Costs of Reductions (\$/ton)



MC = AC of CCAP



MC Increases 10% Every 10 MMTC



MC Increases 20% Every 10 MMTC

MEMORANDUM

TO: Jay Shogren

FROM: Joe Aldy and Quindi Franco

DATE: August 11, 1997

RE: Review of DOE Labs Study, June 10 Draft

We provide an assessment of *U.S. Carbon Reductions by 2010 and Beyond: The Potential Impact of Energy-Efficient and Low-Carbon Technologies* (DOE Labs Study, June 10 draft). The report identifies carbon reductions and their associated costs in the buildings, industry, transportation, and electric power sectors under two hypothetical climate policy scenarios. The study finds that, with unspecified "very aggressive policies" and a \$50/ton permit price, carbon emissions can be stabilized at 1990 levels by 2010. We believe several limitations of the study should be highlighted; some of these are serious.

- First, the authors do not estimate the costs or even describe the programs necessary to stimulate the adoption of technology necessary to reduce emissions of 180 million metric tons of carbon equivalent (MMTCE) by 2010. These reductions correspond to about 1/3 of the reductions needed to attain 1990 levels by 2010. In the absence of cost estimates it is impossible to evaluate the merit of the technology options.

--Based on the actual history of CCAP, we estimate the costs of government programs to achieve these reductions could total \$45 billion (1995\$), depending on the form of the marginal cost curve. We annuitized this figure and found that government programs could cost \$1.1 billion annually into perpetuity. These are costs in addition to existing program costs to improve energy efficiency technology development and adoption.

- Second, the penetration rate of energy efficient technologies may be overestimated because the separate sectoral analyses do not account for declines in fuel prices that would result from adoption.
- Third, the industry sector analysis ignores the costs of accelerating capital retirement.
- Fourth, the transportation sector requires "luck" in terms of technological innovation to achieve the projected emissions reductions.
- Fifth, the utilities sector analysis resulted in double counting of emissions reductions.

Upon receiving the final version of the report and documentation of the analyses, we will update this review.

Overview of Report

The study provides emissions reductions for two scenarios: 1) “efficiency” and 2) “high efficiency/low carbon”, over the period 1998-2010. The study describes neither the policies necessary to achieve emissions reductions nor the costs of federal programs for these scenarios, only their outcomes: increased adoption rates and better technologies through technology development and adoption and fuel switching.

The Study employs the Energy Information Administration’s 1997 baseline (AEO97) for the buildings and industry sectors. For the transportation sector, the authors changed the AEO97 assumption of increasing fuel efficiency in automobiles to constant fuel efficiency. For the utility sector, the baseline was modified to reflect a fully competitive bulk-power market in the year 2010. Discharge, shutdown, repowering, and new construction decisions were optimized to select the amount of capacity that minimized the cost of the power-supply system plus the cost of unserved energy. Compared to AEO97, the final baseline has slightly lower energy prices, larger electricity sales, and a greater share of gas generation.

Efficiency Scenario

This case assumes that all technologies adopted are at zero or negative net cost to the user given more aggressive federal policies to stimulate development and diffusion of energy efficient technologies. The Study estimates that 120 MMTCE will be reduced at negative net cost in this scenario. No fuel switching by utilities or industry occurs in this scenario.

High Efficiency/Low Carbon Scenario

This case assumes a “greater commitment” to reduce emissions through federal policies, in concert with state and private activities and a \$50/ton permit price that stimulates low carbon technologies (read: primarily fuel switching). The policy is announced in 2000 and the policy’s restrictions are phased-in through 2010. There is an assumed announcement effect (although an autonomous energy efficiency index is not specified), increased domestic and international R&D in low-carbon technologies, and a “change in psychology”. The Study estimates reductions of 180 MMTCE from the baseline through energy efficient technology adoption at negative net cost (see high efficiency without low carbon technology in chart below). The carbon permits will yield an additional 150-200 MMTCE of reductions through low-carbon technology adoption. Given that these occur at a permit price of \$50/ton, the Study estimates the upper limits of these costs to be \$10 billion per year in 2010.

Carbon Emissions (MMTCE): 1990 - 2010

1990	2010 Baseline	2010 Efficiency	2010 High Efficiency (w/o Low Carbon Tech)	2010 High Efficiency/Low Carbon
1340	1720	1600	1540	1340 - 1390

Review

The Lab Study employs several important assumptions in the analyses. We discuss several of the most significant assumptions and discussions of their impact below.

The Study Does Not Specify Policies to Achieve Carbon Reductions

“Cost effectiveness is improved because R&D, in combination with increased deployment efforts, result in declining capital costs. We do not specify the policies, economic conditions, or exogenous events that could precipitate such changes” (p. 1.4).

The entire study is premised on two sets of undefined policies: an “aggressive” or “invigorated” public sector effort to stimulate energy efficient technology adoption (efficiency case) and a “very aggressive” public sector effort to stimulate technology development and adoption (high efficiency/low carbon case). The only specific policy instrument mentioned in the report is a \$50/ton tradeable permit. The study merely asserts that these unidentified policies would result in: 1) “better technology” (p. 1.5); 2) “higher penetration rates” (p. 1.6); 3) “changing the capital recovery factor [in industry sector] from 33% to 15%” (p. 4.8); and 4) “technological breakthroughs” (p. 5.3). These policy effects would result in reductions of 180 MMTCE for “free”: firms and individuals receive energy cost-savings in excess of technology costs.

The report specifically states that the efficiency case reduces, but does not eliminate, market barriers (p. x). Market barriers can occur in well-functioning private markets. Even in the presence of such barriers, resource allocation is efficient. Policy intervention to eliminate a market barrier cannot make society better off and usually makes society worse off, regardless of the implementation mechanism.¹ A set of climate change policies to stimulate technology adoption could increase efficiency, but only because they also decrease the effect of a market failure (carbon emissions). Social welfare is improved because the net benefits of indirectly fixing the market failure exceed the costs of removing the barriers. If carbon emissions are appropriately priced (assuming in this case that \$50/ton is the correct carbon price), a policy to remove a barrier (e.g., lower the capital recovery factor from 33% to 15%), will generate negative net benefits. High adoption rates will be realized once prices rise enough for some technologies to clear the barriers.

The economics literature has identified several barriers that may help explain the slow rate of technology adoption.

- Energy efficiency is not the only thing that matters to consumers. Other qualities of products appeal to consumers' preferences. For example, some technology consumers may purchase a product with a lower efficiency than another product because the former is more reliable than the efficiency-superior product.
- New technologies may be costly to integrate with existing technologies. Consumers of new technologies need to expend effort to understand how to match the two sets of

technologies. Until all components of a complex system are fully depreciated, it may make sense to replace an energy-inefficient component with another, likewise inefficient component.

- The social discount rates to evaluate new technologies may not fully capture the uncertainty and risks faced by individuals and firms. These private actors may use a much higher discount rate reflecting the uncertainty of future energy prices, the reliability of the technology, the irreversibility of a technology investment, and the constraints on their ability to borrow capital.
- Just because a technology is cost-effective on average, it does not mean that it is cost-effective for all individuals. Those who use the device less intensively may find it optimal to purchase a less efficient model.

These barriers clearly demonstrate the difference between the technological maximum adoption (which only assumes technology costs) and the economic maximum adoption (which assumes total costs).

The Labs Study does not provide an estimate of the cost to government of lowering market barriers. We estimated the costs of emissions reduction based on the government's experience with the Climate Change Action Plan (CCAP). CCAP promotes carbon reductions through a broad array of voluntary programs that stimulate "cost-effective" technology adoption by private firms.² Firms participating in a CCAP program benefit financially in return for reducing emissions. CCAP received appropriations totaling \$494 million (1995\$) during the FY95 - FY97 period. During this period, the Department of Energy and the Environmental Protection Agency can account for reductions of 14 MMTCE (see attached table).³ Each ton of carbon reduced in CCAP cost the federal government, on average, \$35.29 (1995\$) over this three year period.

Assuming a flat marginal cost curve ($MC = AC$ of CCAP) to reduce 180 MMTCE beyond the baseline, the government costs of the unidentified policies in the Labs Study would exceed \$6.3 billion. To account for the opportunity cost of capital through time, we annuitized this value and found that government costs would run about \$150 million annually into perpetuity.⁴ However, the marginal costs of technology adoption in the efficiency and high efficiency/low carbon scenarios are definitely higher than the average cost of 14 million metric tons reduced in the baseline scenario, especially as more and more efforts to reduce emissions are undertaken. Assuming that costs increase 10% for every 10 million metric tons of carbon reduced, then the government cost would total \$16.1 billion (annuity of \$375 million). This is a slowly increasing marginal cost curve given baseline assumptions of gains in energy efficiency. Assuming that costs increase 20% for every 10 million metric tons of carbon reduced, then the cost to government would exceed \$45.2 billion (annuity of \$1.1 billion) (see attached chart).

Price Declines Resulting from Reductions in Energy Demand Are Not Taken into Account

"The model runs for each of the three end-use sectors were not integrated and therefore

may overstate the effects of technology penetration. In an integrated modeling effort, fuel prices might fall as consumption declines, resulting in less penetration of energy-conserving technologies” (p. 1.1).

The analyses of the various sectors assume that the reduction of 180 MMTCE occurs through energy efficient technology adoption without any energy price effect. This implies that, with government programs, private agents will adopt technologies because the benefits (energy cost-savings) exceed the costs of adoption. The authors claim that these reductions occur at zero or negative net costs. However, if the energy prices fall due to the decline in energy demand, some of those adoptions would no longer generate positive net benefits for private consumers. The Study indicates that energy consumption will decline from the baseline by 11.6% under the high efficiency/low carbon case (p. xi). This decrease in demand should result in a decrease in the price of energy, and cause some energy efficient technologies to become unattractive to private agents.

The efficiency scenario should be modified to reflect the downward effect on prices resulting from decreased energy consumption. The high efficiency scenario should reflect two counteracting effects on prices: the decline in energy consumption and the \$50/ton permit fee. The Study ignores the former effect and insufficiently incorporates the latter effect. For example, in the buildings chapter, the penetration rate is assumed to be 65% instead of 60% of the maximum cost-effective technical potential in this scenario because of the \$50/ton permit price.⁵ However, the energy-cost savings calculations for buildings technologies assume the same energy price as in the business as usual scenario. Since the study assumes that exogenous, undefined policy influences drive the penetration rates, the penetration rate should be set at 60% and the energy cost-savings should be recalculated with the appropriate energy price. In the industry chapter, the high efficiency penetration rate is assumed to be double the rate used in the efficiency scenario, which is the undefined “normal” rate. It is impossible to determine how much of this doubling of penetration results from undefined, aggressive policy efforts and how much results from the permit price.

The Industry Sector Analysis Ignores the Costs of Accelerated Retirement

“When the economic losses of accelerated retirement are accounted for this means that, at the margin, all investments are not likely to be cost effective at our assumed 15% CRF [capital recovery factor]. Since we do not have a model to account for this potential early retirement and the economic losses, we must caveat our estimates of investment and net costs. ...the investment cost may be understated by the amount of loss due to any early retirement that may occur” (p. 4.15).

The omission of costs related to the early retirement of capital implies that either

- the projected emissions reduction should be revised downward, because less technology will be adopted; or
- the cost of reducing emissions should be revised upward; or

- the cost of government programs to somehow force down the CRF from 33% to 15% would increase.

The Transportation Sector Requires "Luck" to Achieve Carbon Reductions

"[B]ecause the [transportation sector] outcomes postulated in the high efficiency/low carbon scenario require technological breakthroughs, they require a certain degree of luck to be achieved by 2010. There are no credible methods to accurately gauge the probability of such breakthroughs -- we believe they stand a decent chance of occurring with an intensification of research efforts, but we stop short of claiming they are a likely outcome of such an intensification" (p. 5.3).

Note that this statement includes two qualifications: luck on top of intensified research efforts. These intensified research efforts may require two to ten times existing funding on transportation (p. 5.3). For perspective on what this might mean, it is worth keeping in mind that the Partnership for a New Generation of Vehicles (PNGV) alone is funded at the federal level at \$263 million, and there are substantial additional private sector costs.

The "luck" apparently pertains to a number of tenuous technological assumptions: commercial development of the fuel cell for passenger cars, commercial availability of cellulosic ethanol (and the elimination of the ethanol excise tax exemption), and an apparently arbitrary 30% reduction in costs for "certain key technologies" (p. 5.24). These technologies are not identified, and the report does not provide documentation for the NEMS model runs conducted for the transportation sector.

Interactions Ignored, Double Counting "Likely" in Utilities Sector Analysis

"Chapter 7 considers other electricity supply technology options, including: converting coal-based power plants to natural gas; cofiring coal with biomass; efficiency improvements in generation and transmission and distribution systems; extending the life of existing nuclear plants; increasing generation and capacity of existing hydropower plants; and constructing new powerplants using advanced coal technologies. Each of these options is assessed independently. Thus, interactions between the options are not taken into account, and the possibility of double counting is therefore likely" (p. 7.1).

The emissions reductions in the electricity sector come from two sources. First, utilities undertake fuel switching at the \$50/ton permit price through carbon-ordered dispatching. Utilities would change their fuel mix by dispatching more electricity from their lower carbon-emitting facilities (e.g., nuclear, hydropower, and natural gas) and less from coal plants. Second, utilities modify their capital stock through several technology options such as those listed in the above quotation. As electricity production moves away from coal through modified dispatching, fewer and fewer plants (and therefore potential emissions reductions) will be available for conversion to natural gas or cofiring with biomass. The second set of analyses were "static" and did not optimize unit/plant production cost, dispatch, or system load. Conversations

with one of the co-authors (Stanton Hadley of Oak Ridge National Laboratory) indicate that 10 GW of coal-to-gas conversions (approximately 9 million tons of carbon reductions, or 7% of reductions for dispatching and conversions) were double-counted.⁵

Wilcox

MEMORANDUM

TO: Jay Shogren

FROM: Joe Aldy and Quindi Franco

DATE: August 11, 1997

RE: Review of DOE Labs Study, June 10 Draft

We provide an assessment of *U.S. Carbon Reductions by 2010 and Beyond: The Potential Impact of Energy-Efficient and Low-Carbon Technologies* (DOE Labs Study, June 10 draft). The report identifies carbon reductions and their associated costs in the buildings, industry, transportation, and electric power sectors under two hypothetical climate policy scenarios. The study finds that, with unspecified "very aggressive policies" and a \$50/ton permit price, carbon emissions can be stabilized at 1990 levels by 2010. ~~In reviewing the report, we believe it is beneficial to highlight several limitations of the study.~~ ^{should be highlighted} First, the authors do not ~~provide~~ ^{describe} descriptions of the government programs necessary to stimulate the necessary technology adoption to reduce emissions of 180 million metric tons of carbon equivalent (MMTCE). Based on the actual history of CCAP, we estimate the costs of government programs to achieve these reductions could total \$45 billion (1995\$), depending on the form of the marginal cost curve. We annuitized this figure and found that government programs could cost \$1.1 billion annually into perpetuity. These are costs in addition to existing program costs to improve energy efficiency technology development and adoption. Second, the analyses across sectors are not integrated. Therefore, the penetration rate of energy efficient technologies may be overestimated because the separate sectoral analyses do not account for declines in fuel prices. Third, the industry sector analysis ignores the costs of accelerating capital retirement, ~~resulting in either an overestimate of reductions or an underestimate of costs.~~ Fourth, the transportation sector requires "luck" in terms of technological innovation to achieve the projected emissions reductions. Fifth, the utilities sector analysis resulted in double counting of emissions reductions. ~~These examples of the qualifications can provide additional insight into the projections of emissions reductions and costs.~~ Upon receiving the final version of the report and documentation of the analyses, we will update this review.

Overview of Report

The Labs Study estimated the carbon emissions reduction opportunities available through technology development and adoption and fuel switching. The Study employs the Energy Information Administration's 1997 baseline (AEO97) for the buildings and industry sectors. For the transportation sector, the authors changed the AEO97 assumption of increasing fuel efficiency in automobiles to constant fuel efficiency. For the utility sector, the baseline was modified to reflect a fully competitive bulk-power market in the year 2010. Discharge,

I find
+
al...
Small

180 ton
is only
1/3 of
the way
might be
steeply
increasing
marginal
cost

Doesn't the analysis
also ignore
implementation costs?

shutdown, repowering, and new construction decisions were optimized to select the amount of capacity that minimized the cost of the power-supply system plus the cost of unserved energy. Compared to AEO97, the final baseline has slightly lower energy prices, larger electricity sales, and a greater share of gas generation. The study provides emissions reductions from this baseline for two scenarios: 1) "efficiency" and 2) "high efficiency/low carbon" over the period 1998-2010. The study describes neither the policies necessary to achieve emissions reductions nor the costs of federal programs for these scenarios, only their outcomes: increased adoption rates and better technologies.

Efficiency Scenario

This case assumes that all technologies adopted are at zero or negative net cost to the user given more aggressive federal policies to stimulate development and diffusion of energy efficient technologies. The Study estimates that 120 MMTCE will be reduced at negative net cost in this scenario. None of these reductions occur in the utility sector as a function of fuel switching or technology adoption to increase combustion efficiency.

High Efficiency/Low Carbon Scenario

This case assumes a "greater commitment" to reduce emissions through federal policies, in concert with state and private activities and a \$50/ton permit price that stimulates low carbon technologies (read: primarily fuel switching). The policy is announced in 2000 and the policy's restrictions are phased-in through 2010. There is an assumed announcement effect (although an AEE is not specified), increased domestic and international R&D in low-carbon technologies, and a "change in psychology". The Study estimates reductions of 180 MMTCE from the baseline through energy efficient technology adoption at negative net cost (see high efficiency without low carbon technology in chart below). The carbon permits will yield an additional 150-200 MMTCE of reductions through low-carbon technology adoption. Given that these occur at a permit price of \$50/ton, the Study estimates the upper limits of these costs to be \$10 billion per year in 2010.

Carbon Emissions (MMTCE): 1990 - 2010

1990	2010 Baseline	2010 Efficiency	2010 High Efficiency (w/o Low Carbon Tech)	2010 High Efficiency/Low Carbon
1340	1720	1600	1540	1340 - 1390

Review

The Lab Study employs several important assumptions in the analyses. ~~Learning about these qualifications can enhance one's understanding of the estimates regarding cost effectiveness and~~

with more electricity and more gas generated and more gasoline consumption, aren't we consuming a lot more energy in the baseline? Does this make sense with lower prices?

What is this sentence saying?

discuss

~~emissions reductions in this study. We present several of the most significant assumptions and discussions of their impact below.~~

The Study Does Not Specify Policies to Achieve Carbon Reductions

"Cost effectiveness is improved because R&D, in combination with increased deployment efforts, result in declining capital costs. We do not specify the policies, economic conditions, or exogenous events that could precipitate such changes" (p. 1.4).

The entire study is premised on two sets of undefined policies: an "aggressive" or "invigorated" public sector effort to stimulate energy efficient technology adoption (efficiency case) and a "very aggressive" public sector effort to stimulate technology development and adoption (high efficiency/low carbon case). The only specific policy instrument mentioned in the report is a \$50/ton tradeable permit. The study ~~makes vague references to policies and only provides details~~ *merely asserts that* on what these unidentified policies would result in: 1) "better technology" (p. 1.5); 2) "higher penetration rates" (p. 1.6); 3) "changing the capital recovery factor [in industry sector] from 33% to 15%" (p. 4.8); and 4) "technological breakthroughs" (p. 5.3). These policy effects would result in reductions of 180 MMTCE for "free": firms and individuals receive energy cost-savings in excess of technology adoption and implementation costs.

The report specifically states that the efficiency case reduces, but does not eliminate, market barriers (p. x), and that implementation costs are ignored (p. xvi). *I thought these were ignored?* First, we will discuss the implications of reducing market barriers, and then we will address the cost issue. "Market barriers" can occur in well-functioning, but occasionally complex, private markets. *Even* Information is fully transmitted among all those in the market, although some information may seem incomplete to non-participants (read: policy or market analysts). A person addresses all real costs, but these costs can go undetected by analysts, hence the term "hidden costs". For market barriers, private costs match social costs, and resource allocation is efficient. Policy intervention to eliminate a market barrier cannot make society better off and usually makes society worse off, regardless of the implementation mechanism.¹

This is so text-lookish.
could insert material here from next page.
The economics literature has identified several barriers that *may help* explain the slow rate of technology adoption: 1) qualitative attributes differ across technologies; 2) private attributes of information; 3) private discount rate diverges from social rate; and 4) heterogeneous usage levels.

Intend • *Energy efficiency is not the only thing that matters to consumers.*
~~Qualitative attributes of technologies can affect adoption. Consumers of technology prefer technologies because of a set of characteristics, not just energy efficiency. For example, some technology consumers may purchase a product with a lower efficiency than another product because the former is more reliable than the efficiency-superior product.~~

¹ In contrast, policy intervention to eliminate a market failure (such as carbon emissions) may make society better off, depending on the costs of the intervention.

- New technologies may be costly to integrate with existing ones. Until Private attributes of information include the tasks of learning how a new technology works with all components of a one's existing suite of technologies and identifying technology suppliers. Transaction costs exist of a complex system are with these tasks. If opportunities for economic gains in supplying this information exist, one would expect arbitrage to occur where middlemen consultants would assess the needs of fully depreciated energy-inefficient component with another likewise. potential adopters and match them with the appropriate suppliers. it may make sense to replace a

(No) The social discount rates to evaluate new technologies may not fully capture the uncertainty and risks faced by individuals and firms. These private actors may use a much higher discount rate reflecting the uncertainty of future energy prices, the reliability of the technology, the irreversibility of a technology investment, and the constraints on their ability to borrow capital. inefficient component

If investment is irreversible, social = private, doesn't it?

Heterogeneous use of energy intensive technology can affect who benefits from efficiency investments and who does not. If a technology is cost-effective on average, it does not mean that it is effective for all individuals, who do not use much energy. Those who may use the device less intensively may find it optimal to purchase a less efficient model.

These four types of market barriers illustrate the economic behavior that explains the apparent under adoption of energy efficiency technology (the "efficiency gap"). These barriers clearly demonstrate the difference between the technological maximum adoption (which only assumes technology costs) and the economic maximum adoption (which assumes total costs). A set of climate change policies to stimulate technology adoption could increase efficiency, but only because they also decrease the effect of a market failure (carbon emissions). Social welfare is improved because the net benefits of indirectly fixing the market failure exceed the costs of removing the barriers. If carbon emissions are appropriately priced (assuming in this case that \$50/ton is the correct carbon price), a policy to remove a barrier (e.g., lower the capital recovery factor from 33% to 15%), will generate negative net benefits. High adoption rates will be realized once prices rise enough for some technologies to clear the barriers.

From the literature on market barriers, we know that the costs of reducing barriers are greater than their benefits. In this case, the authors of the Labs Study do not provide an estimate of the costs to government to lower market barriers to achieve these substantial reductions (and they only provide benefits in terms of projected emissions reductions). We calculated estimates of the costs of emissions reduction programs based on the government's experience with the Climate Change Action Plan (CCAP). CCAP promotes carbon reductions through a broad array of voluntary programs that stimulate "cost-effective" technology adoption by private firms. Participation by a firm in a CCAP program implies that carbon is reduced and the firm gains financially. CCAP received appropriations totaling \$494 million (1995\$) during the FY95-FY97 period. During this period, the Department of Energy and the Environmental Protection Agency can account for reductions of 14 MMTCE (see attached table). Each ton of carbon reduced in CCAP cost the federal government, on average, \$35.29 (1995\$) over this three year period. Assuming a flat marginal cost curve (MC = AC of CCAP), to reduce 180 MMTCE beyond the baseline, the government costs of the unidentified policies in the Labs Study would

Note that CCAP efforts are incorporated in the AEO97 baseline.

Need footnote

questioning why

any gov't action is

required to attain truly cost

I think
stocks
& flows are
confused here.

4

attaining the 180 MMTCE reduction per year

¹ exceed \$6.3 billion. To account for the opportunity cost of capital through time, we annualized this value and found that government costs would run about \$150 million annually into perpetuity. ~~However, the marginal costs of technology adoption in the efficiency and high efficiency/low carbon scenarios are definitely higher than the average cost of 14 million metric tons reduced in the baseline scenario, especially as more and more efforts to reduce emissions are undertaken.~~ Assuming that costs increase 10% for every 10 million metric tons of carbon reduced, then the government cost would total \$16.1 billion ^{per year} (annuity of \$275 million). This is a slowly increasing marginal cost curve given baseline assumptions of gains in energy efficiency. Assuming that costs increase 20% for every 10 million metric tons of carbon reduced, then the cost to government would exceed \$45.2 billion (annuity of \$1.1 billion) (see attached chart).

Are

The price increases induced by the permit scheme taken into account?

Price declines resulting from reductions in energy demand ~~The Sectoral Analyses Are Not Integrated~~ are not taken into account.

"The model runs for each of the three end-use sectors were not integrated and therefore may overstate the effects of technology penetration. In an integrated modeling effort, fuel prices might fall as consumption declines, resulting in less penetration of energy-conserving technologies" (p. 1.1).

The analyses of the various sectors assume that the reduction of 180 MMTCE occurs through energy efficient technology adoption without any price effect. This implies that, with government programs, private agents will adopt technologies because the benefits (energy cost-savings) exceed the costs of adoption. The authors claim that these reductions occur at zero or negative net costs. ~~By failing to account for the effect of decreased energy demand, due to energy efficiency technology adoption, some of those adoption decisions that occur on the margin would no longer generate positive net benefits for private consumers.~~ The ~~Los~~ Study indicates that energy consumption will decline from the baseline by 11.6% under the high efficiency/low carbon case (p. xi). This decrease in demand should result in a decrease in the price of energy, and cause some energy efficient technologies to become unattractive to private agents.

Is this right? Why bother with the \$50/ton fee?

Add FN

In addition, the absence of an integrated analysis precludes an assessment of the economy-wide effects of a tradeable permit system. As previous studies have indicated, the nature of the permit allocation (e.g., grandfathering, auction, or a hybrid) and the characteristics of the revenue recycling (e.g., various adjustments to existing taxes) can affect economy-wide investment. Understanding the effects on investment is instrumental in assessing the likelihood of success of these scenarios, given that they rely on substantial R&D and technology adoption.

The Industry Sector Analysis Ignores the Costs of Accelerated Retirement

"When the economic losses of accelerated retirement are accounted for this means that, at the margin, all investments are not likely to be cost effective at our assumed 15% CRF [capital recovery factor]. Since we do not have a model to

¹ We employed a 7% discount rate to calculate the annuities in this paper.

I'd like to see this really hammer 2 points:

- (1) Firms will do what is profitable regardless of govt programs;
- (2) Assumed hurdle rate for industry is exogenously reduced from

account for this potential early retirement and the economic losses, we must caveat our estimates of investment and net costs. ...the investment cost may be understated by the amount of loss due to any early retirement that may occur" (p. 4.15).

The omission of costs related to early retirement of capital implies that this assumption implies that one of three results should be accounted for in the analysis. First, either the projected emissions reduction should be revised downward, because the assessment of the industry sector overestimates technology adoption by ignoring these costs. Second, the cost of reducing emissions, if the reduced carbon from this sector remains constant, should increase, because some technology will be adopted. Third, if the authors maintain the same costs and emissions estimates, then the costs of government programs to somehow force down the CRF from 33% to 15% would increase.

? This doesn't flow logically

The Transportation Sector Requires "Luck" to Achieve Carbon Reductions

"[B]ecause the [transportation sector] outcomes postulated in the high efficiency/low carbon scenario require technological breakthroughs, they require a certain degree of luck to be achieved by 2010. There are no credible methods to accurately gauge the probability of such breakthroughs — we believe they stand a decent chance of occurring with an intensification of research efforts, but we stop short of claiming they are a likely outcome of such an intensification" (p. 5.3).

Note that this statement includes two qualifications: luck on top of intensified research efforts. To achieve just the efficiency level of emissions reductions for this sector (73 MMTCE), these intensified research efforts may require two to ten times existing funding on transportation (p. 5.3).

For perspective on what this might mean, it is worth keeping in mind that the Partnership for a New Generation of Vehicles (PNGV) alone is funded at the federal level at \$263 million. Private sector costs of participating in the PNGV are in addition to this.

Further, the estimates of costless (on net) carbon reductions relies on a series of tenuous assumptions: commercial development of the fuel cell for passenger cars, commercial availability of cellulosic ethanol (and the elimination of the ethanol excise tax exemption), and an apparently arbitrary 30% reduction in costs for "certain key technologies" (p. 5.24). These technologies are not identified, and the report does not provide documentation for the NEMS model runs conducted for the transportation sector.

Interactions Ignored, Double Counting "Likely" in Utilities Sector Analysis

"Chapter 7 considers other electricity supply technology options, including: converting coal-based power plants to natural gas; cofiring coal with biomass; efficiency improvements in generation and transmission and distribution systems; extending the life of existing nuclear plants; increasing generation and capacity of existing hydropower plants; and constructing new powerplants using advanced coal technologies. Each of these options is assessed independently. Thus,

interactions between the options are not taken into account, and the possibility of double counting is therefore likely" (p. 7.1).

The emissions reductions in the electricity sector come from two sources. First, utilities undertake fuel switching at the \$50/ton permit price through carbon-ordered dispatching [?]. Second, utilities modify their capital stock through several technology options such as those listed in the above quotation. As electricity production moves away from coal in the first analysis, fewer and fewer plants (and therefore potential emissions reductions) will be available for conversion to natural gas or cofiring with biomass. The second set of analyses were "static" and did not optimize unit/plant production cost, dispatch, or system load. Conversations with one of the co-authors (Stanley Hadley of Oak Ridge National Laboratory) indicate that 10 GW of coal-to-gas conversions (approximately 9 million tons of carbon reductions) were double-counted.⁴

What
a first
analysis?

express as a % of something

Furthermore, the analysis of specific options did not examine the effect of increasing fuel prices (from gas demand due to coal-to-gas repowering). Given the range of assumptions considered in the study, the authors actually estimated that repowering coal plants for natural gas could result in carbon reductions between 5 million and 269 million tons (p. 7.2), depending on the gas/coal price differential, the cost of carbon, and the costs of sulfur dioxide and nitrous oxide emissions. This is quite a substantial range. The Labs Study estimates that natural gas consumption will increase 14% to 191% above 2010 baseline consumption. However, the DRI 1.25 run in the IAT report indicates a 16% decline in natural gas consumption, while the SGM run resulted in ~~only~~ a negligible decline and Markal-Macro generated a 6% increase in natural gas consumption. These three models indicate that a non-integrated analysis that does not account for the price change in natural gas may overestimate natural gas substitution for coal and emissions reductions from fuel switching.

message is a bit murky.
what point?

⁴ Hadley noted that a subsequent draft of the report should address at least some of the double counting, but he did not provide details.

Summary of Greenhouse Gas Emissions-Reduction Actions

Million Metric Tons of Carbon Equivalent

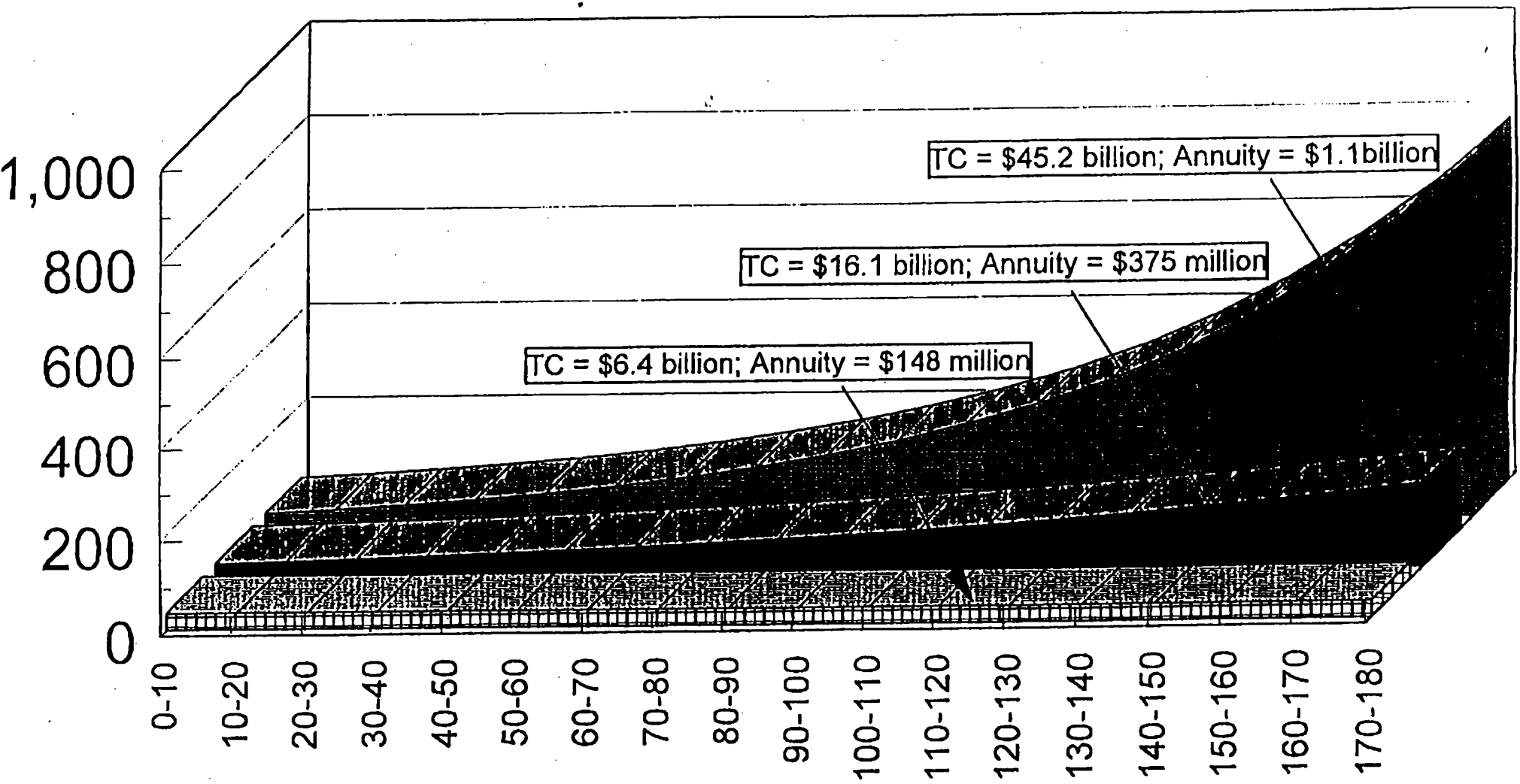
Source: U.S. Climate Action Report—1997

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
Residential & Commercial Sector Actions		26.9	10.3	--
New	Rebuild America	2.0	1.6	--
1 and 2	Expanded Green Lights and Energy Star Buildings	3.6	3.3	--
3	State Revolving Fund for Public Buildings	1.1	Terminated	
4	Cost-Shared Demonstrations of Emerging Technologies	3.8	0.0	--
5	Operation and Maintenance Training for Commercial Building Facility Managers and Operators			
6	Energy Star Products	5.0	4.3	--
7	Residential Appliance Standards	6.8	0.2	--
8 and 11	Energy Partnerships for Affordable Housing	4.4	0.4	--
9	Cool Communities			
10	Update State Building Codes			
New	Construction of Energy-Efficient Commercial and Industrial Buildings		0.1	--
New	Superwindow Collaborative		0.0	--
New	Expand Markets for Next-Generation Lighting Products		0.2	--
New	Fuel Cells Initiative		0.0	--
Industrial Sector Actions		19.0	4.8	--
12	Motor Challenge	8.8	1.8	--
13	Industrial Golden Carrot Programs	2.9	Merged into Action 12 Terminated	
14	Accelerate the Adoption of Energy-Efficient Process Technologies			
15	Industrial Assessment Centers	0.5	CCAP Component Terminated	
16	Waste Minimization	4.2	2.1	--
17	Improve Efficiency of Fertilizer Nitrogen Use	2.7	0.8	--
18	Reduce the Use of Pesticides		Terminated	
Transportation Sector Actions		8.1	5.3	--
19	Cash Value of Parking	6.6	4.6	--
20	Innovative Transportation Strategies			
21	Telecommuting Program			
22	Fuel Economy Labels for Tires	1.5	0.7	--
Energy Supply Actions		10.8	1.3	--
23	Increase Natural Gas Share of Energy Use Through Federal Regulatory Reform	2.2	Terminated	

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
24	Promote Seasonal Gas Use for Control of Nitrogen Oxides	2.8	0.5	--
25	High-Efficiency Gas Technologies	0.6	Terminated	
26	Renewable-Energy Commercialization	0.8	0.3	--
27	Expand Utility Integrated Resource Planning	1.4	Terminated	
28	Profitable Hydroelectric Efficiency Upgrades	2.0	0.0	--
29	Energy-Efficient Distribution Transformer Standards	0.8	0.5	--
30	Energy Star Distribution Transformers			
31	Transmission Pricing Reform	0.8	Terminated	
New	Green Power Network	Not included	0.0	--
Land-Use Change & Forestry Actions		10.0	2.4	--
43	Private Depletion of Nonindustrial Private Forests	4.0	Terminated	
44	Accelerate Tree Planting in Nonindustrial Private Forests	0.5	0.4	--
16	Waste Minimization	4.2	2.0	--
9	Expand Cool Communities	0.5	To be determined	
Methane Actions		16.3	15.5	--
32	Expand Natural Gas STAR	3.0	3.4	--
33	Increase Stringency of Landfill Rule	4.2	6.3	--
34	Landfill Methane Outreach Program	1.1	1.9	--
35	Coalbed Methane Outreach Program	2.2	2.6	--
36	RD&D for Coal Mine Methane	1.5	Terminated	
37	RD&D for Landfill Methane	1.0	Terminated	
38	AgSTAR Program	1.5	0.3	--
39	Ruminant Livestock Efficiency Program	1.8	1.0	--
Actions to Address Other Greenhouse Gases		16.3	25.4	--
17	Improved Fertilizer Management	4.5	5.3	--
40	Significant New Alternatives Program	5.0	6.4	--
41	HFC-23 Partnerships	5.0	5.0	--
42	Voluntary Aluminum Partnership	1.8	2.2	--
New	Environmental Stewardship Initiative	Not included	6.5	--
Foundation Actions			11.3	--
	Climate Wise	Not estimated	1.8	--
	Climate Challenge	Not estimated	7.6	--
	State and Local Outreach Programs	Not estimated	1.9	--
Total GHG Emission Reductions From CCAP		108.6	76.0	14.0

Data is not readily available for cumulative emissions reductions for many CCAP programs. Emissions reductions of about 5 MMTCE can be attributed to DOE's CCAP programs. EPA's Office of Air and Radiation is responsible for emissions reductions of about 9 MMTCE through their CCAP programs.

Costs of Reductions (\$/ton)



Carbon Reductions (MMTC)

 MC = AC of CCAP

 MC Increases 10% Every 10 MMTC

 MC Increases 20% Every 10 MMTC

HUB-11-1997 14:12 CEH H.011/011

MEMORANDUM

TO: Jay Shogren

FROM: Joe Aldy and Quindi Franco

DATE: August 7, 1997

RE: Review of DOE Labs Study, June 10 Draft

We provide an assessment of *U.S. Carbon Reductions by 2010 and Beyond: The Potential Impact of Energy-Efficient and Low-Carbon Technologies* (DOE Labs Study, June 10 draft). The report identifies carbon reductions and their associated costs in the buildings, industry, transportation, and electric power sectors under two hypothetical climate policy scenarios. The study finds that, with "very aggressive policies" and a \$50/ton permit price, carbon emissions can be stabilized at 1990 levels by 2010. In reviewing the report, we believe it is beneficial to highlight several of the caveats the authors explicitly state. *emissions by* First, the authors do not provide descriptions of the government programs necessary to stimulate the necessary technology adoption to reduce 180 million tons of carbon emissions. *net: 2.5 billion (1995\$)* We devised an estimate of the costs of government programs to achieve these reductions based on the nation's experience with CCAP, and found that program costs could total \$45 billion (1995\$). Second, the analyses across sectors are not integrated. Therefore, the penetration rate of energy efficient technologies may be overestimated because the separate sectoral analyses do not account for cross-sector interactions (e.g., in energy prices). Third, the industry sector analysis ignores the costs of accelerating capital retirement, resulting in either an overestimate of reductions or an underestimate of costs. Fourth, the transportation sector requires "luck" in terms of technological innovation to achieve the projected emissions reductions. Fifth, the utilities sector analysis resulted in double counting of emissions reductions. These examples of the qualifications can provide additional insight into the projections of emissions reductions and costs. Upon receiving the final version of the report and documentation of the analyses, we will conduct a more thorough review.

Overview of Report

The Labs Study estimated the carbon emissions reduction opportunities available through technology development and adoption and fuel switching. The Study employs the Energy Information Administration's 1997 baseline (AEO97) for the buildings and industry sectors. For the transportation sector, the authors changed the AEO97 assumption of increasing fuel efficiency in automobiles to constant fuel efficiency. For the utility sector, the baseline was modified to reflect a fully competitive bulk-power market in the year 2010. Discharge, shutdown, repowering, and new construction decisions were optimized to select the amount of capacity that minimized the cost of the power-supply system plus the cost of unserved energy. Compared to AEO97, the final baseline has slightly lower energy prices, larger electricity sales,

neither

and a greater share of gas generation. The study provides emissions reductions from this baseline for two scenarios: 1) "efficiency" and 2) "high efficiency/low carbon". The study ~~does not~~ describe the policies necessary to achieve emissions reductions nor the costs of federal programs for these scenarios, only their outcomes: increased adoption rates and better technologies.

Efficiency

This case assumes that all technologies adopted are cost-effective given more aggressive federal policies to stimulate development and diffusion of energy efficient technologies. Since these technologies are cost-effective, they all have a net cost less than or equal to zero. The Study estimates that 120 ~~MMTCE~~ ^{MMTCE} will be reduced at negative net cost in this scenario. None of these reductions occur in the utility sector as a function of fuel switching or technology adoption to increase combustion efficiency.

High Efficiency/Low Carbon

This case assumes a "greater commitment" to reduce emissions through federal policies, in concert with state and private activities and a \$50/ton permit price that stimulates low carbon technologies (read: primarily fuel switching). The policy is announced in 2000 and the policy's restrictions are phased-in through 2010. There is an assumed announcement effect (although an AEEI is not specified), increased domestic and international R&D in low-carbon technologies, and a "change in psychology". The Study estimates 180 ~~MMTCE~~ ^{MMTCE} of carbon emissions reductions from the baseline through energy efficient technology adoption at negative net cost (see high efficiency without low carbon technology in chart below). The carbon permits will yield an additional 150-200 ~~MMTCE~~ ^{MMTCE} of reductions through low-carbon technology adoption. Given that these occur at a permit price of \$50/ton, the Study estimates the upper limits of these costs to be \$10 billion per year in 2010.

reductions of

Carbon Emissions (~~MMTCE~~ ^{MMTCE}): 1990 - 2010

1990	2010 Baseline	2010 Efficiency	2010 High Efficiency (w/o Low Carbon Tech)	2010 High Efficiency/Low Carbon
1340	1720	1600	1540	1340 - 1390

120

180

Review

The authors of the Lab Study are forthright about many of the assumptions underlying the analysis. Learning about these qualifications can enhance one's understanding of the estimates regarding cost-effectiveness and emissions reductions in this study. We present several of the most significant assumptions and discussions of their impact below.

The Study Does Not Specify Policies to Achieve Carbon Reductions

"Cost effectiveness is improved because R&D, in combination with increased deployment efforts, result in declining capital costs. We do not specify the policies, economic conditions, or exogenous events that could precipitate such changes" (p. 1.4).

The entire study is premised on two sets of undefined policies: an "aggressive" or "invigorated" public sector effort to stimulate energy efficient technology adoption (efficiency case) and a "very aggressive" public sector effort to stimulate technology development and adoption (high efficiency/low carbon case). The only specific policy instrument mentioned in the report is a \$50/ton tradeable permit. The study makes vague references to policies and only provides details on what these unidentified policies would result in: 1) "better technology" (p. 1.5); 2) "higher penetration rates" (p. 1.6); 3) "changing the capital recovery factor [in industry sector] from 33% to 15%" (p. 4.8); and 4) "technological breakthroughs" (p. 5.3).

The authors assume that policies are implemented that significantly lower the barriers to technology adoption without any discussion of their costs. In effect, this assumes the magical wand of government intervention is waved to lower technology marginal costs enough to get 180 million tons of carbon reductions for "free": firms and individuals receive energy cost-savings in excess of the technology adoption and implementation costs.

CEA Alternative Cost Estimates

Since the authors do not provide an estimate of the costs to government to lower market barriers to achieve these substantial reductions, we calculated estimates of the costs of emissions reductions programs based on the government's experience with the Climate Change Action Plan (CCAP). CCAP promotes carbon reductions through a broad array of voluntary programs that stimulate "cost-effective" technology adoption by private firms. Participation by a firm in a CCAP program implies that carbon is reduced and the firm gains financially.¹ CCAP received appropriations totaling \$494 million (1995\$) during the FY95 - FY97 period. During this period, the Department of Energy and the Environmental Protection Agency can account for 14 million metric tons of reduced carbon (see attached table). Each ton of carbon reduced in CCAP cost the federal government \$35.29 (1995\$). Assuming a flat marginal cost curve ($MC=AC$) to reduce 180 million metric tons of carbon beyond the baseline, the government costs of the unidentified policies in the Labs Study would exceed \$6.3 billion. However, the marginal costs of technology adoption are definitely higher than the average cost of the first 14 million metric tons, especially as more and more efforts to reduce emissions are undertaken. Assuming that costs increase 10% for every 10 million metric tons of carbon reduced, then the government cost would come to \$16.1 billion. This is slowly increasing marginal cost curve given baseline assumptions of gains in energy efficiency. Assuming that costs increase 20% for every 10 million metric tons of carbon reduced, then the cost to government would exceed \$45.2 billion.

can be expected to be at least as high as

reduced to emissions reductions

reductions of 14 million

The Sectoral Analyses Are Not Integrated

¹ Note that CCAP efforts are incorporated in AEO97.

"The model runs for each of the three end-use sectors were not integrated and therefore may overstate the effects of technology penetration. In an integrated modeling effort, fuel prices might fall as consumption declines, resulting in less penetration of energy-conserving technologies" (p. 1.1).

The analyses of the various sectors assume that 180 million tons of carbon reduction occurs through energy efficient technology adoption without the price effect of a \$50/ton permit. This implies that, with government programs, private agents will adopt technologies because the benefits (energy cost-savings) exceed the costs of adoption. The authors claim that these reductions occur at negative net costs. By failing to account for the effect of decreased energy demand due to energy efficiency technology adoption, some of those adoption decisions that occur on the margin would no longer generate positive net benefits for private consumers. The Labs Study indicates that energy consumption will decline from the baseline by 11.6% under the high efficiency/low carbon case (p. xi). This decrease in demand should result in a decrease in the price of energy, and cause some energy-intensive technologies to become unattractive to private agents.

In addition, the absence of an integrated analysis precludes an assessment of the economy-wide effects of a tradeable permit system. As previous studies have indicated, the nature of the permit allocation (e.g., grandfathering, auction, or a hybrid) and the characteristics of the revenue recycling (e.g., various adjustments to existing taxes) can affect economy-wide investment. Understanding the effects on investment is instrumental in assessing the likelihood of success of these scenarios, given that they rely on substantial R&D and technology adoption.

The Industry Sector Analysis Ignores the Costs of Accelerated Retirement

"When the economic losses of accelerated retirement are accounted for this means that, at the margin, all investments are not likely to be cost effective at our assumed 15% CRF [capital recovery factor]. Since we do not have a model to account for this potential early retirement and the economic losses, we must caveat our estimates of investment and net costs. ...the investment cost may be understated by the amount of loss due to any early retirement that may occur" (p. 4.15).

This assumption implies that one of three results should be accounted for in the analysis. First, the projected emissions reduction should be revised downward, because the assessment of the industry sector overestimates technology adoption by ignoring these costs. Second, the cost of reducing emissions, if the reduced carbon from this sector remains constant, should increase, with some technology adoption decisions occurring at positive net costs. Third, if the authors maintain the same costs and emissions estimates, then the costs of government programs to somehow force down the CRF from 33% to 15% would increase.

The Transportation Sector Requires "Luck" to Achieve Carbon Reductions

"[B]ecause the [transportation sector] outcomes postulated in the high efficiency/low carbon scenario require technological breakthroughs, they require a certain degree of luck to be achieved by 2010. There are no credible methods to accurately gauge the probability of such breakthroughs -- we believe they stand a decent chance of occurring with an intensification of research efforts, but we stop short of claiming they are a likely outcome of such an intensification" (p. 5.3).

Note that this statement includes two qualifications: luck on top of intensified research efforts. To achieve just the efficiency level of emissions reductions for this sector (73 million tons), these intensified research efforts may require two to ten times existing funding on transportation (p. 5.3). To gain a sense of the magnitude of what such an increase in funding might be, consider that the Partnership for a New Generation of Vehicles alone is funded at the federal level at \$263 million. Further, the estimates of costless (on net) carbon reductions relies on a series of tenuous assumptions: commercial development of the fuel cell for passenger cars, commercial availability of cellulosic ethanol (and the elimination of the ethanol excise tax exemption), and an apparently arbitrary 30% reduction in costs for "certain key technologies" (p. 5.24). These technologies are not identified, and the report does not provide documentation for the NEMS model runs conducted for the transportation sector.

Interactions Ignored, Double Counting "Likely" in Utilities Sector Analysis

"Chapter 7 considers other electricity supply technology options, including: converting coal-based power plants to natural gas; cofiring coal with biomass; efficiency improvements in generation and transmission and distribution systems; extending the life of existing nuclear plants; increasing generation and capacity of existing hydropower plants; and constructing new powerplants using advanced coal technologies. Each of these options is assessed independently. Thus, interactions between the options are not taken into account, and the possibility of double counting is therefore likely" (p. 7.1).

The emissions reductions in the electricity sector come from two sources. First, utilities undertake fuel switching at the \$50/ton permit price through carbon-ordered dispatching. Second, utilities modify their capital stock through several technology options such as those listed in the above quotation. As electricity production moves away from coal in the first analysis, fewer and fewer plants (and therefore potential emissions reductions) will be available for conversion to natural gas or cofiring with biomass. The second set of analyses were "static" and did not optimize unit/plant production cost, dispatch, or system load. Conversations with one of the co-authors (Stanley Hadley of Oak Ridge National Laboratory) indicates that 10 GW of coal-to-gas conversions (approximately 9 million tons of carbon reductions) were double-counted.²

² Hadley noted that a subsequent draft of the report should address at least some of the double counting, but he did not provide details.

Furthermore, the analysis of specific options did not examine the effect of increasing fuel prices (from gas demand due to coal-to-gas repowering). Given the range of assumptions considered in the study, the authors actually estimated that repowering coal plants for natural gas could result in carbon reductions between 5 million and 269 million tons (p. 7.2), depending on the gas/coal price differential, the cost of carbon, and the costs of sulfur dioxide and nitrous oxide emissions. This is quite a substantial range. The Labs Study estimates that natural gas consumption will increase 14% to 191% above 2010 baseline consumption. However, the DRI 1.25 run in the IAT report indicates a 16% decline in natural gas consumption, while the SGM run resulted in only a negligible decline and Markal-Macro generated a 6% increase in natural gas consumption. These three models indicate that a non-integrated analysis that does not account for the price change in natural gas may overestimate natural gas substitution for coal.

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
24	Promote Seasonal Gas Use for Control of Nitrogen Oxides	2.8	0.5	--
25	High-Efficiency Gas Technologies	0.6	Terminated	
26	Renewable-Energy Commercialization	0.8	0.3	--
27	Expand Utility Integrated Resource Planning	1.4	Terminated	
28	Profitable Hydroelectric Efficiency Upgrades	2.0	0.0	--
29	Energy-Efficient Distribution Transformer Standards	0.8	0.5	--
30	Energy Star Distribution Transformers			
31	Transmission Pricing Reform	0.8	Terminated	
New	Green Power Network	Not included	0.0	--
Land-Use Change & Forestry Actions		10.0	2.4	--
43	Private Depletion of Nonindustrial Private Forests	4.0	Terminated	
44	Accelerate Tree Planting in Nonindustrial Private Forests	0.5	0.4	--
16	Waste Minimization	4.2	2.0	--
9	Expand Cool Communities	0.5	To be determined	
Methane Actions		16.3	15.5	--
32	Expand Natural Gas STAR	3.0	3.4	--
33	Increase Stringency of Landfill Rule	4.2	6.3	--
34	Landfill Methane Outreach Program	1.1	1.9	--
35	Coalbed Methane Outreach Program	2.2	2.6	--
36	RD&D for Coal Mine Methane	1.5	Terminated	
37	RD&D for Landfill Methane	1.0	Terminated	
38	AgSTAR Program	1.5	0.3	--
39	Ruminant Livestock Efficiency Program	1.8	1.0	--
Actions to Address Other Greenhouse Gases		16.3	25.4	--
17	Improved Fertilizer Management	4.5	5.3	--
40	Significant New Alternatives Program	5.0	6.4	--
41	HFC-23 Partnerships	5.0	5.0	--
42	Voluntary Aluminum Partnership	1.8	2.2	--
New	Environmental Stewardship Initiative	Not included	6.5	--
Foundation Actions			11.3	--
	Climate Wise	Not estimated	1.8	--
	Climate Challenge	Not estimated	7.6	--
	State and Local Outreach Programs	Not estimated	1.9	--
Total GHG Emission Reductions From CCAP		108.6	76.0	14.0

Data is not readily available for cumulative emissions reductions for many CCAP programs. Emissions reductions of about 5 MMTCE can be attributed to DOE's CCAP programs. EPA's Office of Air and Radiation is responsible for emissions reductions of about 9 MMTCE through their CCAP programs.

Summary of Greenhouse Gas Emissions-Reduction Actions

Million Metric Tons of Carbon Equivalent

Source: U.S. Climate Action Report—1997

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
Residential & Commercial Sector Actions		26.9	10.3	--
New	Rebuild America	2.0	1.6	--
1 and 2	Expanded Green Lights and Energy Star Buildings	3.6	3.3	--
3	State Revolving Fund for Public Buildings	1.1	Terminated	
4	Cost-Shared Demonstrations of Emerging Technologies	3.8	0.0	--
5	Operation and Maintenance Training for Commercial Building Facility Managers and Operators			
6	Energy Star Products	5.0	4.3	--
7	Residential Appliance Standards	6.8	0.2	--
8 and 11	Energy Partnerships for Affordable Housing	4.4	0.4	--
9	Cool Communities			
10	Update State Building Codes			
New	Construction of Energy-Efficient Commercial and Industrial Buildings		0.1	--
New	Superwindow Collaborative		0.0	--
New	Expand Markets for Next-Generation Lighting Products		0.2	--
New	Fuel Cells Initiative		0.0	--
Industrial Sector Actions		19.0	4.8	--
12	Motor Challenge	8.8	1.8	--
13	Industrial Golden Carrot Programs	2.9	Merged into Action 12 Terminated	
14	Accelerate the Adoption of Energy-Efficient Process Technologies			
15	Industrial Assessment Centers	0.5	CCAP Component Terminated	
16	Waste Minimization	4.2	2.1	--
17	Improve Efficiency of Fertilizer Nitrogen Use	2.7	0.8	--
18	Reduce the Use of Pesticides		Terminated	
Transportation Sector Actions		8.1	5.3	--
19	Cash Value of Parking	6.6	4.6	--
20	Innovative Transportation Strategies			
21	Telecommuting Program			
22	Fuel Economy Labels for Tires	1.5	0.7	--
Energy Supply Actions		10.8	1.3	--
23	Increase Natural Gas Share of Energy Use Though Federal Regulatory Reform	2.2	Terminated	

for mmt in efficiency costs
1st ignored/unknown costs
→ policies
implementation
mkt acceptance

MEMORANDUM

TO: Jay Shogren

FROM: Joe Aldy and Quindi Franco

DATE: August 7, 1997

RE: Review of DOE Labs Study, June 10 Draft

$\left(\frac{\text{fixed costs}}{3} \right) \cdot 1.07 \rightarrow \text{arg}$

We provide an assessment of *U.S. Carbon Reductions by 2010 and Beyond: The Potential Impact of Energy-Efficient and Low-Carbon Technologies* (DOE Labs Study, June 10 draft). The report identifies carbon reductions and their associated costs in the buildings, industry, transportation, and electric power sectors under two hypothetical climate policy scenarios. The study finds that, with "very aggressive policies" and a \$50/ton permit price, carbon emissions can be stabilized at 1990 levels by 2010. In reviewing the report, we believe it is beneficial to highlight several of the caveats the authors explicitly state. First, the authors do not provide descriptions of the government programs necessary to stimulate the necessary technology adoption to reduce 180 million tons of carbon emissions. We devised an estimate of the costs of government programs to achieve these reductions based on the nation's experience with CCAP, and found that program costs could total \$45 billion (1995\$). Second, the analyses across sectors are not integrated. Therefore, the penetration rate of energy efficient technologies may be overestimated because the separate sectoral analyses do not account for cross-sector interactions (e.g., in energy prices). Third, the industry sector analysis ignores the costs of accelerating capital retirement, resulting in either an overestimate of reductions or an underestimate of costs. Fourth, the transportation sector requires "luck" in terms of technological innovation to achieve the projected emissions reductions. Fifth, the utilities sector analysis resulted in double counting of emissions reductions. These examples of the qualifications can provide additional insight into the projections of emissions reductions and costs. Upon receiving the final version of the report and documentation of the analyses, we will conduct a more thorough review.

be more explicit
what they want
see in press release

Overview of Report

The Labs Study estimated the carbon emissions reduction opportunities available through technology development and adoption and fuel switching. The Study employs the Energy Information Administration's 1997 baseline (AEO97) for the buildings and industry sectors. For the transportation sector, the authors changed the AEO97 assumption of increasing fuel efficiency in automobiles to constant fuel efficiency. For the utility sector, the baseline was modified to reflect a fully competitive bulk-power market in the year 2010. Discharge, shutdown, repowering, and new construction decisions were optimized to select the amount of capacity that minimized the cost of the power-supply system plus the cost of unserved energy. Compared to AEO97, the final baseline has slightly lower energy prices, larger electricity sales,

and a greater share of gas generation. The study provides emissions reductions from this baseline for two scenarios: 1) “efficiency” and 2) “high efficiency/low carbon”. The study does not describe the policies necessary to achieve emissions reductions nor the costs of federal programs for these scenarios, only their outcomes: increased adoption rates and better technologies.

Efficiency

This case assumes that all technologies adopted are cost-effective given more aggressive federal policies to stimulate development and diffusion of energy efficient technologies. Since these technologies are cost-effective, they all have a net cost less than or equal to zero. The Study estimates that 120 mmtce will be reduced at negative net cost in this scenario. None of these reductions occur in the utility sector as a function of fuel switching or technology adoption to increase combustion efficiency.

High Efficiency/Low Carbon

This case assumes a “greater commitment” to reduce emissions through federal policies, in concert with state and private activities and a \$50/ton permit price that stimulates low carbon technologies (read: primarily fuel switching). The policy is announced in 2000 and the policy’s restrictions are phased-in through 2010. There is an assumed announcement effect (although an AEEI is not specified), increased domestic and international R&D in low-carbon technologies, and a “change in psychology”. The Study estimates 180 mmtce of carbon emissions reductions from the baseline through energy efficient technology adoption at negative net cost (see high efficiency without low carbon technology in chart below). The carbon permits will yield an additional 150-200 mmtce of reductions through low-carbon technology adoption. Given that these occur at a permit price of \$50/ton, the Study estimates the upper limits of these costs to be \$10 billion per year in 2010.

Carbon Emissions (mmtce): 1990 - 2010

1990	2010 Baseline	2010 Efficiency	2010 High Efficiency (w/o Low Carbon Tech)	2010 High Efficiency/Low Carbon
1340	1720	1600	1540	1340 - 1390

Review

The authors of the Lab Study are forthright about many of the assumptions underlying the analysis. Learning about these qualifications can enhance one’s understanding of the estimates regarding cost-effectiveness and emissions reductions in this study. We present several of the most significant assumptions and discussions of their impact below.

The Study Does Not Specify Policies to Achieve Carbon Reductions

“Cost effectiveness is improved because R&D, in combination with increased deployment efforts, result in declining capital costs. We do not specify the policies, economic conditions, or exogenous events that could precipitate such changes” (p. 1.4).

The entire study is premised on two sets of undefined policies: an “aggressive” or “invigorated” public sector effort to stimulate energy efficient technology adoption (efficiency case) and a “very aggressive” public sector effort to stimulate technology development and adoption (high efficiency/low carbon case). The only specific policy instrument mentioned in the report is a \$50/ton tradeable permit. The study makes vague references to policies and only provides details on what these unidentified policies would result in: 1) “better technology” (p. 1.5); 2) “higher penetration rates” (p. 1.6); 3) “changing the capital recovery factor [in industry sector] from 33% to 15%” (p. 4.8); and 4) “technological breakthroughs” (p. 5.3).

The authors assume that policies are implemented that significantly lower the barriers to technology adoption without any discussion of their costs. In effect, this assumes the magical wand of government intervention is waved to lower technology marginal costs enough to get 180 million tons of carbon reductions for “free”: firms and individuals receive energy cost-savings in excess of the technology adoption and implementation costs.

Since the authors do not provide an estimate of the costs to government to lower market barriers to achieve these substantial reductions, we calculated estimates of the costs of emissions reductions programs based on the government’s experience with the Climate Change Action Plan (CCAP). CCAP promotes carbon reductions through a broad array of voluntary programs that stimulate “cost-effective” technology adoption by private firms. Participation by a firm in a CCAP program implies that carbon is reduced and the firm gains financially.¹ CCAP received appropriations totaling \$494 million (1995\$) during the FY95 - FY97 period. During this period, the Department of Energy and the Environmental Protection Agency can account for 14 million metric tons of reduced carbon (see attached table). Each ton of carbon reduced in CCAP cost the federal government \$35.29 (1995\$). Assuming a flat marginal cost curve ($MC=AC$) to reduce 180 million metric tons of carbon beyond the baseline, the government costs of the unidentified policies in the Labs Study would exceed \$6.3 billion. However, the marginal costs of technology adoption are definitely higher than the average cost of the first 14 million metric tons, especially as more and more efforts to reduce emissions are undertaken. Assuming that costs increase 10% for every 10 million metric tons of carbon reduced, then the government cost would come to \$16.1 billion. This is slowly increasing marginal cost curve given baseline assumptions of gains in energy efficiency. Assuming that costs increase 20% for every 10 million metric tons of carbon reduced, then the cost to government would exceed \$45.2 billion.

The Sectoral Analyses Are Not Integrated

¹ Note that CCAP efforts are incorporated in AEO97.

“The model runs for each of the three end-use sectors were not integrated and therefore may overstate the effects of technology penetration. In an integrated modeling effort, fuel prices might fall as consumption declines, resulting in less penetration of energy-conserving technologies” (p. 1.1).

The analyses of the various sectors assume that 180 million tons of carbon reduction occurs through energy efficient technology adoption without the price effect of a \$50/ton permit. This implies that, with government programs, private agents will adopt technologies because the benefits (energy cost-savings) exceed the costs of adoption. The authors claim that these reductions occur at negative net costs. By failing to account for the effect of decreased energy demand due to energy efficiency technology adoption, some of those adoption decisions that occur on the margin would no longer generate positive net benefits for private consumers. The Labs Study indicates that energy consumption will decline from the baseline by 11.6% under the high efficiency/low carbon case (p. xi). This decrease in demand should result in a decrease in the price of energy, and cause some energy-intensive technologies to become unattractive to private agents.

In addition, the absence of an integrated analysis precludes an assessment of the economy-wide effects of a tradeable permit system. As previous studies have indicated, the nature of the permit allocation (e.g., grandfathering, auction, or a hybrid) and the characteristics of the revenue recycling (e.g., various adjustments to existing taxes) can affect economy-wide investment. Understanding the effects on investment is instrumental in assessing the likelihood of success of these scenarios, given that they rely on substantial R&D and technology adoption.

The Industry Sector Analysis Ignores the Costs of Accelerated Retirement

“When the economic losses of accelerated retirement are accounted for this means that, at the margin, all investments are not likely to be cost effective at our assumed 15% CRF [capital recovery factor]. Since we do not have a model to account for this potential early retirement and the economic losses, we must caveat our estimates of investment and net costs. ...the investment cost may be understated by the amount of loss due to any early retirement that may occur” (p. 4.15).

This assumption implies that one of three results should be accounted for in the analysis. First, the projected emissions reduction should be revised downward, because the assessment of the industry sector overestimates technology adoption by ignoring these costs. Second, the cost of reducing emissions, if the reduced carbon from this sector remains constant, should increase, with some technology adoption decisions occurring at positive net costs. Third, if the authors maintain the same costs and emissions estimates, then the costs of government programs to somehow force down the CRF from 33% to 15% would increase.

The Transportation Sector Requires “Luck” to Achieve Carbon Reductions

“[B]ecause the [transportation sector] outcomes postulated in the high efficiency/low carbon scenario require technological breakthroughs, they require a certain degree of luck to be achieved by 2010. There are no credible methods to accurately gauge the probability of such breakthroughs -- we believe they stand a decent chance of occurring with an intensification of research efforts, but we stop short of claiming they are a likely outcome of such an intensification” (p. 5.3).

Note that this statement includes two qualifications: luck on top of intensified research efforts. To achieve just the efficiency level of emissions reductions for this sector (73 million tons), these intensified research efforts may require two to ten times existing funding on transportation (p. 5.3). To gain a sense of the magnitude of what such an increase in funding might be, consider that the Partnership for a New Generation of Vehicles alone is funded at the federal level at \$263 million. Further, the estimates of costless (on net) carbon reductions relies on a series of tenuous assumptions: commercial development of the fuel cell for passenger cars, commercial availability of cellulosic ethanol (and the elimination of the ethanol excise tax exemption), and an apparently arbitrary 30% reduction in costs for “certain key technologies” (p. 5.24). These technologies are not identified, and the report does not provide documentation for the NEMS model runs conducted for the transportation sector.

Interactions Ignored, Double Counting “Likely” in Utilities Sector Analysis

“Chapter 7 considers other electricity supply technology options, including: converting coal-based power plants to natural gas; cofiring coal with biomass; efficiency improvements in generation and transmission and distribution systems; extending the life of existing nuclear plants; increasing generation and capacity of existing hydropower plants; and constructing new powerplants using advanced coal technologies. Each of these options is assessed independently. Thus, interactions between the options are not taken into account, and the possibility of double counting is therefore likely” (p. 7.1).

The emissions reductions in the electricity sector come from two sources. First, utilities undertake fuel switching at the \$50/ton permit price through carbon-ordered dispatching. Second, utilities modify their capital stock through several technology options such as those listed in the above quotation. As electricity production moves away from coal in the first analysis, fewer and fewer plants (and therefore potential emissions reductions) will be available for conversion to natural gas or cofiring with biomass. The second set of analyses were “static” and did not optimize unit/plant production cost, dispatch, or system load. Conversations with one of the co-authors (Stanley Hadley of Oak Ridge National Laboratory) indicates that 10 GW of coal-to-gas conversions (approximately 9 million tons of carbon reductions) were double-counted.²

² Hadley noted that a subsequent draft of the report should address at least some of the double counting, but he did not provide details.

Furthermore, the analysis of specific options did not examine the effect of increasing fuel prices (from gas demand due to coal-to-gas repowering). Given the range of assumptions considered in the study, the authors actually estimated that repowering coal plants for natural gas could result in carbon reductions between 5 million and 269 million tons (p. 7.2), depending on the gas/coal price differential, the cost of carbon, and the costs of sulfur dioxide and nitrous oxide emissions. This is quite a substantial range. The Labs Study estimates that natural gas consumption will increase 14% to 191% above 2010 baseline consumption. However, the DRI 1.25 run in the IAT report indicates a 16% decline in natural gas consumption, while the SGM run resulted in only a negligible decline and Markal-Macro generated a 6% increase in natural gas consumption. These three models indicate that a non-integrated analysis that does not account for the price change in natural gas may overestimate natural gas substitution for coal.

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
24	Promote Seasonal Gas Use for Control of Nitrogen Oxides	2.8	0.5	--
25	High-Efficiency Gas Technologies	0.6	Terminated	
26	Renewable-Energy Commercialization	0.8	0.3	--
27	Expand Utility Integrated Resource Planning	1.4	Terminated	
28	Profitable Hydroelectric Efficiency Upgrades	2.0	0.0	--
29	Energy-Efficient Distribution Transformer Standards	0.8	0.5	--
30	Energy Star Distribution Transformers			
31	Transmission Pricing Reform	0.8	Terminated	
New	Green Power Network	Not included	0.0	--
Land-Use Change & Forestry Actions		10.0	2.4	--
43	Private Depletion of Nonindustrial Private Forests	4.0	Terminated	
44	Accelerate Tree Planting in Nonindustrial Private Forests	0.5	0.4	--
16	Waste Minimization	4.2	2.0	--
9	Expand Cool Communities	0.5	To be determined	
Methane Actions		16.3	15.5	--
32	Expand Natural Gas STAR	3.0	3.4	--
33	Increase Stringency of Landfill Rule	4.2	6.3	--
34	Landfill Methane Outreach Program	1.1	1.9	--
35	Coalbed Methane Outreach Program	2.2	2.6	--
36	RD&D for Coal Mine Methane	1.5	Terminated	
37	RD&D for Landfill Methane	1.0	Terminated	
38	AgSTAR Program	1.5	0.3	--
39	Ruminant Livestock Efficiency Program	1.8	1.0	--
Actions to Address Other Greenhouse Gases		16.3	25.4	--
17	Improved Fertilizer Management	4.5	5.3	--
40	Significant New Alternatives Program	5.0	6.4	--
41	HFC-23 Partnerships	5.0	5.0	--
42	Voluntary Aluminum Partnership	1.8	2.2	--
New	Environmental Stewardship Initiative	Not included	6.5	--
Foundation Actions			11.3	--
	Climate Wise	Not estimated	1.8	--
	Climate Challenge	Not estimated	7.6	--
	State and Local Outreach Programs	Not estimated	1.9	--
Total GHG Emission Reductions From CCAP		108.6	76.0	14.0

Data is not readily available for cumulative emissions reductions for many CCAP programs. Emissions reductions of about 5 MMTCE can be attributed to DOE's CCAP programs. EPA's Office of Air and Radiation is responsible for emissions reductions of about 9 MMTCE through their CCAP programs.

Summary of Greenhouse Gas Emissions-Reduction Actions

Million Metric Tons of Carbon Equivalent

Source: U.S. Climate Action Report—1997

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
Residential & Commercial Sector Actions		26.9	10.3	--
New	Rebuild America	2.0	1.6	--
1 and 2	Expanded Green Lights and Energy Star Buildings	3.6	3.3	--
3	State Revolving Fund for Public Buildings	1.1	Terminated	
4	Cost-Shared Demonstrations of Emerging Technologies			
5	Operation and Maintenance Training for Commercial Building Facility Managers and Operators	3.8	0.0	--
6	Energy Star Products	5.0	4.3	--
7	Residential Appliance Standards	6.8	0.2	--
8 and 11	Energy Partnerships for Affordable Housing			
9	Cool Communities	4.4	0.4	--
10	Update State Building Codes			
New	Construction of Energy-Efficient Commercial and Industrial Buildings		0.1	--
New	Superwindow Collaborative		0.0	--
New	Expand Markets for Next-Generation Lighting Products		0.2	--
New	Fuel Cells Initiative		0.0	--
Industrial Sector Actions		19.0	4.8	--
12	Motor Challenge	8.8	1.8	--
13	Industrial Golden Carrot Programs	2.9	Merged into Action 12	
14	Accelerate the Adoption of Energy-Efficient Process Technologies		Terminated	
15	Industrial Assessment Centers	0.5	CCAP Component Terminated	
16	Waste Minimization	4.2	2.1	--
17	Improve Efficiency of Fertilizer Nitrogen Use	2.7	0.8	--
18	Reduce the Use of Pesticides		Terminated	
Transportation Sector Actions		8.1	5.3	--
19	Cash Value of Parking			
20	Innovative Transportation Strategies	6.6	4.6	--
21	Telecommuting Program			
22	Fuel Economy Labels for Tires	1.5	0.7	--
Energy Supply Actions		10.8	1.3	--
23	Increase Natural Gas Share of Energy Use Though Federal Regulatory Reform	2.2	Terminated	

MEMORANDUM

TO: Jay Shogren

FROM: Joe Aldy and Quindi Franco

DATE: August 7, 1997

RE: Review of DOE Labs Study, June 10 Draft

We provide an assessment of U.S. Carbon Reductions by 2010 and Beyond: The Potential Impact of Energy-Efficient and Low-Carbon Technologies (DOE Labs Study, June 10 draft). The report identifies carbon reductions and their associated costs in the buildings, industry, transportation, and electric power sectors under two hypothetical climate policy scenarios. The study finds that, with "very aggressive policies" and a \$50/ton permit price, carbon emissions can be stabilized at 1990 levels by 2010. In reviewing the report, we believe it is beneficial to highlight several of the caveats the authors explicitly state. First, the authors do not provide descriptions of the government programs necessary to stimulate the necessary technology adoption to reduce 180 million tons of carbon emissions. ~~We devised~~ an estimate of the costs of government programs to achieve these reductions based on the nation's experience with CCAP, and found that program costs could total \$45 billion (1995\$). Second, the analyses across sectors are not integrated. Therefore, the penetration rate of energy efficient technologies may be overestimated because the separate sectoral analyses do not account for cross-sector interactions (e.g., in energy prices). Third, the industry sector analysis ignores the costs of accelerating capital retirement, resulting in either an overestimate of reductions or an underestimate of costs. Fourth, the transportation sector requires "luck" in terms of technological innovation to achieve the projected emissions reductions. Fifth, the utilities sector analysis resulted in double counting of emissions reductions. These examples of the qualifications can provide additional insight into the projections of emissions reductions and costs. Upon receiving the final version of the report and documentation of the analyses, we will conduct a more thorough review.

Overview of Report

The Labs Study estimated the carbon emissions reduction opportunities available through technology development and adoption and fuel switching. The Study employs the Energy Information Administration's 1997 baseline (AEO97) for the buildings and industry sectors. For the transportation sector, the authors changed the AEO97 assumption of increasing fuel efficiency in automobiles to constant fuel efficiency. For the utility sector, the baseline was modified to reflect a fully competitive bulk-power market in the year 2010. Discharge, shutdown, repowering, and new construction decisions were optimized to select the amount of capacity that minimized the cost of the power-supply system plus the cost of unserved energy. Compared to AEO97, the final baseline has slightly lower energy prices, larger electricity sales,

Based on the actual history of CCAP, we estimate...

Randy's evil eye

inspiration of the study

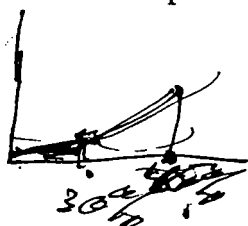
should be...
we do to
tech
costs

source of
do you
not clear

Add \$/ton margins vary.

update this review?

With changing fleet mix towards bigger sport vehicles recently...



and a greater share of gas generation. The study provides emissions reductions from this baseline for two scenarios: 1) "efficiency" and 2) "high efficiency/low carbon". The study does not describe the policies necessary to achieve emissions reductions nor the costs of federal programs for these scenarios, only their outcomes: increased adoption rates and better technologies.

Efficiency Scenario \$25? zero net cost to the user.

This case assumes that all technologies adopted are ~~cost-effective~~ given more aggressive federal policies to stimulate development and diffusion of energy efficient technologies. Since these technologies are ~~cost-effective~~, they all have a net cost less than or equal to zero. The Study estimates that 120 mmtce will be reduced at negative net cost in this scenario. None of these reductions occur in the utility sector as a function of fuel switching or technology adoption to increase combustion efficiency.

Free.
likely
adoption

High Efficiency/Low Carbon Scenario @ \$50/t

This case assumes a "greater commitment" to reduce emissions through federal policies, in concert with state and private activities and a \$50/ton permit price that stimulates low carbon technologies (read: primarily fuel switching). The policy is announced in 2000 and the policy's restrictions are phased-in through 2010. There is an assumed announcement effect (although an AEEI is not specified), increased domestic and international R&D in low-carbon technologies, and a "change in psychology". The Study estimates 180 mmtce of carbon emissions reductions from the baseline through energy efficient technology adoption at negative net cost (see high efficiency without low carbon technology in chart below). The carbon permits will yield an additional 150-200 mmtce of reductions through low-carbon technology adoption. Given that these occur at a permit price of \$50/ton, the Study estimates the upper limits of these costs to be \$10 billion per year in 2010.

Carbon Emissions (mmtce): 1990 - 2010

1990	2010 Baseline	2010 Efficiency	2010 High Efficiency (w/o Low Carbon Tech)	2010 High Efficiency/Low Carbon
1340	1720	1600	1540	1340 - 1390

Review

The authors of the Lab Study are forthright about many of the assumptions underlying the analysis. Learning about these qualifications can enhance one's understanding of the estimates regarding cost-effectiveness and emissions reductions in this study. We present several of the most significant assumptions and discussions of their impact below.

1) Does a delay in effecting these programs require adjustment to the calculation?

~~~~~

The Study Does Not Specify Policies to Achieve Carbon Reductions

"Cost effectiveness is improved because R&D, in combination with increased deployment efforts, result in declining capital costs. We do not specify the policies, economic conditions, or exogenous events that could precipitate such changes" (p. 1.4).

The entire study is premised on two sets of undefined policies: an "aggressive" or "invigorated" public sector effort to stimulate energy efficient technology adoption (efficiency case) and a "very aggressive" public sector effort to stimulate technology development and adoption (high efficiency/low carbon case). The only specific policy instrument mentioned in the report is a \$50/ton tradeable permit. The study makes vague references to policies and only provides details on what these unidentified policies would result in: 1) "better technology" (p. 1.5); 2) "higher penetration rates" (p. 1.6); 3) "changing the capital recovery factor [in industry sector] from 33% to 15%" (p. 4.8); and 4) "technological breakthroughs" (p. 5.3).

The authors assume that policies are implemented that significantly lower the barriers to technology adoption without any discussion of their costs. In effect, this assumes the magical wand of government intervention is waved to lower technology marginal costs enough to get 180 million tons of carbon reductions for "free": firms and individuals receive energy cost-savings in excess of the technology adoption and implementation costs.

Since the authors do not provide an estimate of the costs to government to lower market barriers to achieve these substantial reductions, we calculated estimates of the costs of emissions reductions programs based on the government's experience with the Climate Change Action Plan (CCAP). CCAP promotes carbon reductions through a broad array of voluntary programs that stimulate "cost-effective" technology adoption by private firms. Participation by a firm in a CCAP program implies that carbon is reduced and the firm gains financially.¹ CCAP received appropriations totaling \$494 million (1995\$) during the FY95 - FY97 period. During this period, the Department of Energy and the Environmental Protection Agency can account for 14 million metric tons of reduced carbon (see attached table). Each ton of carbon reduced in CCAP cost the federal government \$35.29 (1995\$). Assuming a flat marginal cost curve ($MC=AC$) to reduce 180 million metric tons of carbon beyond the baseline, the government costs of the unidentified policies in the Labs Study would exceed \$6.3 billion. However, the marginal costs of technology adoption are definitely higher than the average cost of the first 14 million metric tons, especially as more and more efforts to reduce emissions are undertaken. Assuming that costs increase 10% for every 10 million metric tons of carbon reduced, then the government cost would come to \$16.1 billion. This is slowly increasing marginal cost curve given baseline assumptions of gains in energy efficiency. Assuming that costs increase 20% for every 10 million metric tons of carbon reduced, then the cost to government would exceed \$45.2 billion.

good to have other evidence on how fast MC rise

3

~~~~~

¹ Note that CCAP efforts are incorporated in AEO97.

~~~~~

~~~~~

The Sectoral Analyses Are Not Integrated

"The model runs for each of the three end-use sectors were not integrated and therefore may overstate the effects of technology penetration. In an integrated modeling effort, fuel prices might fall as consumption declines, resulting in less penetration of energy-conserving technologies" (p. 1.1).

zero or
The analyses of the various sectors assume that 180 million tons of carbon reduction occurs through energy efficient technology adoption without the price effect of a \$50/ton permit. This implies that, with government programs, private agents will adopt technologies because the benefits (energy cost-savings) exceed the costs of adoption. The authors claim that these reductions occur at negative net costs. By failing to account for the effect of decreased energy demand due to energy efficiency technology adoption, some of those adoption decisions that occur on the margin would no longer generate positive net benefits for private consumers. The Labs Study indicates that energy consumption will decline from the baseline by 11.6% under the high efficiency/low carbon case (p. xi). This decrease in demand should result in a decrease in the price of energy, and cause some energy-intensive technologies to become unattractive to private agents.

Do we have an estimate of how much they over-predict?
In addition, the absence of an integrated analysis precludes an assessment of the economy-wide effects of a tradeable permit system. As previous studies have indicated, the nature of the permit allocation (e.g., grandfathering, auction, or a hybrid) and the characteristics of the revenue recycling (e.g., various adjustments to existing taxes) can affect economy-wide investment. Understanding the effects on investment is instrumental in assessing the likelihood of success of these scenarios, given that they rely on substantial R&D and technology adoption.

The Industry Sector Analysis Ignores the Costs of Accelerated Retirement

"When the economic losses of accelerated retirement are accounted for this means that, at the margin, all investments are not likely to be cost effective at our assumed 15% CRF [capital recovery factor]. Since we do not have a model to account for this potential early retirement and the economic losses, we must caveat our estimates of investment and net costs. ...the investment cost may be understated by the amount of loss due to any early retirement that may occur" (p. 4.15).

This assumption implies that one of three results should be accounted for in the analysis. First, the projected emissions reduction should be revised downward, because the assessment of the industry sector overestimates technology adoption by ignoring these costs. Second, the cost of reducing emissions, if the reduced carbon from this sector remains constant, should increase, with some technology adoption decisions occurring at positive net costs. Third, if the authors maintain the same costs and emissions estimates, then the costs of government programs to somehow force down the CRF from 33% to 15% would increase.

The Transportation Sector Requires "Luck" to Achieve Carbon Reductions

"[B]ecause the [transportation sector] outcomes postulated in the high efficiency/low carbon scenario require technological breakthroughs, they require a certain degree of luck to be achieved by 2010. There are no credible methods to accurately gauge the probability of such breakthroughs -- we believe they stand a decent chance of occurring with an intensification of research efforts, but we stop short of claiming they are a likely outcome of such an intensification" (p. 5.3).

are there
with
included
in your
5.5 & ?

Note that this statement includes two qualifications: luck on top of intensified research efforts. To achieve just the efficiency level of emissions reductions for this sector (73 million tons), these intensified research efforts may require two to ten times existing funding on transportation (p. 5.3). To gain a sense of the magnitude of what such an increase in funding might be, consider that the Partnership for a New Generation of Vehicles alone is funded at the federal level at \$263 million. Further, the estimates of costless (on net) carbon reductions relies on a series of tenuous assumptions: commercial development of the fuel cell for passenger cars, commercial availability of cellulosic ethanol (and the elimination of the ethanol excise tax exemption), and an apparently arbitrary 30% reduction in costs for "certain key technologies" (p. 5.24). These technologies are not identified, and the report does not provide documentation for the NEMS model runs conducted for the transportation sector.

Interactions Ignored, Double Counting "Likely" in Utilities Sector Analysis

"Chapter 7 considers other electricity supply technology options, including: converting coal-based power plants to natural gas; cofiring coal with biomass; efficiency improvements in generation and transmission and distribution systems; extending the life of existing nuclear plants; increasing generation and capacity of existing hydropower plants; and constructing new powerplants using advanced coal technologies. Each of these options is assessed independently. Thus, interactions between the options are not taken into account, and the possibility of double counting is therefore likely" (p. 7.1).

The emissions reductions in the electricity sector come from two sources. First, utilities undertake fuel switching at the \$50/ton permit price through carbon-ordered dispatching. Second, utilities modify their capital stock through several technology options such as those listed ~~in the above quotation~~. As electricity production moves away from coal in the first analysis, fewer and fewer plants (and therefore potential emissions reductions) will be available for conversion to natural gas or cofiring with biomass. The second set of analyses were "static" and did not optimize unit/plant production cost, dispatch, or system load. Conversations with one of the co-authors (Stanley Hadley of Oak Ridge National Laboratory) indicates that 10 GW

of coal-to-gas conversions (approximately 9 million tons of carbon reductions) were double-counted.²

Furthermore, the analysis of specific options did not examine the effect of increasing fuel prices (from gas demand due to coal-to-gas repowering). Given the range of assumptions considered in the study, the authors actually estimated that repowering coal plants for natural gas could result in carbon reductions between 5 million and 269 million tons (p. 7.2), depending on the gas/coal price differential, the cost of carbon, and the costs of sulfur dioxide and nitrous oxide emissions. This is quite a substantial range. The Labs Study estimates that natural gas consumption will increase 14% to 191% above 2010 baseline consumption. However, the DRI 1.25 run in the IAT report indicates a 16% decline in natural gas consumption, while the SGM run resulted in only a negligible decline and Markal-Macro generated a 6% increase in natural gas consumption. These three models indicate that a non-integrated analysis that does not account for the price change in natural gas may overestimate natural gas substitution for coal.

² Hadley noted that a subsequent draft of the report should address at least some of the double counting, but he did not provide details.

Summary of Greenhouse Gas Emissions-Reduction Actions

Million Metric Tons of Carbon Equivalent

Source: U.S. Climate Action Report—1997

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
Residential & Commercial Sector Actions		26.9	10.3	--
New	Rebuild America	2.0	1.6	--
1 and 2	Expanded Green Lights and Energy Star Buildings	3.6	3.3	--
3	State Revolving Fund for Public Buildings	1.1	Terminated	
4	Cost-Shared Demonstrations of Emerging Technologies	3.8	0.0	--
5	Operation and Maintenance Training for Commercial Building Facility Managers and Operators			
6	Energy Star Products	5.0	4.3	--
7	Residential Appliance Standards	6.8	0.2	--
8 and 11	Energy Partnerships for Affordable Housing	4.4	0.4	--
9	Cool Communities			
10	Update State Building Codes			
New	Construction of Energy-Efficient Commercial and Industrial Buildings		0.1	--
New	Superwindow Collaborative		0.0	--
New	Expand Markets for Next-Generation Lighting Products		0.2	--
New	Fuel Cells Initiative		0.0	--
Industrial Sector Actions		19.0	4.8	--
12	Motor Challenge	8.8	1.8	--
13	Industrial Golden Carrot Programs	2.9	Merged into Action 12 Terminated	
14	Accelerate the Adoption of Energy-Efficient Process Technologies			
15	Industrial Assessment Centers	0.5	CCAP Component Terminated	
16	Waste Minimization	4.2	2.1	--
17	Improve Efficiency of Fertilizer Nitrogen Use	2.7	0.8	--
18	Reduce the Use of Pesticides			
Transportation Sector Actions		8.1	5.3	--
19	Cash Value of Parking	6.6	4.6	--
20	Innovative Transportation Strategies			
21	Telecommuting Program			
22	Fuel Economy Labels for Tires	1.5	0.7	--
Energy Supply Actions		10.8	1.3	--
23	Increase Natural Gas Share of Energy Use Though Federal Regulatory Reform	2.2	Terminated	

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
24	Promote Seasonal Gas Use for Control of Nitrogen Oxides	2.8	0.5	--
25	High-Efficiency Gas Technologies	0.6	Terminated	
26	Renewable-Energy Commercialization	0.8	0.3	--
27	Expand Utility Integrated Resource Planning	1.4	Terminated	
28	Profitable Hydroelectric Efficiency Upgrades	2.0	0.0	--
29	Energy-Efficient Distribution Transformer Standards	0.8	0.5	--
30	Energy Star Distribution Transformers			
31	Transmission Pricing Reform	0.8	Terminated	
New	Green Power Network	Not included	0.0	--
Land-Use Change & Forestry Actions		10.0	2.4	--
43	Private Depletion of Nonindustrial Private Forests	4.0	Terminated	
44	Accelerate Tree Planting in Nonindustrial Private Forests	0.5	0.4	--
16	Waste Minimization	4.2	2.0	--
9	Expand Cool Communities	0.5	To be determined	
Methane Actions		16.3	15.5	--
32	Expand Natural Gas STAR	3.0	3.4	--
33	Increase Stringency of Landfill Rule	4.2	6.3	--
34	Landfill Methane Outreach Program	1.1	1.9	--
35	Coalbed Methane Outreach Program	2.2	2.6	--
36	RD&D for Coal Mine Methane	1.5	Terminated	
37	RD&D for Landfill Methane	1.0	Terminated	
38	AgSTAR Program	1.5	0.3	--
39	Ruminant Livestock Efficiency Program	1.8	1.0	--
Actions to Address Other Greenhouse Gases		16.3	25.4	--
17	Improved Fertilizer Management	4.5	5.3	--
40	Significant New Alternatives Program	5.0	6.4	--
41	HFC-23 Partnerships	5.0	5.0	--
42	Voluntary Aluminum Partnership	1.8	2.2	--
New	Environmental Stewardship Initiative	Not included	6.5	--
Foundation Actions			11.3	--
	Climate Wise	Not estimated	1.8	--
	Climate Challenge	Not estimated	7.6	--
	State and Local Outreach Programs	Not estimated	1.9	--
Total GHG Emission Reductions From CCAP		108.6	76.0	14.0

Data is not readily available for cumulative emissions reductions for many CCAP programs. Emissions reductions of about 5 MMTCE can be attributed to DOE's CCAP programs. EPA's Office of Air and Radiation is responsible for emissions reductions of about 9 MMTCE through their CCAP programs.

Office of Economic Policy

Department of the Treasury
Washington, D.C. 20220

FAX

Date: Dec. 30, 1997
Number of pages including cover sheet: 5

Name	Fax Number	Phone Number
To: <u>Jeff Frankel</u>	<u>395-1958</u>	<u>395-5046</u>
From: <u>Jon Gruber</u>	<u>202-622-2633</u>	

REMARKS: ☐ Urgent ☐ For your review ☐ Reply ASAP ☐ Please commentHold Close

Jeff -

Larry Summers suggested that I talk, on deep background, to a couple of outside experts to see what they would view as reasonable for our economic analysis. I attach (for your eyes only, obviously) some discussion of their views. I also attach a revised set of runs that I think Joe should do, reflecting these views. I haven't passed these on to Joe yet.

My only question is: have I been too conservative on the possibilities for JI/LDC participation? Maybe we should do some runs where JI/LDCs give us more benefits than the 20% that I assume? I don't know enough about the structure of the model to assess this.

Give me a call when you get in and lets discuss.

Jon

Expert Opinion on Economic Analysis

Contacts: Rob Stavins, Mike Toman, Dick Schmalensee

Starting Point: Roughly \$100/ton from SGM model (this is with domestic only, and 1% AEEI)

All experts seem comfortable with this model and have great respect for Edmunds and Batelle. They seem to think that this is a sensible starting point. Stavins did note that this assumes that we equate marginal costs and pursue only least cost efficient paths to reduction. He points out that in reality this is unlikely. Schmalensee highlighted that timing is key - but the runs that CEA is using are calibrated for reductions to start in 2005, when our permit system kicks in.

Annex I Trading: Pure Annex I trading can roughly halve costs to \$50; the umbrella might get the price down to \$30

There was general comfort with the numbers, but all highlighted that this was conditional on perfect trading being in place, and there was also general skepticism that this could emerge. Stavins once again highlighted that this assumes we find global least cost reductions, which seems even more suspect since it requires other countries to be efficient as well. On the other hand, all recognize the huge value of the Russian tons. There was some skepticism that the EU would, at the end of the day, let themselves get shut out of the Russian tons.

Technology: The IAT used an AEEI of 1.25, and it was mildly criticized as a bit optimistic - but this was before the \$6 billion in the budget, and without any price signal. 5 Labs implies an AEEI of 1.71. An AEEI of 1.25 would bring price down to roughly \$80.

I think that there would be support for 1.25 AEEI, but not for much more - certainly nothing approaching 5 labs. Schmalensee pointed out that, even without an explicit price signal, Kyoto highlights that "the train is moving" and should promote the growth of the energy efficient technologies.

Joint Implementation and LDCs: Models tell us effect of Annex I trading, and worldwide trading. Question is: how much of the gap between these two is closed by JI?

Would be little support for claiming anything close to the majority of this gap. But there would, I think, be support for claiming a small share, say 10-20% of the gap. Schmalensee said <10%, Toman said up to 20%. There was no real view on the prospects of additional LDC participation, but pretty strong skepticism that it would amount to much.

Electricity Restructuring: We can claim economic benefits from restructuring. Can we claim some enviro benefits as well?

Gruenspecht says that we can get electricity savings of 10% from restructuring. This is \$20 billion now and ??? in 2010. Joskow says 8-10%, but will defer to Howard as well. By 2010, stranded costs are all paid, so that we get full benefits of lower prices.

There was generally strong skepticism among this group about claims of environmental benefits. Toman even pointed out that Howard Gruenspecht had actually changed his position on this over the past year. I think that the best we can do here is claim environmental neutrality, and maybe some qualitative statements about potential gains - putting numbers on this is going to get us in trouble.

Other Benefits: There may be gains from reducing costs of meeting NAAQS, or health benefits (but not both).

There was support for some benefits here. Toman thought that most of the action would be health benefits, since he didn't think that NAAQS would be effective by 2010. Ray notes that administration policy is that NAAQS will be effective by then, so that the benefits will be in dollars, not health.

Bottom Line: There seems to be professional support for claiming some technology gains, some small JI/LDC benefit, full Annex I trading gains, and perhaps for some gains from umbrella. But we have to recognize that this analysis will be criticized by some folks on the grounds that it is too idealistic on trading, and by others on the grounds that it implies that we buy our way out of the majority of our reductions. Both these criticisms will rise in proportion to the gains that we claim from umbrella.

It seems like an analysis with 1.25 AEEI, Annex I trading including EU (no umbrella), and JI/LDC that gets 20% of WW trading benefits would be pretty well received. Moving to the umbrella would bring some criticism, but not an avalanche. Going beyond that on trading or technology would be steeply criticized. I remain unclear on how much we can justify on JI/LDC

Given these comments, here is a revised set of runs that I think we should do:

Model Permutations to Consider:

- 1) Full Annex I trading
- 2) Umbrella - trading block that excludes EU and Eastern Europe
- 3) AEEI of 1.25
- 4) JI/LDC participation that gets us 20% of the gains of worldwide trading (beyond Annex I trading).

Question: Are interactions linear? Worth trying some combined and separate estimates to get a feel for this, although we don't want to get out of control. I would suggest the following set of runs:

- 1-3) Do the first three factors individually
- 4) Annex I trading with JI/LDC
- 5) Annex I trading, with umbrella, and JI/LDC
- 6) Higher AEEI, with Annex I trading
- 7) Higher AEEI, with Annex I trading and umbrella
- 8) Higher AEEI, with Annex I trading and JI/LDC
- 9) Higher AEEI, with Annex I trading, umbrella, and JI/LDC

For each of these cases, we should show what happens to permit price, and what share of our reductions are purchased abroad.

Office of Economic Policy

Department of the Treasury
Washington, D.C. 20220

FAX

Date: Dec. 30, 1997
Number of pages including cover sheet: 5

Name	Fax Number	Phone Number
To: <u>Jeff Frankel</u>	<u>395-1A58</u>	<u>395-5D46</u>
From: <u>Jon Gruber</u>	<u>202-622-2633</u>	

REMARKS: ☐ Urgent ☐ For your review ☐ Reply ASAP ☐ Please commentHold Close

Jeff -

Larry Summers suggested that I talk, on deep background, to a couple of outside experts to see what they would view as reasonable for our economic analysis. I attach (for your eyes only, obviously) some discussion of their views. I also attach a revised set of runs that I think Joe should do, reflecting these views. I haven't passed these on to Joe yet.

My only question is: have I been too conservative on the possibilities for JI/LDC participation? Maybe we should do some runs where JI/LDCs give us more benefits than the 20% that I assume? I don't know enough about the structure of the model to assess this.

Give me a call when you get in and lets discuss.

Jon

Expert Opinion on Economic Analysis

Contacts: Rob Stavins, Mike Toman, Dick Schmalensee

Starting Point: Roughly \$100/ton from SGM model (this is with domestic only, and 1% AEEI)

All experts seem comfortable with this model and have great respect for Edmunds and Batelle. They seem to think that this is a sensible starting point. Stavins did note that this assumes that we equate marginal costs and pursue only least cost efficient paths to reduction. He points out that in reality this is unlikely. Schmalensee highlighted that timing is key - but the runs that CEA is using are calibrated for reductions to start in 2005, when our permit system kicks in.

Annex I Trading: Pure Annex I trading can roughly halve costs to \$50; the umbrella might get the price down to \$30

There was general comfort with the numbers, but all highlighted that this was conditional on perfect trading being in place, and there was also general skepticism that this could emerge. Stavins once again highlighted that this assumes we find global least cost reductions, which seems even more suspect since it requires other countries to be efficient as well. On the other hand, all recognize the huge value of the Russian tons. There was some skepticism that the EU would, at the end of the day, let themselves get shut out of the Russian tons.

Technology: The IAT used an AEEI of 1.25, and it was mildly criticized as a bit optimistic - but this was before the \$6 billion in the budget, and without any price signal. 5 Labs implies an AEEI of 1.71. An AEEI of 1.25 would bring price down to roughly \$80.

I think that there would be support for 1.25 AEEI, but not for much more - certainly nothing approaching 5 labs. Schmalensee pointed out that, even without an explicit price signal, Kyoto highlights that "the train is moving" and should promote the growth of the energy efficient technologies.

Joint Implementation and LDCs: Models tell us effect of Annex I trading, and worldwide trading. Question is: how much of the gap between these two is closed by JI?

Would be little support for claiming anything close to the majority of this gap. But there would, I think, be support for claiming a small share, say 10-20% of the gap. Schmalensee said <10%, Toman said up to 20%. There was no real view on the prospects of additional LDC participation, but pretty strong skepticism that it would amount to much.

Electricity Restructuring: We can claim economic benefits from restructuring. Can we claim some enviro benefits as well?

Gruenspecht says that we can get electricity savings of 10% from restructuring. This is \$20 billion now and ??? in 2010. Joskow says 8-10%, but will defer to Howard as well. By 2010, stranded costs are all paid, so that we get full benefits of lower prices.

There was generally strong skepticism among this group about claims of environmental benefits. Toman even pointed out that Howard Gruenspecht had actually changed his position on this over the past year. I think that the best we can do here is claim environmental neutrality, and maybe some qualitative statements about potential gains - putting numbers on this is going to get us in trouble.

Other Benefits: There may be gains from reducing costs of meeting NAAQS, or health benefits (but not both).

There was support for some benefits here. Toman thought that most of the action would be health benefits, since he didn't think that NAAQS would be effective by 2010. Ray notes that administration policy is that NAAQS will be effective by then, so that the benefits will be in dollars, not health.

Bottom Line: There seems to be professional support for claiming some technology gains, some small JI/LDC benefit, full Annex I trading gains, and perhaps for some gains from umbrella. But we have to recognize that this analysis will be criticized by some folks on the grounds that it is too idealistic on trading, and by others on the grounds that it implies that we buy our way out of the majority of our reductions. Both these criticisms will rise in proportion to the gains that we claim from umbrella.

It seems like an analysis with 1.25 AEEI, Annex I trading including EU (no umbrella), and JI/LDC that gets 20% of WW trading benefits would be pretty well received. Moving to the umbrella would bring some criticism, but not an avalanche. Going beyond that on trading or technology would be steeply criticized. I remain unclear on how much we can justify on JI/LDC

Given these comments, here is a revised set of runs that I think we should do:

Model Permutations to Consider:

- 1) Full Annex I trading
- 2) Umbrella - trading block that excludes EU and Eastern Europe
- 3) AEEI of 1.25
- 4) JI/LDC participation that gets us 20% of the gains of worldwide trading (beyond Annex I trading).

Question: Are interactions linear? Worth trying some combined and separate estimates to get a feel for this, although we don't want to get out of control. I would suggest the following set of runs:

- 1-3) Do the first three factors individually
- 4) Annex I trading with JI/LDC
- 5) Annex I trading, with umbrella, and JI/LDC
- 6) Higher AEEI, with Annex I trading
- 7) Higher AEEI, with Annex I trading and umbrella
- 8) Higher AEEI, with Annex I trading and JI/LDC
- 9) Higher AEEI, with Annex I trading, umbrella, and JI/LDC

For each of these cases, we should show what happens to permit price, and what share of our reductions are purchased abroad.

Talking Points for Calls to Potential Economist Validators

- Wanted to talk to you about global climate change and the Kyoto agreement.
- Know you have been following issue, and wanted to provide our perspective on the economics involved:
 - As the letter from 2,500 economists [which you signed] on this issue indicates, "The most efficient approach to slowing climate change is through market based policies. In order for the world to achieve its climate objectives at minimum cost, a cooperative approach among nations is required -- such as an international emissions trading program."
 - The treaty we agreed to in Kyoto, and the Administration's overall approach to climate change, emphasize this market-based approach. The Kyoto agreement includes provisions for international trading, for a Clean Development Mechanism, and for other sources of flexibility. We prevailed on these and other key points against very broad opposition.

At same time, the treaty did not bring developing countries on board and that is the next great hurdle. Without it, treaty will never get ratified and the global problem won't get solved.
- I think it is extremely important that economists start pointing out that if the provisions of the Kyoto agreement are fully implemented, the costs are likely to be quite modest. In particular, international trading and other aspects of the treaty (e.g., six gases, sinks) dramatically reduce the costs involved, and many outside studies are neglecting to reflect the institutional details of what was actually agreed.
- The opposition, as you may have seen, is already on the field. [WEFA]
- What I would like to do is start to engage thoughtful leaders like yourself on this issue. I would like to get your best thoughts on how we should be proceeding in analyzing the issue and making our case with the public. And I would hope to enlist your moral support for our efforts to deal with this issue in a sound and sober manner.
 - We will also need your help in thinking through many of the important questions as we move forward. For example, if we ratify the Kyoto agreement, designing an effective cap-and-trade system for carbon emissions will be one of our most important public policy challenges over the next decade, and we will need the help of people like you to make sure we get it right.
- We are trying to organize a dinner with the Vice President, Deputy Secretary Summers, and Chair Yellen in the near future to focus on the economic aspects of climate change, and I hope you'll be available to join us.

JF 10/16/97

DRAFT TALKING POINTS, TO DEFEND AN AGGRESSIVE GCC PROGRAM

We will protect the environment, and at the same time protect the economy.
Vigorous economic growth and environmental protection must go hand in hand.

The President has spent five years growing the economy, and laying the foundations to sustain that growth into the future. He is not going to endanger that record now. "I have worked far too hard to revitalize the American economy to jeopardize our progress now." [Oct. 1, 1997, WH meeting with weather forecasters.]

The U.S. will not go along with an agreement that threatens sustained economic growth.

While the President is deeply committed to reducing carbon emission, no one could reasonably expect that he -- or future administrations or Congresses -- would allow the costs of this effort to become extreme. That's why we have built in regular economic reviews, to monitor our progress and re-assess how the economy is responding.

Economic models are always subject to a great deal of uncertainty, and forecasts are all the more so. In this case we are talking about unexplored territory.

Fifteen years ago, we never thought we would see an unemployment rate under 5 percent, a core inflation rate of under 2.5 percent, and a Federal budget deficit well under \$50 billion. But that's what has happened. So a degree of modesty with regard to our forecasting abilities is appropriate.

The economics of technological progress, for example, is a big unknown. The processes of invention, innovation, diffusion, and learning, fall under the sway of other Muses at least as much as under the dictates of the goddess of Economics.

The President has faith in the American people, in their ingenuity and determination to overcome obstacles.

In 1941, President Roosevelt called the leaders of industry to the White House, and asked how much, with an all-out effort, they could increase their production of war-related materials and equipment. He then announced to the American people goals that were more ambitious by an order of ___ %. In the end, those goals were attained. The key was national mobilization in the face of a shared global threat. Climate change is a shared global threat. We might not be able to replicate the achievement of 1941. The American people are not all familiar with the new threat. But the President believes that we will never know what we can accomplish unless we try.

"If we would change our habits tomorrow, just some of our habits, we could with no extra charge, no cost at all on society, get rid of 20 percent of the GHG with presently available technology"[8/4/97 press conference]. It is impossible to know to what extent Americans will heed the call. We consumers are fond of our incandescent light bulbs, our high-flow showers and our sport utility vehicles. Industry is fond of its old ways of doing things as well. But the adoption of carbon-saving technology has to be a large part of the solution, and there is no knowing how far it can take us.

Even more unknown than future technological progress is the extent to which the cost of addressing climate change can be substantially reduced by so-called "where flexibility." There are many other countries that could reduce emissions relative to their "business-as-usual" paths at lower costs than can industrialized countries such as the U.S.. We are insisting at Kyoto on a number of treaty provisions that would take advantage of this to reduce the costs to the American economy. These provisions include international trading, joint implementation, and -- most significantly -- participation by developing countries. Many countries disagree with one or more of these proposals. Furthermore, even if we somehow were able to win agreement with all our flexibility proposals, it is difficult to know whether they could be implemented efficiently and enforced fully. But if these uncertainties were resolved in a positive manner, there would be scope for bringing down the costs very substantially.

DRAFT

Q: DO YOU BELIEVE THAT IT IS POSSIBLE TO MEET THE BINDING TARGET OF 1990 EMISSIONS LEVELS BY 2010 WITHOUT INFLICTING HEAVY COSTS ON THE ECONOMY?

A: I believe that the President's package of R&D initiatives, tax cuts for energy efficiency, Federal government energy initiatives, and the market-based permit trading system will be a solid first step in addressing the critical problem of global climate change. While the President is deeply committed to reducing carbon emissions, no one could reasonably expect that he -- or future administrations or Congresses -- would allow the costs of this effort to become extreme. That's why we have built in regular economic reviews, to monitor our progress and re-assess how the economy is responding. [SAFETY VALVE ALSO.]

After all, making predictions 10 or 15 years into the future is very difficult. We can not know with any precision how factors such as technological breakthroughs or successful international trading could lower the costs of addressing climate change.

Q: BUT DON'T MODELS SHOW THAT REACHING 1990 LEVELS BY 2010 WILL REQUIRE \$100 OR \$200 PER TON INCREASES IN CARBON PRICES?

A: There is no definitive answer as to how much it will cost to reach 1990 levels by 2010. Different economic models come up with different numbers based on different assumptions. Many published estimates are in the range that you mention. But as just one example of the uncertainties involved, full worldwide permit trading -- which admittedly may be difficult to implement -- has the potential to reduce costs substantially, to perhaps \$10 or \$20 per ton. If such a worldwide system of trading were to develop, the costs will thus be substantially lower.

In sum, there is substantial uncertainty surrounding how the economy will behave in 10 or 15 years. I must admit that 15 years ago, I never thought I would see an unemployment rate under 5 percent, a core inflation rate of under 2.5 percent, and a Federal budget deficit well under \$50 billion. But that's what's happened. So I would urge a similar degree of modesty here. The important point is that the President's plan is a solid first step in reducing carbon emissions without inflicting excessive costs on the economy.

Q: BUT DOESN'T YOUR OWN ANALYSIS SHOW THAT REACHING 1990 BY 2010 WOULD INVOLVE SUBSTANTIAL COSTS?

A: It seems inappropriate for me to reveal the analysis and views that I have shared with the President. I can say that I have informed him of the results from conventional economic models available in the public domain, and discussed both the benefits and limitations of such models. Given the importance I attach to frank internal discussions, I would prefer not to elaborate beyond that.

Q: HOW DO YOU DEFINE "EXCESSIVE" COSTS? IS \$50 PER TON EXCESSIVE?

A: [ANSWER DEPENDS ON SAFETY VALVE DECISION.]

Q: BUT WON'T THIS EFFORT CAUSE JOB LOSSES OF OVER 1.5 MILLION JOBS?

A: President Clinton's top priority, since his first days in office, has been revitalizing the economy, creating jobs and investing in people and technology to enhance long-term growth. And we have made tremendous progress: growth is strong, unemployment is down to 4.9 percent, and over 13 million jobs have been created since January 1993. He is not going to jeopardize that progress.

As for the specific impact of reducing carbon emissions to 1990 levels by 2010, I would emphasize once again that different economic models come up with different numbers based on different assumptions, and that there is substantial uncertainty involved in the estimates. Furthermore, no one could reasonably expect that this President -- or future administrations or Congresses -- would allow the costs of the effort to become extreme. That's why we have built in regular economic reviews, to monitor our progress and re-assess how the economy is responding. [SAFETY VALVE ALSO.]

Q: IF YOU DON'T KNOW HOW MUCH IT WILL COST TO REACH 1990 LEVELS BY 2010, HOW CAN YOU JUSTIFY GOING FORWARD WITH SUCH A POLICY?

As I have said, it is difficult to determine the exact cost of policies designed to reach 1990 emissions levels by 2010. Global climate change involves economic and physical processes that operate globally and over decades, if not centuries.

But the science is clear and compelling: we humans are changing the global climate. Over time, climate changes will disrupt agriculture, cause droughts and floods and the spread of infectious diseases. We must take steps now to reduce greenhouse gas emissions, and after carefully weighing the advantages and disadvantages of different approaches, the President has decided that reducing emissions to 1990 levels by 2010 is the best way forward.

The President's approach -- which starts with increased R&D spending, tax incentives for energy efficiency, and an aggressive effort on the Federal government's own energy efficiency -- recognizes the uncertainties involved in reducing carbon emissions. No one could reasonably expect that this President -- or future administrations or Congresses -- would allow the costs of the effort to become extreme. That's why we have built in regular economic reviews, to monitor our progress and re-assess how the economy is responding. [SAFETY VALVE ALSO.]

DRAFT

Q: DO YOU BELIEVE THAT IT IS POSSIBLE TO MEET THE BINDING TARGET OF 1990 EMISSIONS LEVELS BY 2010 WITHOUT INFLICTING HEAVY COSTS ON THE ECONOMY?

A: I believe that the President's package of R&D initiatives, tax cuts for energy efficiency, Federal government energy initiatives, and the market-based permit trading system will be a solid first step in addressing the critical problem of global climate change. While the President is deeply committed to reducing carbon emissions, no one could reasonably expect that he -- or future administrations or Congresses -- would allow the costs of this effort to become extreme. That's why we have built in regular economic reviews, to monitor our progress and re-assess how the economy is responding. [SAFETY VALVE ALSO.]

After all, making predictions 10 or 15 years into the future is very difficult. We can not know with any precision how factors such as technological breakthroughs or successful international trading could lower the costs of addressing climate change.

Q: BUT DON'T MODELS SHOW THAT REACHING 1990 LEVELS BY 2010 WILL REQUIRE \$100 OR \$200 PER TON INCREASES IN CARBON PRICES?

A: There is no definitive answer as to how much it will cost to reach 1990 levels by 2010. Different economic models come up with different numbers based on different assumptions. Many published estimates are in the range that you mention. But as just one example of the uncertainties involved, full worldwide permit trading -- which admittedly may be difficult to implement -- has the potential to reduce costs substantially, to perhaps \$10 or \$20 per ton. If such a worldwide system of trading were to develop, the costs will thus be substantially lower.

In sum, there is substantial uncertainty surrounding how the economy will behave in 10 or 15 years. I must admit that 15 years ago, I never thought I would see an unemployment rate under 5 percent, a core inflation rate of under 2.5 percent, and a Federal budget deficit well under \$50 billion. But that's what's happened. So I would urge a similar degree of modesty here. The important point is that the President's plan is a solid first step in reducing carbon emissions without inflicting excessive costs on the economy.

Q: BUT DOESN'T YOUR OWN ANALYSIS SHOW THAT REACHING 1990 BY 2010 WOULD INVOLVE SUBSTANTIAL COSTS?

A: It seems inappropriate for me to reveal the analysis and views that I have shared with the President. I can say that I have informed him of the results from conventional economic models available in the public domain, and discussed both the benefits and limitations of such models. Given the importance I attach to frank internal discussions, I would prefer not to elaborate beyond that.

Q: HOW DO YOU DEFINE "EXCESSIVE" COSTS? IS \$50 PER TON EXCESSIVE?

A: [ANSWER DEPENDS ON SAFETY VALVE DECISION.]

Q: BUT WON'T THIS EFFORT CAUSE JOB LOSSES OF OVER 1.5 MILLION JOBS?

A: President Clinton's top priority, since his first days in office, has been revitalizing the economy, creating jobs and investing in people and technology to enhance long-term growth. And we have made tremendous progress: growth is strong, unemployment is down to 4.9 percent, and over 13 million jobs have been created since January 1993. He is not going to jeopardize that progress.

As for the specific impact of reducing carbon emissions to 1990 levels by 2010, I would emphasize once again that different economic models come up with different numbers based on different assumptions, and that there is substantial uncertainty involved in the estimates. Furthermore, no one could reasonably expect that this President -- or future administrations or Congresses -- would allow the costs of the effort to become extreme. That's why we have built in regular economic reviews, to monitor our progress and re-assess how the economy is responding. [SAFETY VALVE ALSO.]

Q: IF YOU DON'T KNOW HOW MUCH IT WILL COST TO REACH 1990 LEVELS BY 2010, HOW CAN YOU JUSTIFY GOING FORWARD WITH SUCH A POLICY?

As I have said, it is difficult to determine the exact cost of policies designed to reach 1990 emissions levels by 2010. Global climate change involves economic and physical processes that operate globally and over decades, if not centuries.

But the science is clear and compelling: we humans are changing the global climate. Over time, climate changes will disrupt agriculture, cause droughts and floods and the spread of infectious diseases. We must take steps now to reduce greenhouse gas emissions, and after carefully weighing the advantages and disadvantages of different approaches, the President has decided that reducing emissions to 1990 levels by 2010 is the best way forward.

The President's approach -- which starts with increased R&D spending, tax incentives for energy efficiency, and an aggressive effort on the Federal government's own energy efficiency -- recognizes the uncertainties involved in reducing carbon emissions. No one could reasonably expect that this President -- or future administrations or Congresses -- would allow the costs of the effort to become extreme. That's why we have built in regular economic reviews, to monitor our progress and re-assess how the economy is responding. [SAFETY VALVE ALSO.]

Some analysts have proposed using revenues from the sale of emissions permits (designed to slow global warming) to plug the projected entitlements financing gap. This memo argues that earmarking is a bad idea, because there is no inherent connection between the magnitude of the two streams, and because the size of both streams (particularly the emission permit revenues) is extremely uncertain.

Comparison of Anticipated Magnitudes

The first three columns of the attached table show the Social Security Actuary's low, intermediate, and high estimates of the annual financing shortfall in the Social Security system as a fraction of GDP (excluding interest payments or receipts on trust fund balances).¹ In the intermediate projections, the shortfall is monotonically increasing over time, although about 80 percent of the ultimate deterioration has occurred by 2030, when the shortfall is projected to be about 1.7 percent of GDP.

The next three columns show projected emissions permit revenues as a fraction of GDP under the "Peak in 2015" plan (the least aggressive option considered), under three assumptions about the nature of the market for emissions permits: no international trading, trading among Annex I countries, and global trading.² Revenue estimates in 2030 vary by about a factor of ten depending on the assumption about trading. In the "no trading" regime, revenues in 2030 are roughly the same size as the Social Security shortfall, but under the other two options revenues fall far short. By 2050, revenues under "no trading" are more than twice the Social Security shortfall, but under the Annex I trading regime revenues are about 3/4 of the shortfall. The remaining columns of the table show projections of revenues under Annex I trading for the main alternatives to the "Peak in 2015" plan. Revenues for either the "-10% in 2010" or the "1995 in 2010" plans roughly match the intermediate projection of the Social Security financing gap by 2050, but in the early decades revenues substantially exceed the financing gap. Revenues from the "1990 in 2010" plan exceed the financing gap early on but are about 2/3 of the financing gap by 2050.

Of course, the emission-permit revenue scenarios that best match the intermediate projections of the Social Security shortfall do not even remotely match the low or high projections of the Social Security shortfall. Furthermore, the degree of uncertainty about the emission permit revenues is enormous. As an example, the current market price of sodium dioxide emissions permits in the US is about 1/10 of the price that economists had anticipated before the opening of the market.

Public Finance Considerations

Standard public finance theory indicates that earmarked taxes are generally a bad idea, because an optimizing social planner should be free to choose the overall tax schedule to minimize

¹This memo ignores Medicare because the cost estimates for Medicare are so extremely uncertain at this point.

²The permit price streams, emissions paths, and GDP for the climate policy simulations are outputs of SGM. Permit revenues assume an annual auction of all permits allocated to the U.S. government.

efficiency losses, and free to allocate incoming revenues to the places where the social marginal utility of expenditure is highest. From this perspective, the circumstances in which earmarking is least damaging are those in which the tax revenues bear some relationship to expenditure needs. The best example is the dedication of gasoline tax revenues to a trust fund for highway construction and maintenance. On this test, earmarking emissions permit revenues to financing Social Security is a terrible idea. Many of the kinds of shocks that would affect emission permit revenues (especially improvement of emissions technologies) are completely unrelated to shocks to the need for Social Security revenues, while shocks to Social Security needs are probably *negatively* correlated with emission permit revenues. For example, if fertility increases, Social Security financing needs will decline (at least over the projection period), but the extra population will produce more pollution and therefore *more* emission permit revenues.

The most persuasive arguments for earmarked taxes are generally public choice or political economy arguments, which begin either from the premise that the policymaker's objective function differs from that of society, or that the politics of the specific earmarked tax and expenditure have some important interaction that justifies the inefficiencies of earmarking. The best argument that can be made along such lines in this context is that the emission permit is "good" in a sense not likely to be appreciated by the political system at large (presumably because of global externalities), and that therefore it is important to tie the selfish interests of some powerful constituency to the fate of the emissions permits revenues. Specifically, the argument is that if emission permits are perceived as funding Social Security, they may survive political battles because the AARP would defend them (I use the AARP here as a stand-in for all self-proclaimed guardians of Social Security). This argument is not persuasive. The enormous uncertainty about the magnitude of emission permit revenues makes it seem very unlikely that the AARP would be keen to tie the fate of Social Security to an emissions-permit horse in the first place. Even if the Social Security and emissions permits could be linked initially, it seems likely that any shocks to emissions permit revenues would only make the AARP more eager to switch to a more reliable source of revenues. By contrast, the payroll tax is very well-suited as a source of Social Security revenues, because benefits are a function of wages and wage growth, so long-term productivity shocks affect both revenues and expenditures in similar ways.

Conclusion

A less explicit link between entitlements needs and emission permit revenues is more palatable than earmarking. In essentially any foreseeable future, the retirement of the baby boom generation will expand the Federal spending beyond any automatic increase in revenues, putting pressure on the Federal deficit. Extra general revenues from emissions permits would likely be used to some extent to plug that deficit hole, although it also seems likely that part of the revenues would be absorbed by extra spending. One could then use standard public finance arguments to say that, if emission permits are desirable from a social welfare perspective, they should be phased in gradually over time, with a time path chosen to deliver revenues just when the budget deficit is under the greatest pressure.

Year

Social Security Financing Gap (Annual, Percent of GDP)		
Low	Intermediate	High

2000	0.6	0.4	0.2
2005	0.7	0.3	-0.2
2010	0.7	0.1	-0.5
2015	0.3	-0.3	-1.0
2020	-0.2	-0.9	-1.6
2025	-0.5	-1.4	-2.3
2030	-0.7	-1.7	-2.7
2035	-0.7	-1.8	-3.0
2040	-0.5	-1.7	-3.2
2045	-0.4	-1.7	-3.4
2050	-0.3	-1.7	-3.6

Emissions Trading Revenues (Annual, Percent of GDP)						
Peak in 2015			1990 in 2010	-10% in 2010	1995 in 2010	
US Only	Annex I	Global	Annex I	Annex I	Annex I	

0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.6	1.2	1.2	1.2
0.0	0.0	0.0	0.8	1.4	1.4	1.4
0.1	0.4	0.1	0.9	1.5	1.5	1.5
1.2	0.7	0.2	1.0	1.5	1.6	1.6
1.7	0.9	0.2	1.0	1.5	1.6	1.6
2.3	1.1	0.2	1.1	1.6	1.7	1.7
3.0	1.2	0.3	1.2	1.6	1.8	1.8
3.7	1.3	0.3	1.2	1.7	1.9	1.9
4.7	1.3	0.3	1.3	1.8		

Social Security & Carbon Tax Revenues

Some analysts have proposed using revenues from the sale of emissions permits (designed to slow global warming) to plug the projected entitlements financing gap. This memo argues that earmarking is a bad idea, because there is no inherent connection between the magnitude of the two streams, and because the size of both streams (particularly the emission permit revenues) is extremely uncertain.

Comparison of Anticipated Magnitudes

The first three columns of the attached table show the Social Security Actuary's low, intermediate, and high estimates of the annual financing shortfall in the Social Security system as a fraction of GDP (excluding interest payments or receipts on trust fund balances).¹ In the intermediate projections, the shortfall is monotonically increasing over time, although about 80 percent of the ultimate deterioration has occurred by 2030, when the shortfall is projected to be about 1.7 percent of GDP.

The next three columns show projected emissions permit revenues as a fraction of GDP under the "Peak in 2015" plan (the least aggressive option considered), under three assumptions about the nature of the market for emissions permits: no international trading, trading among Annex I countries, and global trading.² Revenue estimates in 2030 vary by about a factor of ten depending on the assumption about trading. In the "no trading" regime, revenues in 2030 are roughly the same size as the Social Security shortfall, but under the other two options revenues fall far short. By 2050, revenues under "no trading" are more than twice the Social Security shortfall, but under the Annex I trading regime revenues are about 3/4 of the shortfall. The remaining columns of the table show projections of revenues under Annex I trading for the main alternatives to the "Peak in 2015" plan. Revenues for either the "-10% in 2010" or the "1995 in 2010" plans roughly match the intermediate projection of the Social Security financing gap by 2050, but in the early decades revenues substantially exceed the financing gap. Revenues from the "1990 in 2010" plan exceed the financing gap early on but are about 2/3 of the financing gap by 2050.

Of course, the emission-permit revenue scenarios that best match the intermediate projections of the Social Security shortfall do not even remotely match the low or high projections of the Social Security shortfall. Furthermore, the degree of uncertainty about the emission permit revenues is enormous. As an example, the current market price of sodium dioxide emissions permits in the US is about 1/10 of the price that economists had anticipated before the opening of the market.

Public Finance Considerations

Standard public finance theory indicates that earmarked taxes are generally a bad idea, because an optimizing social planner should be free to choose the overall tax schedule to minimize

¹This memo ignores Medicare because the cost estimates for Medicare are so extremely uncertain at this point.

²The permit price streams, emissions paths, and GDP for the climate policy simulations are outputs of SGM. Permit revenues assume an annual auction of all permits allocated to the U.S. government.

efficiency losses, and free to allocate incoming revenues to the places where the social marginal utility of expenditure is highest. From this perspective, the circumstances in which earmarking is least damaging are those in which the tax revenues bear some relationship to expenditure needs. The best example is the dedication of gasoline tax revenues to a trust fund for highway construction and maintenance. On this test, earmarking emissions permit revenues to financing Social Security is a terrible idea. Many of the kinds of shocks that would affect emission permit revenues (especially improvement of emissions technologies) are completely unrelated to shocks to the need for Social Security revenues, while shocks to Social Security needs are probably *negatively* correlated with emission permit revenues. For example, if fertility increases, Social Security financing needs will decline (at least over the projection period), but the extra population will produce more pollution and therefore *more* emission permit revenues.

The most persuasive arguments for earmarked taxes are generally public choice or political economy arguments, which begin either from the premise that the policymaker's objective function differs from that of society, or that the politics of the specific earmarked tax and expenditure have some important interaction that justifies the inefficiencies of earmarking. The best argument that can be made along such lines in this context is that the emission permit is "good" in a sense not likely to be appreciated by the political system at large (presumably because of global externalities), and that therefore it is important to tie the selfish interests of some powerful constituency to the fate of the emissions permits revenues. Specifically, the argument is that if emission permits are perceived as funding Social Security, they may survive political battles because the AARP would defend them (I use the AARP here as a stand-in for all self-proclaimed guardians of Social Security). This argument is not persuasive. The enormous uncertainty about the magnitude of emission permit revenues makes it seem very unlikely that the AARP would be keen to tie the fate of Social Security to an emissions-permit horse in the first place. Even if the Social Security and emissions permits could be linked initially, it seems likely that any shocks to emissions permit revenues would only make the AARP more eager to switch to a more reliable source of revenues. By contrast, the payroll tax is very well-suited as a source of Social Security revenues, because benefits are a function of wages and wage growth, so long-term productivity shocks affect both revenues and expenditures in similar ways.

Conclusion

A less explicit link between entitlements needs and emission permit revenues is more palatable than earmarking. In essentially any foreseeable future, the retirement of the baby boom generation will expand the Federal spending beyond any automatic increase in revenues, putting pressure on the Federal deficit. Extra general revenues from emissions permits⁴ would likely be used to some extent to plug that deficit hole, although it also seems likely that part of the revenues would be absorbed by extra spending. One could then use standard public finance arguments to say that, if emission permits are desirable from a social welfare perspective, they should be phased in gradually over time, with a time path chosen to deliver revenues just when the budget deficit is under the greatest pressure.

Year	Social Security Financing Gap (Annual, Percent of GDP)		
	Low	Intermediate	High
2000	0.6	0.4	0.2
2005	0.7	0.3	-0.2
2010	0.7	0.1	-0.5
2015	0.3	-0.3	-1.0
2020	-0.2	-0.9	-1.6
2025	-0.5	-1.4	-2.3
2030	-0.7	-1.7	-2.7
2035	-0.7	-1.8	-3.0
2040	-0.5	-1.7	-3.2
2045	-0.4	-1.7	-3.4
2050	-0.3	-1.7	-3.6

Emissions Trading Revenues (Annual, Percent of GDP)						
Peak in 2015			1990 in 2010	-10% in 2010	1995 in 2010	
US Only	Annex I	Global	Annex I	Annex I	Annex I	
0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0	0.0	0.6	1.2	1.2	
0.0	0.0	0.0	0.8	1.4	1.4	
0.1	0.4	0.1	0.9	1.5	1.5	
1.2	0.7	0.2	1.0	1.5	1.6	
1.7	0.9	0.2	1.0	1.5	1.6	
2.3	1.1	0.2	1.1	1.6	1.6	
3.0	1.2	0.3	1.2	1.6	1.7	
3.7	1.3	0.3	1.2	1.7	1.8	
4.7	1.3	0.3	1.3	1.8	1.9	

Office of Economic Policy

Department of the Treasury
Washington, D.C. 20220

FAX

Date: 9/11/97
Number of pages including cover sheet: 11

Name	Fax Number	Phone Number
To: <u>Joe Aldy</u>	<u>395-16853</u>	<u>395-1455</u>
From: <u>Lara Baldwin</u>	<u>202-622-2633</u>	<u>1022-6773</u>

REMARKS: ☐ Urgent ☐ For your review ☐ Reply ASAP ☐ Please comment

ranges

	Effect on Fuel Prices								
	ΔP if permit price = \$100	ΔP if permit price = \$50	ΔP if permit price = \$80	ΔP if permit price = \$90	ΔP if permit price = \$140	ΔP if permit price = \$30	ΔP if permit price = \$200	ΔP if permit price = \$5	ΔP if permit price = \$25
Natural gas \$/thousand Cubic Feet	\$1.6000	\$0.8000	\$1.2800	\$1.4400	\$2.2400	\$0.4800	\$3.2000	\$0.0800	0.4
Fuel Oil \$/gallon	\$0.3000	\$0.1500	\$0.2400	\$0.2700	\$0.4200	\$0.0900	\$0.6000	\$0.0150	0.075
Electricity \$/kWh	\$0.0150	\$0.0075	\$0.0120	\$0.0135	\$0.0210	\$0.0045	\$0.0300	\$0.0008	0.00375
LPG \$/gallon	\$0.3000	\$0.1500	\$0.2400	\$0.2700	\$0.4200	\$0.0900	\$0.6000	\$0.0150	0.075
Gasoline \$/gallon	\$0.2600	\$0.1300	\$0.2080	\$0.2340	\$0.3640	\$0.0780	\$0.5200	\$0.0130	0.065
Coal \$/ton	\$70.00	\$35.00	\$56.00	\$63.00	\$98.00	\$21.00	\$140.00	\$3.50	17.5
Oil \$/barrel	\$14.00	\$7.00	\$11.20	\$12.60	\$19.60	\$4.20	\$28.00	\$0.70	3.5

Joe's Runs

Incidence of an Energy tax by Percent Share of Current Income
Permit price = \$5

	Number of HH (millions)	Units/HH	% HH using this fuel	Q/hh of each US HH	P	ΔP	QAP	QAP Scaled down by 12%	$\Delta Q/Q$	Δ Expenditure - $\epsilon = -0.4$
Natural Gas	58.7	87.50	60.77%	53.17	\$6.20	0.08	\$4.25	\$3.74	-0.01	\$2.53
Units - thousand cubic feet					\$/gal					
Fuel Oil	10.8	684.00	11.18%	76.47	\$0.90	0.02	\$1.15	\$1.01	-0.01	\$0.68
Units - Gallons					\$/gal					
Electricity	96.6	9,965.00	100.00%	9,965.00	\$0.08	0.00	\$7.47	\$6.58	0.00	\$4.46
Units - kWh					\$/kWh					
LPG	8.1	513.00	8.39%	43.02	\$0.92	0.02	\$0.65	\$0.57	-0.01	\$0.38
Units - Gallons					\$/gal					
Gasoline	84.9	1,067.00	87.89%	937.77	\$1.16	0.01	\$12.19	\$10.73	0.00	\$7.26
Units - Gallons					\$/gal	\$/gal				
Total Direct Costs per Household (1992 dollars)							\$25.71	\$22.63		\$15.31
Total Indirect Costs per Household (1992 dollars)							\$28.45	\$25.04		\$16.94
Total Costs per Household (1992 dollars)							\$54.16	\$47.66		\$32.25
Median HH Income (1992 dollars)							\$30,543.18	\$30,543.18		\$30,543.18
increased direct expenditure as a percentage of median income							0.08%	0.07%		0.05%
increased total expenditure as a percentage of median income							0.18%	0.16%		0.11%

Joe's Runs

Incidence of an Energy tax by Percent Share of Current Income
 Permit price = \$25

	Number of HH (millions)	Units/HH	% HH using this fuel	Q/hh of each US HH	P	ΔP	QAP	QAP Scaled down by 12%	$\Delta Q/Q$	Δ Expenditure - $\epsilon = -0.4$
Natural Gas	58.7	87.50	60.77%	53.17	\$6.20	0.40	\$21.27	18.72	-0.03	\$12.21
Units - thousand cubic feet					\$/gal					
Fuel Oil	10.8	684.00	11.18%	76.47	\$0.90	0.08	\$5.74	5.05	-0.03	\$3.25
Units - Gallons					\$/gal					
Electricity	96.6	9,965.00	100.00%	9,965.00	\$0.08	0.00	\$37.37	32.88	-0.02	\$21.74
Units - kWh					\$/kWh					
LPG	8.1	513.00	8.39%	43.02	\$0.92	0.08	\$3.23	2.84	-0.03	\$1.83
Units - Gallons					\$/gal					
Gasoline	84.9	1,067.00	87.89%	937.77	\$1.16	0.07	\$60.95	53.64	-0.02	\$35.21
Units - Gallons					\$/gal	\$/gal				
Total Direct Costs per Household (1992 dollars)							\$128.55	\$113.13		\$74.24
Total Indirect Costs per Household (1992 dollars)							\$142.25	\$125.18		\$82.15
Total Costs per Household (1992 dollars)							\$270.80	\$238.31		\$156.38
Median HH Income (1992 dollars)							\$30,543.18	\$30,543.18		\$30,543.18
increased direct expenditure as a percentage of median income							0.42%	0.37%		0.24%
increased total expenditure as a percentage of median income							0.89%	0.78%		0.51%

Joe's Runs

Incidence of an Energy tax by Percent Share of Current Income
Permit price = \$30

	Number of HH (millions)	Units/HH	% HH using this fuel	Q/hh of each US HH	P	ΔP	Q ΔP	Q ΔP Scaled down by 12%	$\Delta Q/Q$	Δ Expenditure - $\epsilon = -0.4$
Natural Gas	58.7	87.50	60.77%	53.17	\$6.20	\$0.4800	\$25.52	\$22.46	-0.03	\$14.52
Units - thousand cubic feet					\$/gal	\$/gal				
Fuel Oil	10.8	684.00	11.18%	76.47	\$0.90	\$0.0900	\$6.88	\$6.06	-0.04	\$3.85
Units - Gallons					\$/gal	\$/gal				
Electricity	96.6	9,965.00	100.00%	9,965.00	\$0.08	\$0.0045	\$44.84	\$39.46	-0.02	\$25.92
Units - kWh					\$/kWh	\$/kWh				
LPG	8.1	513.00	8.39%	43.02	\$0.92	\$0.0900	\$3.87	\$3.41	-0.04	\$2.17
Units - Gallons					\$/gal	\$/gal				
Gasoline	84.9	1,067.00	87.89%	937.77	\$1.16	\$0.0780	\$73.15	\$64.37	-0.03	\$41.92
Units - Gallons					\$/gal	\$/gal				
Total Direct Costs per Household (1992 dollars)							\$154.26	\$135.75		\$88.39
Total Indirect Costs per Household (1992 dollars)							\$170.70	\$150.22		\$97.81
Total Costs per Household (1992 dollars)							\$324.97	\$285.97		\$186.20
Median HH Income (1992 dollars)							\$30,543.18	\$30,543.18		\$30,543.18
increased direct expenditure as a percentage of median income							0.51%	0.44%		0.29%
increased total expenditure as a percentage of median income							1.06%	0.94%		0.61%

ranges

Incidence of an Energy tax by Percent Share of Current Income
 Permit price = \$50

	Number of HH (millions)	Units/HH	% HH using this fuel	Q/hh of each US HH	P	ΔP	$\Delta Q/Q$	Δ Expenditure - $\epsilon = -0.4$	Q ΔP	Q ΔP scaled down by 12%
Natural Gas	58.7	87.50	60.77%	53.17	\$6.20	0.80	-0.05	\$23.33	\$42.54	\$37.43
Units - thousand cubic feet					\$/gal	\$/gal				
Fuel Oil	10.8	684.00	11.18%	76.47	\$0.90	0.15	-0.07	\$6.12	\$11.47	\$10.09
Units - Gallons					\$/gal	\$/gal				
Electricity	96.6	9,965.00	100.00%	9,965.00	\$0.08	0.01	-0.04	\$42.11	\$74.74	\$65.77
Units - kWh					\$/kWh	\$/kWh				
LPG	8.1	513.00	8.39%	43.02	\$0.92	0.15	-0.07	\$3.45	\$6.45	\$5.68
Units - Gallons					\$/gal	\$/gal				
Gasoline	84.9	1,067.00	87.89%	937.77	\$1.16	0.13	-0.04	\$67.68	\$121.91	\$107.28
Units - Gallons					\$/gal	\$/gal				
Total Direct Costs per Household (1992 dollars)								\$142.68	\$257.11	\$226.25
Total Indirect Costs per Household (1992 dollars)								\$157.89	\$284.50	\$250.36
Total Costs per Household (1992 dollars)								\$300.57	\$541.61	\$476.62
Median HH Income (1992 dollars)								\$30,543.18	\$30,543.18	\$30,543.18
increased direct expenditure as a percentage of median income								0.47%	0.84%	0.74%
increased total expenditure as a percentage of median income								0.98%	1.77%	1.56%

ranges

Incidence of an Energy tax by Percent Share of Current Income
 Permit price = \$80

	Number of HH (millions)	Units/HH	% HH using this fuel	Q/hh of each US HH	P	ΔP	$\Delta Q/Q$	Δ Expenditure $e - \epsilon = -0.4$	Q ΔP	Q ΔP scaled down by 12%
Natural Gas	58.7	87.50	60.77%	53.17	\$6.20	1.28	-0.08	\$35.21	\$68.06	\$59.89
Units - thousand cubic feet					\$/gal	\$/gal				
Fuel Oil	10.8	684.00	11.18%	76.47	\$0.90	0.24	-0.11	\$9.05	\$18.35	\$16.15
Units - Gallons					\$/gal	\$/gal				
Electricity	96.6	9,965.00	100.00%	9,965.00	\$0.08	0.01	-0.06	\$64.75	\$119.58	\$105.23
Units - kWh					\$/kWh	\$/kWh				
LPG	8.1	513.00	8.39%	43.02	\$0.92	0.24	-0.10	\$5.12	\$10.32	\$9.08
Units - Gallons					\$/gal	\$/gal				
Gasoline	84.9	1,067.00	87.89%	937.77	\$1.16	0.21	-0.07	\$103.04	\$195.06	\$171.65
Units - Gallons					\$/gal	\$/gal				
Total Direct Costs per Household (1992 dollars)								\$217.18	\$411.37	\$362.01
Total Indirect Costs per Household (1992 dollars)								\$240.32	\$455.21	\$400.58
Total Costs per Household (1992 dollars)								\$457.50	\$866.58	\$762.59
Median HH Income (1992 dollars)								\$30,543.18	\$30,543.18	\$30,543.18
increased direct expenditure as a percentage of median income								0.71%	1.35%	1.19%
increased total expenditure as a percentage of median income								1.50%	2.84%	2.50%

ranges

Incidence of an Energy tax by Percent Share of Current Income
 Permit price = \$90

	Number of HH (millions)	Units/HH	% HH using this fuel	Q/hh of each US HH	P	ΔP	$\Delta Q/Q$	Δ Expenditur e - $\epsilon = -0.4$	Q Δ P	Q Δ P scaled down by 12%
Natural Gas	58.7	87.50	60.77%	53.17	\$6.20	1.44	-0.09	\$38.83	\$76.57	\$67.38
Units - thousand cubic feet					\$/gal	\$/gal				
Fuel Oil	10.8	684.00	11.18%	76.47	\$0.90	0.27	-0.12	\$9.91	\$20.65	\$18.17
Units - Gallons					\$/gal	\$/gal				
Electricity	96.6	9,965.00	100.00%	9,965.00	\$0.08	0.01	-0.07	\$71.86	\$134.53	\$118.38
Units - kWh					\$/kWh	\$/kWh				
LPG	8.1	513.00	8.39%	43.02	\$0.92	0.27	-0.12	\$5.61	\$11.61	\$10.22
Units - Gallons					\$/gal	\$/gal				
Gasoline	84.9	1,067.00	87.89%	937.77	\$1.16	0.23	-0.08	\$113.96	\$219.44	\$193.10
Units - Gallons					\$/gal	\$/gal				
Total Direct Costs per Household (1992 dollars)								\$240.16	\$462.79	\$407.26
Total Indirect Costs per Household (1992 dollars)								\$265.75	\$512.11	\$450.65
Total Costs per Household (1992 dollars)								\$505.90	\$974.90	\$857.91
Median HH Income (1992 dollars)								\$30,543.18	\$30,543.18	\$30,543.18
increased direct expenditure as a percentage of median income								0.79%	1.52%	1.33%
increased total expenditure as a percentage of median income								1.66%	3.19%	2.81%

Incidence

**Incidence of an Energy tax by Percent Share of Current Income
For a \$100/ton Permit**

	Number of HH (millions)	Units/HH	% HH using this fuel	Q/hh of each US HH	P	ΔP	$\Delta Q/Q$	Δ Expenditure – $\epsilon = -0.4$	Q Δ P – unadjusted	
Natural Gas	58.7	87.50	60.77%	53.17	6.20	1.60	-0.10	\$42.26	\$85.07	74.86377
Units - thousand cubic feet					\$/gal	\$/gal				
Fuel Oil	10.8	684.00	11.18%	76.47	0.90	0.30	-0.13	\$10.71	\$22.94	20.18862
Units – Gallons					\$/gal	\$/gal				
Electricity	96.6	9,965.00	100.00%	9,965.00	0.08	0.02	-0.07	\$78.75	\$149.48	131.538
Units – kWh					\$/kWh	\$/gal				
LPG	8.1	513.00	8.39%	43.02	0.92	0.30	-0.13	\$6.06	\$12.90	11.3561
Units – Gallons					\$/gal	\$/gal				
Gasoline	84.9	1,067.00	87.89%	937.77	1.16	0.26	-0.09	\$124.43	\$243.82	214.5611
Units – Gallons					\$/gal	\$/gal				
Total Direct Costs per Household (1992 dollars)								\$262.21	\$514.21	452.5076
Total Indirect Costs per Household (1992 dollars)								\$290.15	\$569.01	500.7256
Total Costs per Household (1992 dollars)								\$552.35	\$1,083.22	953.2332
Median HH Income (1992 dollars)								\$30,543.18	\$30,543.18	
increased direct expenditure as a percentage of median income								0.86%	1.68%	
increased total expenditure as a percentage of median income								1.81%	3.55%	

Sources: Number of HH – Energy Information Administration/Household Energy Consumption and Expenditures Survey 1993, adjusted to 1994 dollars

Units/HH – EIA, RECS 1993 Average Consumption per HH (adjusted to 1994 dollars)

% HH using this Fuel – (Number of hh)/(units/HH)

Q/hh of each US HH – (Units/HH)*(%HH using the Fuel)

Price – EIA

ΔP – Buisness Daily, August 7, 1997, p.1

$\Delta Q/Q$ – based on price elasticity of demand for energy of -0.4 from *Energy Economics and Policy*, 1980, p. 232.

Δ Expenditure – $\epsilon = -0.4 \rightarrow$ new price*new quantity - old price*old quantity

Q Δ P – unadjusted

ranges

Incidence of an Energy tax by Percent Share of Current Income
 Permit price = \$140

	Number of HH (millions)	Units/HH	% HH using this fuel	Q/HH of each US HH	P	ΔP	$\Delta Q/Q$	Δ Expenditur e - $\epsilon = -0.4$	Q Δ P	Q Δ P scaled down by 12%
Natural Gas	58.7	87.50	60.77%	53.17	\$6.20	2.24	-0.14	\$54.25	\$119.10	\$104.81
Units - thousand cubic feet					\$/gal					
Fuel Oil	10.8	684.00	11.18%	76.47	\$0.90	0.42	-0.19	\$13.28	\$32.12	\$28.26
Units - Gallons					\$/gal					
Electricity	96.6	9,965.00	100.00%	9,965.00	\$0.08	0.02	-0.10	\$104.12	\$209.27	\$184.15
Units - kWh					\$/kWh					
LPG	8.1	513.00	8.39%	43.02	\$0.92	0.42	-0.18	\$7.54	\$18.07	\$15.90
Units - Gallons					\$/gal					
Gasoline	84.9	1,067.00	87.89%	937.77	\$1.16	0.36	-0.13	\$161.96	\$341.35	\$300.39
Units - Gallons					\$/gal	\$/gal				
Total Direct Costs per Household (1992 dollars)								\$341.15	\$719.90	\$633.51
Total Indirect Costs per Household (1992 dollars)								\$377.50	\$796.61	\$701.02
Total Costs per Household (1992 dollars)								\$718.65	\$1,516.51	\$1,334.53
Median HH Income (1992 dollars)								\$30,543.18	\$30,543.18	\$30,543.18
increased direct expenditure as a percentage of median income								1.12%	2.36%	2.07%
increased total expenditure as a percentage of median income								2.35%	4.97%	4.37%

Joe's Runs

Incidence of an Energy tax by Percent Share of Current Income
 Permit price = \$200

	Number of HH (millions)	Units/HH	% HH using this fuel	Q/hh of each US HH	P	ΔP	Q ΔP	Q ΔP Scaled down by 12%	$\Delta Q/Q$	Δ Expenditure - $\epsilon = -0.4$
Natural Gas	58.7	87.50	60.77%	53.17	\$6.20	\$3.2000	\$170.14	\$149.73	-0.21	\$66.96
Units - thousand cubic feet					\$/gal	\$/gal				
Fuel Oil	10.8	684.00	11.18%	76.47	\$0.90	\$0.6000	\$45.88	\$40.38	-0.27	\$15.29
Units - Gallons					\$/gal	\$/gal				
Electricity	96.6	9,965.00	100.00%	9,965.00	\$0.08	\$0.0300	\$298.95	\$263.08	-0.15	\$135.62
Units - kWh					\$/kWh	\$/kWh				
LPG	8.1	513.00	8.39%	43.02	\$0.92	\$0.6000	\$25.81	\$22.71	-0.26	\$8.75
Units - Gallons					\$/gal	\$/gal				
Gasoline	84.9	1,067.00	87.89%	937.77	\$1.16	\$0.5200	\$487.64	\$429.12	-0.18	\$205.14
Units - Gallons					\$/gal	\$/gal				
Total Direct Costs per Household (1992 dollars)							\$1,028.43	\$905.02		\$431.77
Total Indirect Costs per Household (1992 dollars)							\$1,138.01	\$1,001.45		\$477.78
Total Costs per Household (1992 dollars)							\$2,166.44	\$1,906.47		\$909.56
Median HH Income (1992 dollars)							\$30,543.18	\$30,543.18		\$30,543.18
increased direct expenditure as a percentage of median income							3.37%	2.96%		1.41%
increased total expenditure as a percentage of median income							7.09%	6.24%		2.98%

Comments on \$500 million/year Technology Proposal

DOE's response does not appear to have answered the request of the Principals for a detailed description of the "technology option" in terms of specific policies (dollars spent on R&D, dollars spent on diffusion, imposition of standards, price measures, and moral suasion) and their best-guess estimated effects. At first DOE seems to say that the predicted effects are pure R&D, and then it turns out that there are hidden assumptions about public awareness changing or standards being changed. We continue to believe that much, if not all, of the R&D is probably worth doing, particularly along the lines of the PCAST report. But we also continue to believe in a pessimistic bottom line for the odds of incremental payoffs in terms of carbon reductions by 2010. As John Holdren said in his 9/28 presentation, the time lag for the payoff, even to applied R&D, is simply too long to expect that by 2010 we would get more than "diddly" from new spending.

DOE stated that this proposal is based on the efficiency case in the 5 Labs Study. In a review of the proposal presented on 9/29, it appears that there are numerous divergences from the 5 Labs Study efficiency case. In light of the inconsistencies apparent in the proposal, and the substantial methodological flaws in the 5 Labs Study, it seems imprudent to base significant policy decisions on information received thus far. The point was raised at the 8/19/97 meeting on the 5 Labs Study that this study should not go to or be used by principals. To date, there appears to be insufficient justification to modify this view.

General Comments

- The 5 Labs Study indicates that government programs, utility programs, and state programs cost 15% of technology costs (p. 1.13). Since DOE apportions all carbon savings in their proposal to the federal programs listed in the summary chart, we assume that all costs accrue to the federal government. In the "optimistic" assessment of the costs and benefits, DOE claims that government programs will likely only cost about 7% of technology costs, because half of emissions reductions occur through standards (see below). Assuming that this is true, and that the technology costs of the efficiency case range between \$26 - \$49 billion/year in the optimistic assessment (p. 1.14), then government programs should cost between \$1.82 - \$3.49 billion/year. However, using a 13.5% government cost stipulation (based on a 15% government program cost, minus 10% [instead of 50%] of these costs because of standards), the costs of government programs would range between \$3.51 - \$6.62 billion/year. The proposal presented on 9/29 costs 3 to 13 times less than projected by the 5 Labs Study, and yet generates greater carbon savings.
- The proposal employs standards to a much lesser extent than the 5 Labs Study. In the Study, "at least half of the efficiency occurs as a result of federal policies (e.g., standards and carbon permit charges)" (p. 1.13). Since the efficiency case does not include a carbon permit system, we assume that half of the carbon savings in the efficiency case result from standards. However, in this proposal, only about 10% of the emissions reductions occur due to standards (on the high ends of the ranges, 20 MMTCE out of 206 MMTCE).

- The projected carbon savings for 2010, while indicated as approximately 155 MMTCE, has a range of 127-206 MMTCE. Note that this large range does not overlap with the 5 Labs Study projection of 126 MMTCE (p. 1.12).
- The efficiency case is portrayed in the 5 Labs Study as carbon savings that occur because of already available and cost-effective technologies. In effect, government policies are only necessary to overcome market barriers. However, this proposal appears to be more reliant on R&D than on deployment and diffusion of existing technologies. Using the upper bounds of the ranges of carbon savings, we find that more than half of emissions reductions (104 of 206 MMTCE) result from R&D programs.

Specific Comments

Buildings Sector

Two programs claim to achieve 17-29 MMTCE. Note that under the 5 Labs efficiency case, 25 MMTCE of potential reductions were identified (p. 1.12), with a different penetration assumption than the one provided in the summary chart. The Study employed a 35% penetration rate assumption (p. 3.3), while this summary chart claims to be based on a 15-25% assumption for equipment efficiency and a 25% assumption for 21st Century Housing. With the lower penetration rate assumed in this proposal, we would assume that the carbon savings would be less than those found in the 5 Labs Study -- instead, they are greater. Based on these assumptions and the information provided by the 5 Labs Study, we would expect carbon savings to range between 11-18 MMTCE.

Equipment Efficiency: The 5 Labs Study indicates that a total of 25 MMTCE can be reduced in residential and commercial buildings under the efficiency case. The 9/26 memo describes this set of programs to include fuel cells, even though fuel cells are not in the 5 Labs efficiency case (they only come into play in high efficiency case, although the text is very unclear about whether fuel cells actually generate any benefits prior to 2020).

21st Century Housing: There is insufficient detail provided in the 9/26 memo to identify the appropriate carbon savings in the 5 Labs Study.

Transportation Sector

The 5 Labs Study projects 73 MMTCE reductions in emissions under the efficiency case (p. 1.12), while this proposal estimates carbon savings ranging between 65 - 87 MMTCE. Note that this upper bound is almost equivalent to the high efficiency case with a \$25/ton permit fee in the Study (88 MMTCE).

Two PNGV Categories: The 5 Labs Study indicates that annual PNGV funding is approximately \$250 million/year (p. 5.2). The two categories of increased PNGV programs would sum to \$140 million/year in FY99 and \$260 million/year in FY03. This increase is much less than believed necessary to achieve the goals of the PNGV program. The authors of the 5 Labs Study note that for PNGV to be successful, "substantial additional funding for R&D will be required, perhaps two to

ten times what is presently being spent” (p. 5.7). The proposal increases funding to just the lower end of this required spending level.

Industry Sector

The 5 Labs Study projects 28 MMTCE of carbon emissions reductions under its efficiency case (p. 1.12). This proposal estimates carbon savings under three categories of programs ranging between 30 - 65 MMTCE. Note that the upper end of this range is 11 MMTCE more than the high efficiency case with a \$25/ton permit fee in the 5 Labs Study.

Industries of the Future: In the 5 Labs Study, the list of heavy manufacturing industries in table 4.6 (p. 4.10) corresponds to the list of the Industries of the Future on the DOE webpage (<http://www.oit.doe.gov/iof/industry.html>). In this table, these industries account for only 9 MMTCE in the efficiency case and 21 MMTCE in the high efficiency case (\$50/ton permit system). However, the proposal notes that Industries of the Future programs can achieve carbon reductions ranging between 10 - 20 MMTCE.

Utilities Sector

Three categories of programs claim to generate carbon savings of 15-25 MMTCE. However, the efficiency case in the 5 Labs Study does not project any reductions in carbon emissions in this sector (p. 1.12). Further, the carbon sequestration R&D category of programs is not described in the 9/26 memo.

For additional review of the methodological flaws in the sectoral analyses, refer to earlier memos that provide comments on the 5 Labs Study.



EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL OF ECONOMIC ADVISERS
WASHINGTON, D.C. 20500

SENIOR ECONOMIST

MEMORANDUM

TO: Joe Romm
Acting Assistant Secretary for Energy Efficiency and Renewable Energy
U.S. Department of the Energy

FROM: Jason Shogren *JS* and Joe Aldy *JA*

DATE: August 22, 1997

RE: Review of 5-Labs Report: *Scenarios of U.S. Carbon Reductions*

Enclosed you will find our comments on the report *Scenarios of U.S. Carbon Reductions*. We appreciate the opportunity to review the report and we trust you will incorporate our comments.

Comments on "Scenarios of U.S. Carbon Reductions" (5 Labs Study)

General comment

The report, *Scenarios of U.S. Carbon Reductions*, presents a useful cataloging of the technological options that could play a key role in reducing greenhouse gas emissions. The report does not present the specific policies or the behavioral responses that will trigger the adoption or diffusion of these technologies. As such, the report cannot serve as the basis of decision-making by top policy-makers (as opposed to background detail that others may find useful). The report as written, however, leaves the impression that these technologies are policy, which they are not. The U.S. government does not have directly under its control the decisions of private firms and consumers whether to adopt these technologies. The report must be either redone to reflect how likely these technologies will be used given the behavioral responses to likely policies, or reframed to reflect what it is--a catalog of technologies that might be used to address global climate change. The latter path is more straightforward and could readily be accomplished. *Among other changes, it is essential that DOE remove references to "net savings" from the report because this does not reflect the actual costs of implementing these policies.*

Our specific comments follow.

Executive Summary

- 1) paragraph 3: The point regarding the opportunity to reduce emissions through "a vigorous national commitment" should be explicit that this commitment is implemented through federal policies. To state that 120 MMTCE can be reduced by "energy efficiency alone" seems to imply that these reductions are free. These reductions through energy efficiency are induced by aggressive policies, and the statement should reflect that. The subsequent discussion of reductions with carbon permits should also reflect that the level of reductions can occur only through a carbon pricing policy in addition to any non-price policies (e.g., standards).
- 2) Paragraph 4: Estimates of energy cost savings should not be provided unless and until an adequate estimation approach is used to calculate cost savings.
- 3) Paragraph 5: This paragraph should really concentrate on the point that this study identifies a vast array of technologies that may reduce carbon emissions through climate policy. This is the true strength of the study, and it should be emphasized more.

Chapter 1

4) The entire study is premised on two sets of undefined policies: an “aggressive” or “invigorated” public sector effort to stimulate energy efficient technology adoption (efficiency case) and a “very aggressive” public sector effort to stimulate technology development and adoption (high efficiency/low carbon case). The only specific policy instrument mentioned in the report is a tradeable permit at prices of \$25/ton and \$50/ton. The study merely asserts that these unidentified policies would result in: 1) “better technology” (p. 2.5); 2) “higher penetration rates” (p. 2.5); 3) “changing the capital recovery factor [in industry sector] from 33% to 15%” (p. 4.6); and 4) “technological breakthroughs” (p. 5.3). These policy effects would result in reductions of about 200 MMTCE for “free”: firms and individuals receive energy cost-savings greater than or equal to technology adoption costs.

The report specifically states that the efficiency case reduces, but does not eliminate, market barriers and that implementation costs are ignored. Policy intervention to eliminate a market barrier cannot make society better off and generally makes society worse off to the extent that it imposes costs. In particular, a set of climate change policies to stimulate technology adoption could increase efficiency, but only because they also decrease the effect of a market failure (carbon emissions). Social welfare is improved because the net benefits of indirectly fixing the market failure exceed the costs of removing the barriers. If carbon emissions are appropriately priced (assuming in this case that \$50/ton is the correct carbon price), a policy to remove a barrier will generate negative net benefits. High adoption rates will be realized once prices rise enough for some technologies to clear the barriers.¹

The economics literature has identified several barriers that help explain the slow rate of technology adoption.²

- Qualitative attributes of technologies can affect adoption. Consumers of technology prefer technologies because of a set of characteristics, not just energy efficiency. For example, some consumers may purchase a product with a lower efficiency because the former is more reliable than the efficiency-superior product.

¹ In contrast, policy intervention to address a market failure (such as unpriced carbon emissions) may well make society better off, depending on the stringency of the intervention.

² For a review of these issues, see Gilbert Metcalf and Kevin Hassett, “Measuring the Energy Savings from Home Improvement Investments: Evidence from Monthly Billing Data,” National Bureau of Economic Research Working Paper 6074, June 1997; Jeffrey A. Dubin and Daniel L. McFadden, “An Econometric Analysis of Residential Electric Appliance Holdings and Consumption,” *Econometrica*, vol. 52, no. 2, 1984; Adam B. Jaffe and Robert N. Stavins, “Energy-Efficiency Investments and Public Policy,” *Energy Journal*, vol. 15, no. 2, 1994; Albert L. Nichols, “Demand-Side Management: Overcoming Market Barriers or Obscuring Real Costs?” *Energy Policy*, vol. 22, no. 10, 1994; Jerry Hausman, “Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables,” *Bell Journal of Economics*, vol. 10, 1979.

- New technologies may be costly to integrate with existing ones. Until all components of a complex system are fully depreciated it may make sense to replace energy inefficient components with another like-wise inefficient component.
- Uncertainty of future energy prices, or constraints on the ability to borrow capital may make households act as if they have implausibly high implicit discount rates.
- Just because a technology is cost-effective on average does not mean that it is cost-effective for all individuals. Those who may use the device less intensively may find it optimal to purchase a less efficient model.

These barriers clearly demonstrate that investments to minimize energy costs are different from investments to minimize the total costs of production.

The study provides a crude estimate of the costs to government of lowering market barriers to achieve the estimated emissions reductions. A sense of the likely costs can be derived by evaluating the experience of the Climate Change Action Plan (CCAP). CCAP promotes carbon reductions through a broad array of voluntary programs that stimulate "cost-effective" technology adoption by private firms. Participation by a firm in a CCAP program is supposed to reduce carbon emissions and to offer financial returns.³ We do not address an important threshold question of why cost-minimizing firms would ever need any need help from government programs to take actions that would lower their costs.

CCAP received appropriations totaling \$494 million (1995\$) during the FY95 - FY97 period. We assume that these costs are distributed uniformly over the three years. During this period, the Department of Energy and the Environmental Protection Agency can account for reductions of 14 MMTCE (see attached table). Evaluating the cost effectiveness of these programs requires an assumption about emissions reductions in the outyears. Since the programs are persuading firms to adopt innovations that offer financial returns, we believe that the firms would soon have adopted them in the absence of the programs. Thus the emissions reductions might last for several years. To develop illustrative cost estimates we assume between 2 and 7 years of emissions reductions. We describe our estimates given the assumption of 2 years; the method for the assumption of 7 years is identical.⁴ Assuming constant effectiveness of program expenditures, the emissions reductions attributable to past expenditures would grow from 2.8 million tons in the first year to 5.6 million in the second year and third years, and then decline to 2.8 million tons in the 4th year, before falling to 0 in the 5th and subsequent years. The ratio of

³ Note that CCAP efforts are incorporated in the AEO97 baseline.

⁴ This analysis was conducted based on the June 10 draft that stated 180 MMTCE of reductions associated with government programs could be expected under a "very aggressive" set of policies. Since the August 1 draft notes that more non-price policy induced reductions would be expected, the cost estimates provided in this discussion underestimate the program costs associated with this greater number of reductions.

the present value of these costs and of these tons is \$33/ton using a 7 percent discount rate. Thus taking into account the lag between program expenditures and emissions reductions, the average cost effectiveness is \$33/ton (with a 7 year assumption the cost effectiveness is \$13/ton). Assuming constant program effectiveness would imply Federal costs of \$5.9 billion per year (with the 7 year assumption the total cost estimate would be half as much.)

We believe that there are several good reasons to think that the cost of reducing emissions will rise, however, as these or similar programs are expanded. For example, if the potential adopters differed in terms of their cost savings (or willingness to adopt innovations) then the government program would encounter diminishing returns as it tried to reach the less receptive users of technology. Suppose that the (marginal) program cost effectiveness deteriorated by 10 percent every time the annual reductions in emissions grew by as much as the annual reductions implied by the current program. In this instance the marginal cost of achieving 180 million tons of emissions reductions would be about 21 times greater than the marginal cost of the existing program, and far in excess of reasonable values for a ton of carbon emissions averted. In this case the total cost of the program would be \$45 billion per year. Similar assumptions for the 7 year case would lead to total costs of nearly \$7 billion per year, and marginal costs of \$80/ton. Thus we believe that the cost of a government program to ensure energy reductions of 180 million metric tons of carbon could easily run into many tens of billions of dollars per year. In addition, the marginal cost-effectiveness of these programs could substantially exceed reasonable estimates of the value of carbon emissions reductions.

Of course the government might choose to achieve these reductions using command and control type regulations, such as national building codes, or increasingly stringent CAFE standards. These would substitute private sector costs for government administrative costs.

5) 1.1, paragraph 1: Sentence 3 should note that “the improved performance and increased penetration of efficient and low-carbon technologies” are program- and price-induced.

6) 1.1, section 1.1, purpose 1: The statement about a “vigorous national commitment” should be explicit that this means a commitment through government programs.

7) 1.4, Table 1.1: The study notes that it employs EIA’s Annual Energy Outlook 1997 projections for the business-as-usual case in 2010 with a modification to the transportation sector. However, the numbers in this chart do not match up with the numbers in the AEO97 reference case. In fact, they are much closer to the AEO97 low economic growth case (for industry and buildings). We assume that the study is using the reference case from AEO97 since it uses the reference case carbon emissions for 2010. If this is the case, then the following should be the sectoral breakdown of energy consumption (AEO97, pp. 97-99, and pp. 125-127):

Buildings:	36.81 quads
Residential:	20.83 quads
Commercial:	15.98 quads
Industrial:	39.69 quads
Transportation:	31.39+ quads ⁵
Total:	107.89+ quads

If the labs study employs the low economic growth case, then it should state so explicitly in the report and explain why this case, as opposed to the reference or other cases, was selected. Otherwise, the AEO97 numbers should be used.

8) 1.6, Table 1.2: The 2010 BAU carbon emissions for buildings and industry seem not to match the AEO97 reference case emissions for these sectors. AEO97 projects carbon emissions to be 576.1 MMTCE for buildings (residential: 321.4; commercial: 254.7) and industry to be 548.5 MMTCE in 2010. This implies that, with the adjusted transportation emissions, BAU should total 1740 MMTCE, not 1720.

9) 1.8, Table 1.3: The study states that it employs the Annual Energy Outlook business-as-usual (BAU) forecast for the buildings and industry sectors, with modifications that are “not greatly different from the EIA case” (p. 1.2) for the transportation sector.⁶ The one modification stated in the study affects the fuel efficiency of the light duty vehicle fleet. While AEO97 assumes that fuel efficiency will increase in the future, the labs study assumes that fuel efficiency will remain constant. This change should result in a slower rate of energy efficiency improvement in the economy under business as usual conditions.

The AEO97 BAU forecast assumes an improvement of energy efficiency of 0.9% per year through 2015 (annual E/GDP = -0.9%) (AEO97, p. 4). The study assumes energy efficiency improvement under BAU occurs at a rate of 0.77%. This difference appears to be somewhat significant. Inferring from the transportation chapter (table 5.1), this report states that energy use would increase 0.9 quads over the AEO97 reference case. CEA contacted Art Andersen at the Energy Information Administration to determine how much of an effect holding fuel efficiency constant would have on the E/GDP ratio.⁷ According to Andersen, constant fuel efficiency would “disappear in the rounding” in the E/GDP ratio. He stated that this assumption would

⁵ The 1997 AEO projects transportation energy consumption to be 31.39 quads in 2010. With the labs study assumption regarding constant fuel efficiency, the projected energy consumed in this sector should increase. Although the text never explicitly states the extent of this increase, we inferred that it is 0.9 quads. However, since Andersen informed us that the increase would be 0.6 quads, we assessed both in a subsequent comment.

⁶ The labs study also modified the electricity sector forecast, but that modification is not relevant to our discussion of the energy efficiency of the economy.

⁷ Art Andersen is the Director of the Energy Demand and Integration Division, EIA.

result in energy use increasing by 0.6 quads in 2010 over the reference case. CEA recalculated the E/GDP ratio used in the AEO97 BAU to account for this extra energy use (assuming GDP remains the same across these cases), and found that annual E/GDP would decrease 0.86% under the constant fuel efficiency assumption (0.6 quads case). With the inference from the transportation chapter, the annual E/GDP rate would be -0.85% (0.9 quads case). The labs study BAU assumes fewer energy efficiency improvements than should be expected under these adjusted BAU scenarios.

Two related implications arise from this. First, since the study employs a modified version of the AEO97 energy use forecast, it should modify the AEO97 carbon emissions forecast. With a slower improvement in energy efficiency under the lab study assumptions, the 2010 BAU carbon emissions should be greater than the 1722.4 MMTCE in AEO97 (AEO97, p. 120). As we note in the previous comment, by incorporating the AEO97 reference case carbon emissions for buildings and industry, the BAU should be about 1740 MMTCE. This obviously implies that more reductions will be necessary to stabilize emissions at the 1990 level in 2010.

Second, the carbon reductions calculated for the various scenarios in this study are based on this -0.77% E/GDP BAU. This implies that some of the carbon reductions claimed under the efficiency and high efficiency cases actually occur in the -0.86% BAU. This double-counting could be significant. The CEA-generated BAU (0.6 quads case) accounts for 17% of the E/GDP gains assumed in the efficiency case (see attached chart).⁸ The alternative CEA-generated BAU (0.9 quads case) accounts for 15% of the E/GDP gains assumed in the efficiency case. Assuming that E/GDP and carbon reductions are perfectly correlated (given that the efficiency case involves no fuel switching, this is reasonable), then the efficiency case overestimates emissions reductions by 18 to 20 MMTCE.

The text should explain why the lab study E/GDP ratio differs from the AEO97 ratio since it does not seem to result exclusively from keeping fuel efficiency constant. Further, the 2010 BAU emissions reductions should reflect the E/GDP ratio (whether it is -0.77%, -0.85%, -0.86%, or some other rate) used in the study.

10) 1.11, Table 1.4: It would be valuable to understand the effect of non-price policies and permit prices on the carbon reductions. Could you break down the high efficiency cases into two categories: non-price policy induced and permit induced technology adoption?

11) 1.12, paragraph 1: The discussion on government programs costing 15% of investment costs should include references to the literature that have estimated this percentage. Does the literature describe the marginal costs for government programs, or does it just provide this average cost value? Consistent with the literature on technology adoption, the marginal costs should not be

⁸ The AEO97 BAU would capture 25% of the efficiency gains in the efficiency scenario.

assumed to be the same for all units of adoption. In fact, it is likely that the marginal costs increase for higher rates of adoption.

12) 1.12, paragraph 1: The text in this paragraph notes that government costs in the best estimate case are 15% of total investment costs, while figure A-1.1 on p. A-1.2 indicates that the costs are 7% of investment costs for the end-use sectors and 1% for the electricity sector. Which costs are correct?

13) 1.12, paragraph 1: The text notes that “one could argue that... a social discount rate” of 3% or 7% should be used. Alternatively, one could argue that since these analyses assess private decisions on technology adoption, that private marginal rates of time preference should be used that reflect “current market behavior”. This analysis is not attempting to conduct a social benefit-cost analysis. Rather, it is attempting to model the private individual or firm’s benefits and costs associated with a technology adoption decision. Since this report projects technology adoption assuming a set of aggressive policies, the rates of time preference actually used by individuals and firms should be used in assessing the extent of adoption.

Further, the report should not rely on government fiat to lower discount rates. It is very difficult to lower people’s time preferences through policy. Government programs do not increase adoption rates by lowering time preferences, but by lowering the costs of adoption or increasing the benefits of adoption. For example, government programs cost-share the adoption of environmentally-benign agricultural production techniques through the Environmental Quality Incentives Program. Farmers still employ the same discount rate, but their stream of costs are lower because of the government subsidy, and so adoption increases. The report should not assume that government policies can lower private time preference rates, but rather that government policies can affect the stream of costs and benefits of an adoption decision.

14) 1.12, paragraph 5: Again, until the complete costs of investment and accurate cost-savings can be estimated, the text on net benefits should be deleted.

15) 1.13, Table 1.5: The estimates of carbon reductions under the alternative view do not appear to match with the carbon reductions in table A-1.2 on p. A-1.5. It seems implausible that discount rates could double and have no effects on any technology adoption decision in this report. Are the numbers in the appendix the right set? Is it true that every single energy efficient technology adoption decision is cost-effective under the “best estimate” discount rate and the “alternative view” discount rate? If these technologies are such big winners, then why aren’t people and firms already adopting them?

16) 1.14: Unless and until the costs and cost-savings issues are adequately addressed, estimates of net savings should be omitted.

17) 1.15, paragraph 3: As stated in the executive summary comments, the text should not state “energy efficiency alone can take the nation 30 to 50% of the way to 1990 levels.” If energy

efficiency could achieve these reductions “alone”, there would be no need for an invigorated federal policy effort. It should be explicitly stated that policy instruments to achieve this goal are omitted from the analysis.

Chapter 2

18) 2.6, transportation sector bullet: The text states that the transportation sector analysis uses a 5 year time horizon. However, the description of the best estimate and alternative view cost effectiveness calculations on p. A-1.10 indicate that a time horizon of 14 years was used. Further, the transportation chapter indicates that the cost effectiveness analyses were conducted using a 6% discount rate in combination with a decline in usage and depreciation to calculate fuel savings (p. 5.45). The footnote to table 5.9 implies that the analyses used a 14 year time horizon as well. The report should clarify these inconsistencies.

Chapters 3-7

19) There does not appear to be any discussion of the \$25/ton permit scenario in these chapters. Further, the appendices do not explicitly detail this case. The results from this scenario need to be documented in the text and in the appendices. For example, it is impossible to identify the penetration rate for this scenario in the buildings chapter (see p. 3.3). The industry chapter discusses three scenarios: BAU, efficiency, and high efficiency (p. 4.2). The descriptions of the high efficiency case in transportation on p. 5.3 and p. 5.31 do not even mention a permit price. The electricity sector appears to only consider a \$50/ton permit (p. 6.9).

20) The results from the alternative view cost analysis should be incorporated in these chapters.

Chapter 3

21) 3.3: In the context of fully incorporating the effects of climate policy on energy prices, the analyses on buildings technologies should be modified. Under the efficiency case, energy consumption declines. This scenario should be changed to reflect the downward effect on prices resulting from this decreased energy consumption. The result would be to reduce the net improvement in energy use resulting from technological advances. The high efficiency scenario should reflect two counteracting effects on prices: the decline in energy consumption and the \$50/ton permit fee. The study ignores the former effect and insufficiently incorporates the latter effect. For example, in the buildings chapter, the penetration rate is assumed to be 65% instead of 60% of the maximum cost-effective technical potential in this scenario because of the \$50/ton permit price. However, the energy-cost savings calculations for buildings technologies assume the same energy price as in the business as usual scenario. Since the study assumes that exogenous, undefined policy influences drive the penetration rates, the penetration rate should be set at 60% and the energy cost-savings should be recalculated with the appropriate energy price. In addition, the assumed energy use for these technologies should be based on consumers' responses to the lower operating costs. For example, if running an air conditioner becomes less

expensive with a new energy efficient technology, people will run the air conditioner more. This latter effect decreases the carbon reductions associated with each adoption decision.

22) 3.9 and Appendix C-1: The study uses the average cost of electricity to calculate the energy cost savings of these technologies. Many of the electricity-dependent technologies are only cost effective based on the assumption of average, not marginal electricity prices. Since marginal prices may be much lower than average prices, especially in cases where households use less electricity, this may overestimate the extent of cost effective technologies. The analysis should be modified using marginal electricity prices.

23) 3.23, box: The text in the box is not clear on the inclusion of fuel cell technology in the high efficiency scenarios. The first paragraph states that fuel cells were not included in the main building sector scenarios. However, emissions reductions of 3 MMTCE from fuel cells are listed under buildings in Table 1.4 on p. 1.11. Further, the discussion on fuel cells in the text outside of this box implies that fuel cell technology will not be available until 2020 (since it falls in the section "Potential for Advanced Technologies in 2020"). If the study relies on ADL's analysis of fuel cell adoption, then the assumptions of ADL's assessment should be provided in an appendix. Two issues should be addressed here. First, if fuel cells are projected to be adopted under the high efficiency scenarios, then this discussion should be placed in the appropriate section of this chapter (not the 2020 section), and the inconsistencies in the text should be remedied. Second, if fuel cells are adopted, then a discussion of the carbon emissions accounting should be provided to ensure that the study does not double count emissions reductions from energy efficient technology adoption and from switching energy sources to fuel cells.

24) 3.29, summary bullet two: This states that the high efficiency scenario yields 91 MMTCE of carbon reductions from the BAU emissions level. However, Table 1.4 indicates that only 44 MMTCE of reductions occur under the \$25/ton permit price and only 62 MMTCE of reductions occur under the \$50/ton permit price. Which carbon reduction estimate is correct?

Chapter 4

25) 4.6, paragraph 4: The analysis assumes that the capital recovery factor falls by more than half. This appears to be an arbitrary reduction. Did industry behave as if it operated under a lower CRF during the 1970s oil shocks? There is no discussion of the economic behavior necessary to result in this outcome.

26) 4.6, paragraph 4: The high efficiency penetration rate is assumed to be double the rate used in the efficiency scenario, which is the undefined "normal" rate. It is impossible to determine how much of this doubling of penetration results from undefined, aggressive policy efforts and how much results from the permit price. It would be valuable to understand the relative impacts of both.

27) 4.13, paragraph 4: The text states that the high efficiency case causes an acceleration of capital retirement, but does not estimate these costs. Could you estimate the costs of early retirement? If not, can you provide some information on the extent of early retirement (e.g., percentage of capital retired early under this scenario)?

Chapter 5

28) Does this sectoral analysis consider the impact of a permit price? Neither the \$25/ton permit nor the \$50/ton permit are mentioned in the entire chapter. Do all improvements in fuel efficiency and cellulosic ethanol result from non-price policy responses? As the report states, a degree of “luck” is required to achieve the necessary technological breakthroughs to result in the projected carbon reductions. However, without a price incentive, the probability of the nation becoming “lucky” appears more unlikely. If this analysis does not incorporate the permit prices, then this should be made explicit in the discussion of the high efficiency case.

29) The methodology for this sector is insufficiently transparent to grasp easily the impact of technology development and adoption on carbon reductions. Further, the appendices for transportation do not provide the details to remedy the shortcomings in the chapter. It is difficult to compute carbon reductions from increases in fuel efficiency. The text should take the reader through the process of piecing together all of these energy efficient technologies, illustrating the final effect on fuel economy, and then translating this into carbon reductions.

30) 5.4, Table 5.1: Why do the energy consumption numbers for this sector in 1997 vary across scenarios? We understand that the start year for the scenario analyses is 1998 (e.g., refer to Table 4.8 on p. 4.12 that implies 1998 as the start year for assessing cumulative incremental investment).

31) 5.21, paragraph 2: Does the assumption about reducing technology costs reflect any empirical analysis on transportation technologies? For example, the 1970s oil shocks and fuel efficient imports spurred domestic fuel efficiency R&D. Does this analysis incorporate information about accelerating technology development and lowering technology costs that may be available from this earlier period?

32) 5.23, paragraph 3: As we have noted before, it is difficult to modify consumers’ preferences. Assuming that the demand for horsepower will decrease because consumers will become “more green” over the next decade appears tenuous. This statement is repeated on p. 5.32. Is there any evidence that concern about global warming has affected consumers’ purchase decisions to date?

33) 5.25, paragraph 1: If the turbocompound diesel engine and the advanced LE-55 heat engine are not available in the reference case (which implies that the earliest these are available is 2016), then how are they made available by 2003? Is there any precedent for accelerating transportation technology from a time horizon of at least 18 years to a horizon of only 5 years? How do these

engines conform to present emissions standards for particulates and NO_x and how will future standards under the new ozone and particulate matter rules affect them?

34) 5.25, paragraph 1: The efficiency case assumes that advanced drag reduction in heavy trucks has become available this year, but this is excluded from the reference case. First, has this actually occurred? Second, if it has already occurred, then why is it excluded from BAU?

35) 5.25, paragraph 4: Again, the assumption of reducing a technology price appears arbitrary. What is the basis for assuming that the trigger price for heavy truck technologies will fall?

36) 5.25, paragraph 5: The efficiency analysis assumes penetration rates of 100% for several of the heavy truck technologies over a 20 year period. This seems incongruous with the assumptions in the other sector analyses that imply much lower penetration rates. 100% penetration of a technology within 20 years, that is not expected to be available 18 years from now in the BAU, appears to be an extreme and unsubstantiated assumption.

37) 5.32, paragraph 1: The analysis assumes that fuel cells, because their costs are unknown, will be cost effective. This is an entirely arbitrary assumption, especially for a technology that is not even projected to become available in the BAU scenario. There is absolutely no economic basis for this assumption. This assumption is all the more extraordinary given that this analysis does not (apparently) incorporate the impacts of a carbon permit on fuel prices.

38) 5.36, Table 5.7: If the scenarios overestimate fuel economy, as stated in the footnote, then the numbers should be revised to remedy this error.

39) 5.38, paragraph 2: The modification of assumed improvement of fuel efficiency by multiplying the expected improvement by 0.7 to reflect offsetting performance effects, appears arbitrary. Why wouldn't the fraction be much smaller? The introduction to this chapter indicates that almost all improvements in fuel efficiency are offset by performance effects. Why would only 30% of fuel efficiency improvements in the future be offset?

40) 5.45: The chapter is not explicit about its accounting of fuel efficiency improvements in light duty vehicles and the change in the fuel mix reflecting an increase in cellulosic ethanol and the use of fuel cell technology. We cannot determine if carbon reductions are double counted. The study does not discuss how cellulosic ethanol and fuel cells are accounted for in the energy cost savings description on pp. 5.43-5.45. If the reductions from fuel efficiency and the reductions from cellulosic ethanol and fuel cells do not overlap, then this should be stated explicitly. Again, a more transparent presentation of the methodology would address the readers' uncertainty about this issue.

41) 5.45, Table 5.9: The cost effectiveness estimates assume a constant price of \$1.20 per gallon through the life of the vehicles. The gasoline price should be adjusted down to reflect the impact of decreased gasoline consumption due to fuel efficiency. Further, vehicle miles traveled should

increase through time as cars become more fuel efficient, consistent with the trend to date, instead of held constant.

Chapter 7

42) 7.1, paragraph 2: If the report has eliminated the double counting in this sector evident in the June 10 draft, then the sentence that states that double counting is “a likely possibility” should be deleted. A reference to appendix G-2 should be inserted.

43) 7.2, paragraph 3: Again, if the double counting has been remedied by integrating the dispatching and repowering analyses, then the following sentence should be modified: “The analytical approach was static in that the cost of repowering was computed for each candidate power plant but the analysis did not optimize unit/plant production cost, dispatch, or system load.”

44) 7.6, paragraph 5: The reference to appendix G-2 appears to be wrong. This reference implies that appendix G-2 provides a methodology for SO₂ and NO_x benefits. Nothing in the text of chapter 7 reads as if the double counting issue from the June 10 draft has been resolved.

Appendices

45) A-1.9: The alternative view cost-effective estimates for buildings assumes an 18 year time horizon. However, the methodology discussion on p. 2.5 states that a “technology is defined as ‘cost-effective’ if it delivers a good or service at equal or lower life-cycle costs relative to the current practice”. If cost-effectiveness is measured in terms of a technology’s life cycle, then shouldn’t the time horizon for calculating the stream of benefits be constrained by the life of the product? It is not possible for a technology to generate cost savings beyond its lifetime. In the buildings case, the end uses with the largest potential carbon reductions in the high efficiency case are other uses (10 MMTCE commercial, 6 MMTCE residential) and lighting (7 MMTCE commercial, 6 MMTCE residential). These account for 29 of the 62 MMTCE of reductions for this sector. However, the lifetimes for these end uses are much shorter than 18 years. For other uses, the lifetime ranges from 7 (commercial) to 10 years (residential). For lighting, the lifetime ranges from 1 (residential) to 12 years (commercial). The cost effectiveness estimates should be recalculated using specific end use lifetimes.

Summary of Greenhouse Gas Emissions-Reduction Actions

Million Metric Tons of Carbon Equivalent

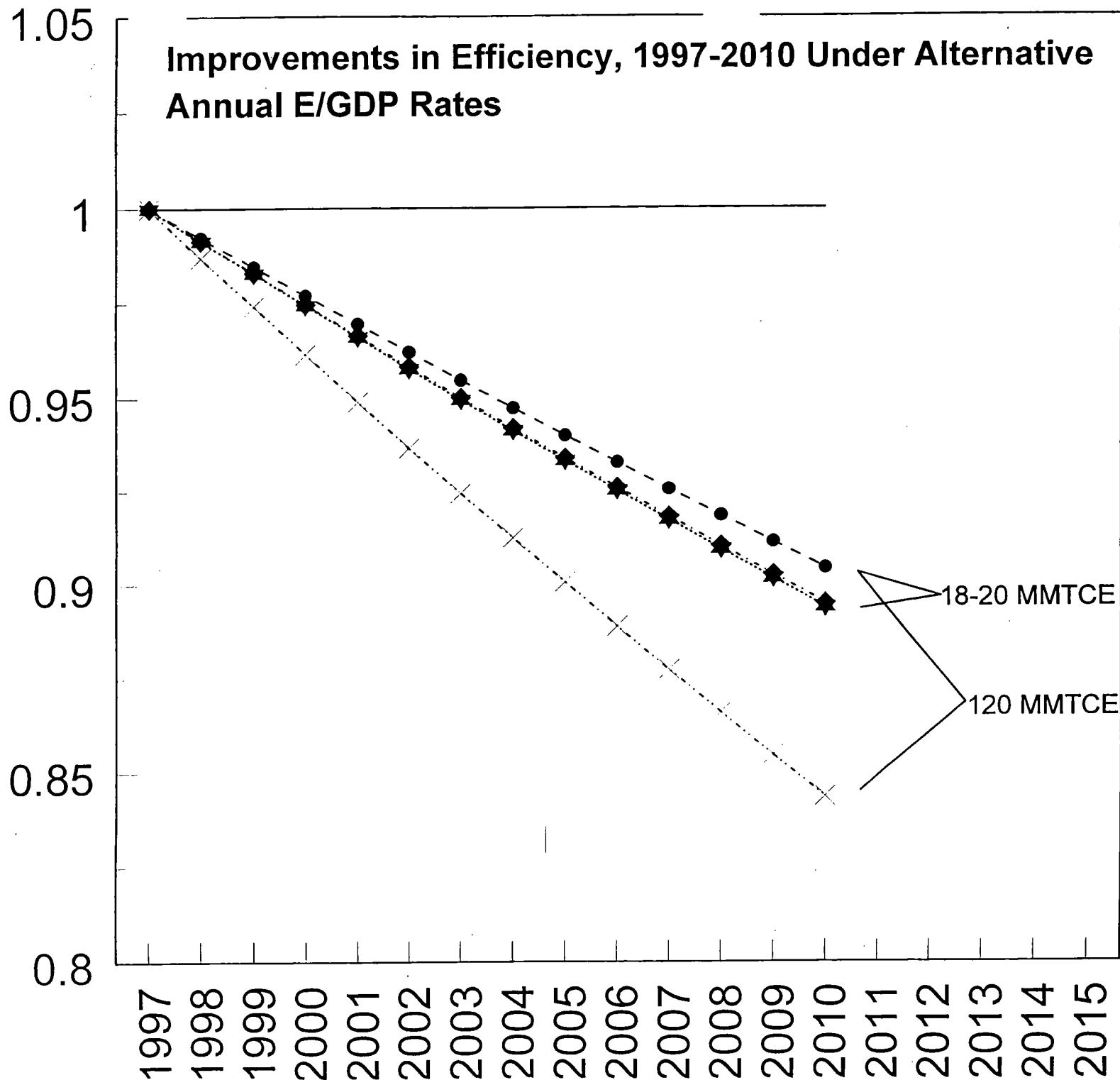
Source: U.S. Climate Action Report—1997

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
Residential & Commercial Sector Actions		26.9	10.3	
New	Rebuild America	2.0	1.6	--
1 and 2	Expanded Green Lights and Energy Star Buildings	3.6	3.3	--
3	State Revolving Fund for Public Buildings	1.1	Terminated	
4	Cost-Shared Demonstrations of Emerging Technologies	3.8	0.0	--
5	Operation and Maintenance Training for Commercial Building Facility Managers and Operators			
6	Energy Star Products	5.0	4.3	--
7	Residential Appliance Standards	6.8	0.2	--
8 and 11	Energy Partnerships for Affordable Housing	4.4	0.4	--
9	Cool Communities			
10	Update State Building Codes			
New	Construction of Energy-Efficient Commercial and Industrial Buildings		0.1	--
New	Superwindow Collaborative		0.0	--
New	Expand Markets for Next-Generation Lighting Products		0.2	--
New	Fuel Cells Initiative		0.0	--
Industrial Sector Actions		19.0	4.8	
12	Motor Challenge	8.8	1.8	--
13	Industrial Golden Carrot Programs	2.9	Merged into Action 12 Terminated	
14	Accelerate the Adoption of Energy-Efficient Process Technologies			
15	Industrial Assessment Centers	0.5	CCAP Component Terminated	
16	Waste Minimization	4.2	2.1	--
17	Improve Efficiency of Fertilizer Nitrogen Use	2.7	0.8	--
18	Reduce the Use of Pesticides		Terminated	
Transportation Sector Actions		8.1	5.3	
19	Cash Value of Parking	6.6	4.6	--
20	Innovative Transportation Strategies			
21	Telecommuting Program			
22	Fuel Economy Labels for Tires	1.5	0.7	--
Energy Supply Actions		10.8	1.3	
23	Increase Natural Gas Share of Energy Use Through Federal Regulatory Reform	2.2	Terminated	

Action Number	Action Title	1993 Action Plan Estimate for 2000	1997 U.S. CAR Revised Estimate for 2000	Actual Reductions to Date
24	Promote Seasonal Gas Use for Control of Nitrogen Oxides	2.8	0.5	--
25	High-Efficiency Gas Technologies	0.6	Terminated	
26	Renewable-Energy Commercialization	0.8	0.3	--
27	Expand Utility Integrated Resource Planning	1.4	Terminated	
28	Profitable Hydroelectric Efficiency Upgrades	2.0	0.0	--
29	Energy-Efficient Distribution Transformer Standards	0.8	0.5	--
30	Energy Star Distribution Transformers			
31	Transmission Pricing Reform	0.8	Terminated	
New	Green Power Network	Not included	0.0	--
Land-Use Change & Forestry Actions		10.0	2.4	--
43	Private Depletion of Nonindustrial Private Forests	4.0	Terminated	
44	Accelerate Tree Planting in Nonindustrial Private Forests	0.5	0.4	--
16	Waste Minimization	4.2	2.0	--
9	Expand Cool Communities	0.5	To be determined	
Methane Actions		16.3	15.5	--
32	Expand Natural Gas STAR	3.0	3.4	--
33	Increase Stringency of Landfill Rule	4.2	6.3	--
34	Landfill Methane Outreach Program	1.1	1.9	--
35	Coalbed Methane Outreach Program	2.2	2.6	--
36	RD&D for Coal Mine Methane	1.5	Terminated	
37	RD&D for Landfill Methane	1.0	Terminated	
38	AgSTAR Program	1.5	0.3	--
39	Ruminant Livestock Efficiency Program	1.8	1.0	--
Actions to Address Other Greenhouse Gases		16.3	25.4	--
17	Improved Fertilizer Management	4.5	5.3	--
40	Significant New Alternatives Program	5.0	6.4	--
41	HFC-23 Partnerships	5.0	5.0	--
42	Voluntary Aluminum Partnership	1.8	2.2	--
New	Environmental Stewardship Initiative	Not included	6.5	--
Foundation Actions			11.3	--
	Climate Wise	Not estimated	1.8	--
	Climate Challenge	Not estimated	7.6	--
	State and Local Outreach Programs	Not estimated	1.9	--
Total GHG Emission Reductions From CCAP		108.6	76.0	14.0

Data is not readily available for cumulative emissions reductions for many CCAP programs. Emissions reductions of about 5 MMTCE can be attributed to DOE's CCAP programs. EPA's Office of Air and Radiation is responsible for emissions reductions of about 9 MMTCE through their CCAP programs.

Improvements in Efficiency, 1997-2010 Under Alternative Annual E/GDP Rates



No Efficiency

BAU-CEA (0.6)

BAU-CEA (0.9)

BAU-DOE5

Efficiency Case

18-20 MMTCE

120 MMTCE

All efficiency values are shown relative to a 1997 E/GDP ratio indexed to 1.

Office of Economic Policy

Department of the Treasury • Washington, D. C. 20220


FAXDate: August 20, 1997 at 11:38 AMNumber of pages including cover sheet: 8

	<u>Name</u>	<u>FAX Number</u>	<u>Phone Number</u>
To:	JAY SHOGREN	395-6809	
	JOE ALDY		

From:	Robert Gillingham	202-622-2633	202-622-2220
--------------	-------------------	--------------	--------------

REMARKS: ☐ Urgent ☒ For your review ☐ Reply ASAP ☐ Please comment

See what you think.

COMMENTS ON *SCENARIOS OF U.S. CARBON REDUCTIONS*

Scenarios of U.S. Carbon Reductions, commonly known as the "5-labs study," examines the "potential for energy-efficient and low-carbon technologies to reduce carbon emissions in the United States." This study does a very nice job of cataloging the current state and likely future path of technological developments. What it does not do, however, is shed much light on what role technology is likely to play in mitigating the growth of carbon emissions, or on what government can or should do to enhance this role.

As a tool for developing and implementing a technology policy, the report is hampered by the fact that it does not address any of the processes that determine the rate at which technology is developed and implemented. Rather, it catalogs technologies that currently exist, are likely to exist or could possibly exist by 2010, determines whether they are "cost-effective," and then makes somewhat arbitrary assumptions about the rate at which they are implemented. Although the analysis is couched in terms of the adoption of cost-effective technologies, cost-effectiveness is not rigorously defined; no evidence is presented on whether decision-makers are or are not acting in their best interest. It is important to recognize that the paper *does not demonstrate an irrational unwillingness to invest in energy efficiency*. The paper suggests that the adoption of standards and codes is necessary to ensure appropriate consumer behavior; again, *no such demonstration is made*. In other words, the study does not and cannot present evidence on the costs to either society or individual consumers and businesses of alternative technology paths.

The study reaches three overarching conclusions:

- A vigorous national commitment to develop and deploy cost-effective energy-efficient and low-carbon technologies has the potential to substantially reduce energy consumption and carbon emissions.
 - ◆ We would not argue with this conclusion. Rather we question (1) the level of government involvement—government R&D, tax incentives, efficiency standards, etc.—that would be necessary in the absence of energy-price increases and (2) whether the substantial increases in relative energy prices that would likely accompany constraints on carbon emissions would not be the most important component of any national commitment to reduce emissions.
- Carbon emissions can be reduced in ways that reduce energy costs more than they increase other societal costs.
 - ◆ We question this assertion. The study makes only rudimentary cost-benefit calculations that ignore important considerations that reasonably effect decisions to invest in energy efficiency. It also substantially understates the costs of government policies to promote technology.
- The next generation of energy-efficient and low-carbon technologies promises to

enable the continuation of an aggressive pace of cost-effective carbon reductions over the next quarter century.

- ♦ Again, absent a careful cost-benefit analysis, this conclusion is overly speculative. For instance, with respect to the transportation sector, the report concedes that future technological breakthroughs will be necessary to develop and implement the high-efficiency, low-carbon technologies. It is a stretch to *assume* that these breakthroughs will be forthcoming and that they will pass rigorous cost-benefit tests, especially in the absence of strong price signals.

The methodology used in the report is to analyze sequentially the three major end-users of energy—the residential and commercial building, industry and transportation sectors—and separately analyze the electric utility sector. For each sector, the study develops three scenarios—business-as-usual, efficiency, and high-efficiency/low carbon. They are conceptually defined as follows:

- *Business-as-usual (BAU)*. Best estimate of future energy use given current trends in service demand, stock turnover and natural progress in the efficiency of new equipment. Assumes no change in federal policies.¹
- *Efficiency (EFF)*. Likely market penetration of “cost-effective,” energy-efficient technologies given “an invigorated effort to promote energy efficiency through enhanced public and private-sector R&D and market transformation activities.”
- *High-efficiency/low-carbon (HE/LC)*. Optimistic but feasible market penetration for energy efficient and low-carbon technologies given a “greater commitment to reduce carbon emissions resulting from actions that might include the creation of a market value for carbon of \$25 and \$50 per tonne.”

With the exception of the range of carbon emission charges, which seems out of place and is largely ignored in the study, these conceptual definitions are very vague. The operational definitions vary by sector and will be discussed in turn below.

BUILDINGS

For buildings, the business-as-usual scenario is the Annual Energy Outlook (AEO) reference case. The efficiency scenario assumes that 35 percent of the “cost-effective energy savings potential” relative to the BAU is achieved. The high-efficiency/low-carbon scenario assumes that 65 percent of these savings are achieved. We have a number of problems with this analysis.

The cost-effective energy saving potential is badly defined. The study makes two critical assumptions in defining cost effectiveness. First, the analysis takes as given

¹ The report provides relatively little analysis of past trends and their determinants. The past has certainly informed our view of the future, and a more detailed analysis of the price and quantity paths, both past and in the BAU scenario, would be very useful.

that engineering estimates of energy use for alternative technologies are known with certainty and independent of the age of the capital good in which the technology is embodied. There is evidence that adopting these estimates is likely to overestimate savings (e.g., attic insulation may not be perfectly installed; consumers may increase usage rates for energy-efficient appliances or consumers may add more windows when their energy costs are reduced).² Second, the analysis ignores the trends and uncertainty around these trends in the future prices of both capital goods and energy as well as the potential irreversibility of investment decisions (proper treatment of these issues goes a long way toward explaining high measured internal rates of return, which are often confused with high discount rates).³ As a result of these two assumptions, the study almost certainly exaggerates the "cost-effectiveness" of investments in energy efficiency.

The assumed take-up rates of 35 percent and 65 percent are arbitrary. The study makes no attempt to model behavior; rather it makes arbitrary assumptions about the rate at which energy-saving investments are made. With no idea what determines the rate at which new technologies are adopted, we have no basis for informed policy-making. The HE/LC case includes substantial price increases in energy, yet the study simply raises the take-up rate for technologies deemed cost-effective *under a different—and much lower—scenario of energy prices.* The assumed take-up rate under the EFF case is bad enough, but the failure to explain how a carbon price would change the decision-making calculus in the HE/LC case is even worse.

A number of the examples are based on 1997 technologies. For instance, the refrigerator example assumes adoption of an energy-efficient 1995 model. This ignores the fact that refrigerator efficiency has been improving at a rapid rate for over 20 years (6.2 percent per year from 1972 to 1991). What does the AEO assume for the 1995 to 2010 period? Is it reasonable to assume that the type of saving assumed in the EFF case should be incorporated in the BAU case? Or is the BAU unnecessarily pessimistic?

The bulk of the savings in buildings are largely unexplained, coming from "miscellaneous electricity uses." The study admits that because of the importance of these uses, "it is crucial that more research be carried out, both to characterize how energy is used in the miscellaneous category and to identify technologies for improving the efficiency of sub-categories." With no clear understanding of these fundamental aspects of electricity use, how can we be confident to assume that this

² See, e.g., Gilbert Metcalf and Kevin Hassett, "Measuring the Energy Savings from Home Improvement Investments: Evidence from Monthly Billing Data," National Bureau of Economic Research Working Paper 6074, June 1997.

³ See Robert Pindyck, "Irreversibility, Uncertainty, and Investment," *Journal of Economic Literature* 29, 1991, for a review of some of these issues. Also, see Gilbert Metcalf and Donald Rosenthal, "The 'New' View of Investment Decisions and Public Policy Analysis: An Application to Green Lights and Refrigerators," *Journal of Policy Analysis and Management*, Vol. 14, No. 4, 1995, for an application.

category accounts for most of the presumed savings?

INDUSTRY

For the industrial sector, the study relies on the Long-Term Industrial Energy Forecasting (LIEF) model, an econometric forecasting model, to explain investment in conservation technology; it uses the industrial module of the National Energy Modeling System (NEMS), which does not model investment, to assess the effect of that investment on energy use. The business-as-usual scenario is the Annual Energy Outlook (AEO) reference case. The efficiency scenario assumes that the "capital recovery factor" (CRF) for energy-efficient investment in the LIEF is reduced from 33 percent to 15 percent.⁴ The high-efficiency/low-carbon scenario assumes, in addition, that the penetration rates for energy-efficient technology are doubled relative to the BAU scenario. This analysis suffers from problems similar to those in the analysis of the buildings sector.

The study models investment in the EFF and HE/LC scenarios by arbitrarily assuming that the return criterion for energy-efficient investment is reduced by more than 50 percent. No rationale is provided for this approach, nor are any policies posited that would lead to this result. Rather, it is simply a device to increase investment. As noted above, arbitrary assumptions about hurdle rates beg critical questions about the effect of uncertainty, changing relative prices and irreversibility on investment behavior. The approach used provides no insights into investment behavior; it implicitly assumes that behavior.

The HE/LC scenario depends on an arbitrary assumption about penetration rates and ignores price effects. The LIEF model "provides a mechanism for evaluating general investment in conservation technology as a function of energy prices, capital recovery rates, and other prices." Yet in evaluating the HE/LC scenario, the study ignores the postulated \$25 and \$50 carbon prices that are part of this scenario. Instead it assumes a doubling of penetration rates for new technology and retirement rates for old capital. The study makes no attempt to demonstrate that an increase in penetration/retirement rates is economically motivated.

Although no policies are modeled or advocated, the study lists a number of potentially costly and/or intrusive policies that could promote energy efficiency. These include accelerated depreciation, rebates or tax credits, regulation and efficiency standards, pricing and fiscal policies, and "other economic incentive programs."

TRANSPORTATION

For the transportation sector, the business-as-usual scenario is the Annual

⁴ A \$50 carbon fee would certainly increase investment in energy efficiency, as does the drop in the CRF. The latter approach is not the right way to model expected relative price increases, however. Again, uncertainty and irreversibility should be explicitly modeled, making it clear that a high *apparent* hurdle rate is not the same as a high discount rate.

Energy Outlook (AEO) reference case, adjusted to reduce the assumed improvement in light-duty vehicle fuel economy. The efficiency scenario assumes earlier introduction of advanced fuel economy technology and adds certain key technologies that are not in the BAU. The high-efficiency/low-carbon scenario postulates future "breakthroughs" in technology. As with the other sectors, this analysis provides few insights for technology policy.

The efficiency scenario assumes accelerated adoption of existing technologies, but provides no reason why this might occur. Unlike the analysis of the other sectors, the analysis of the transportation sector does not even include any economic assumptions that might imply its conclusions. As a result, it promises no medium or longer-term gains.

The HE/LC scenario is even more ephemeral; it requires technological breakthroughs, primarily in fuel-cell technology. As the report notes, the EFF and HE/LC scenarios "differ from each other less in effort than in outcome. . . . In contrast, because the outcomes postulated in the high-efficiency/low-carbon scenario require technological breakthroughs, they require a certain degree of luck to be achieved by 2010." In other words, we do not need to try any harder to achieve the HE/LC scenario; we just have to be lucky.

The analysis raises the AEO energy baseline, but not the emissions baseline. Since it raises the AEO energy baseline, the study should also adjust the emissions baseline. As a result, the savings postulated relative to the AEO baseline would be reduced.

ELECTRICITY

The analysis of the electricity sector describes how the electricity demands inherent in the BAU, EFF and HE/LC scenarios can be met with lower carbon emissions. The BAU scenario is a fully competitive bulk-power market in the year 2010. The demands on this system are then adjusted to reflect the effects on electricity demand and supply of the EFF and HE/LC scenarios. These results are used in the sector analyses to evaluate carbon savings attributable to reductions in electricity consumption. They are also used to evaluate the opportunities for reducing carbon emissions in electricity generation in response to \$25 and \$50 carbon prices.

The EFF and HE/LC scenarios predict substantial reductions in electricity demand from baseline. The two scenarios predict reductions of 9 and 16 percent, respectively, in end-use electricity demand relative to BAU. In fact, they assume essentially zero growth in electricity demand between 1997 and 2010. To put this into perspective, electricity sales increased at an annual rate of 2.0 percent annual rate so far in the 90s and at more than a 3 percent rate over the past 25 years.

IMPLICATIONS OF THE STUDY

As the above discussion demonstrates, the study is primarily a catalog of

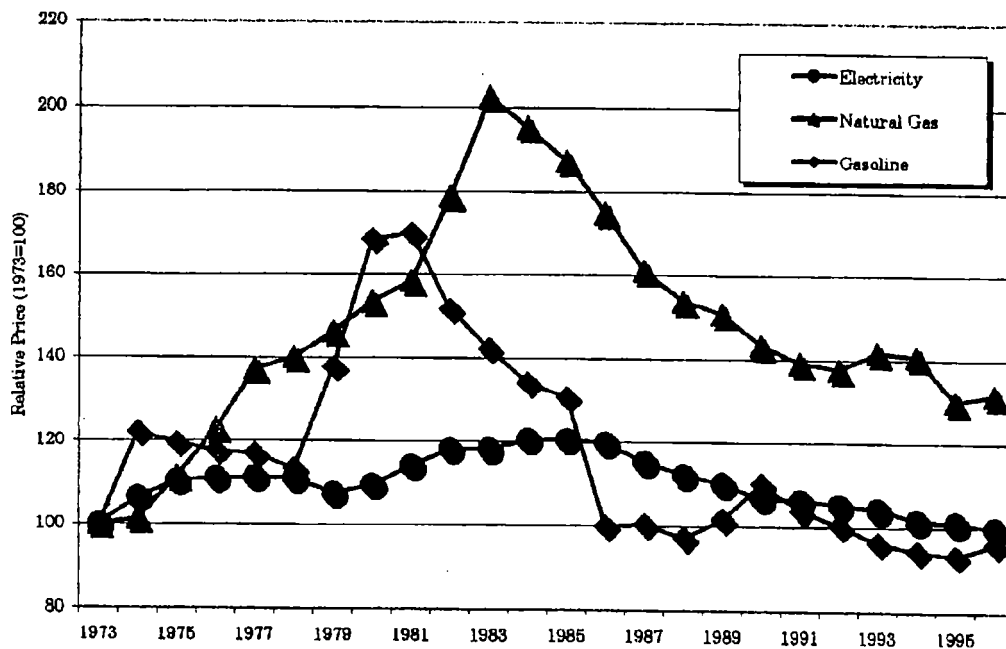
potential improvements in energy efficiency. Neither the determinants of these improvements, nor their implications for energy demand behavior are examined. Rather, the study provides an *accounting* of two very stylized scenarios. Without developing and detailing the relationship between the study's scenarios and the policy mixes that would have to accompany them, it would be inappropriate to draw any conclusions from the study about the role of technology, much less the role of technology policy, in addressing global warming. Although the study provides no policy recommendations, it does hint at possibilities. Listing them provides some insight into the potential difficulties in making the scenarios "come true."

- *Aggressive R&D, both public and private.* The study continually refers to the need for aggressive R&D, but provides no suggestions as to how it could be fostered and at what cost.⁵ The EFF scenario is basically an extrapolation of the Climate Change Action Plan; the likely success of this effort is at best problematic. Some have suggested a more vigorous effort, similar to the Apollo project. Although this sounds good, we should remember that the Apollo project required rechanneling 0.4 percent of the entire GDP of the 1960s into this one government project. Many of the climate change modeling efforts predict that reducing emissions levels to 1990 levels in 2010 would not cost much more than that in the absence of a technology program.
- *Tax incentives.* Investment tax credits, accelerated depreciation, and other tax incentives are available to spur the development and adoption of energy-saving technology. This approach has two problems. First, energy-efficiency investments should not be singled out unless they impose special costs. If they do, *disincentives* for using energy are more efficient than *incentives* for saving energy. Second, any substantial incentives would have to be "paid for" with other tax increases and spending cuts. As recent history has demonstrated, reaching consensus is not easy.
- *Regulations and standards.* Implicit in this study is the idea that regulations and standards could go a long way toward achieving the EFF and HE/LC scenarios. The types of standards that would be needed, however, would be very pervasive and potentially very intrusive. For instance, standards would have to be applied to building components (windows, insulation, etc.) and constructions techniques, consumer and commercial appliances, utility and industrial equipment, etc. If standard setting is a major policy instrument, achieving the standards could be very costly. Standards work best if they impose little cost, as the report alleges they often would. Basing policy on this assumption moves us quickly to the idea that better results depend less on effort than on luck.

⁵ The study (arbitrarily) assumes that government costs to promote energy conservation are equal to 7 percent of *energy savings*. This is very optimistic. For instance, a 10 percent tax credit would cost 10 percent of the total cost of all qualifying investment, even that which would have taken place in the absence of the credit. The load factor for explicit government subsidies would be roughly 10 times as large.

- **Higher prices.** The most obvious policy to spur energy conservation is to increase energy prices. The study presumes a substantial increase in prices in its HE/LC scenario, but never draws out the implications of higher prices for the development and adoption of advanced technology. The study points out how rapidly energy efficiency improves prior to the late 80s and 90s. This is not surprising, given price trends. As the chart below demonstrates, consumer energy prices, relative to other prices, grew very rapidly during the 70s and into the 80s. A commitment to reduce emissions and internal climate costs would presumably result in substantial increase in relative prices and accompanying increases in efficiency.

RELATIVE PRICES OF CONSUMER ENERGY



Under almost any feasible scenario that reduces carbon emissions, the pace of technological advance in energy conservation will increase. The importance and role of technology are not in question. What is in question is the value of looking at technology in a vacuum. The 5-labs study provides a plethora of useful information. It does not present this information in a form that is useful for policymaking, however. To be useful, it needs to be merged with careful analysis of the determinants of both consumer and business investment in energy-saving technology.

Review of DOE Labs Study

Unspecified Policies:

- *No Program Descriptions:* The authors do not estimate the costs or even describe the programs necessary to stimulate the adoption of the new energy-efficient technology they find could reduce emissions of approximately 200 million metric tons of carbon equivalent (MMTCE) by 2010. These reductions correspond to about ½ of the reductions needed to attain 1990 levels by 2010. In the absence of cost estimates this information is of little use in the evaluation of alternative policy options.
- *Costs of Programs:* Given reasonable assumptions, government programs may cost many tens of billions of dollars per year above the costs of existing programs to reduce 200+ million tons of carbon. The marginal cost of emissions reductions, including the cost of the government program, is likely to greatly exceed the permit price. As a result these programs may be less cost-effective than a cap-and-trade emissions control program.
- *Luck:* The transportation sector requires “luck” in terms of technological innovation to achieve the projected emissions reductions. Without a permit price, this luck appears likely only through stringent standards, such as increasing CAFE.

Overestimates Reductions/Underestimates Costs:

- *Behavioral Changes Ignored:* The analysis appears to ignore the behavioral changes that offset the energy efficiencies promised by the new technologies. For example, more efficient windows lead to houses with more glass, and more efficient cars lead to more vehicle miles traveled. Thus these innovations offer real value to consumers, but smaller energy savings than engineers forecast.
- *Cost Effectiveness Calculated Using Average, Not Marginal Prices:* Many of the innovations in electrical use appear to be assumed to be cost effective based on an assumption of average, not marginal electricity prices. The marginal prices may be half as much as the average prices.
- *Price Declines Resulting from Reductions in Energy Demand Are Not Taken into Account:* The study assumes a 12% decrease in energy use, but does not account for this effect on price when calculating cost effectiveness for energy efficient technologies.
- *Study Double Counts Emissions Reductions Occurring Under Business-As-Usual:* The labs study double counts 22 MMTCE in reductions in the efficiency case that will occur under the business-as-usual case.
- *Interactions Ignored, Double Counting “Likely” in Utilities Sector Analysis:* The double counting of dispatching and retooling coal plants to natural gas results in about 9 MMTCE of overestimated reductions.
- *Industry Sector Analysis Ignores the Costs of Accelerating Retirement.*

Excerpt from the President's speech at American University, 9/9/97

"And we also need people who have the confidence in our ability to break new technological and scientific barriers to stand up and say, you cannot make me believe that we can't reduce greenhouse gas emissions substantially and still grow the American economy. We could reduce them 20 percent tomorrow with technology that is already available at no cost if we just changed the way we do things."

The President's statement reflects the result of a study conducted by five Department of Energy research laboratories titled *Scenarios of U.S. Carbon Reductions*. This study, still in draft form, claims that carbon emissions can be reduced to 1990 levels in 2010 at "net costs to the U.S. economy [that] are near or below zero in this time frame [1998-2020]" (p. 16, chapter 1, 8/29/97 draft). The Council of Economic Advisers and the Department of Treasury have reviewed this report and found the economic analyses to be inadequate to support this assertion. The study suffers two serious flaws. First, it merely assumes "aggressive" and "invigorated" government policies to stimulate technology adoption, without a discussion of the political feasibility of these policies or whether these technologies would be voluntarily adopted by private parties. The study does not provide reliable estimates of the costs of government programs nor does it estimate the costs of extensive and intrusive new regulations implied, including stringent CAFE standards, national building codes, and very aggressive appliance standards. This country's experience with the Climate Change Action Program implies that the government costs of achieving this goal would be in the billions of dollars annually. Second, the analyses on individuals' and firms' adoption decisions do not assess economic behavior, but rather invoke a set of engineering assumptions that generate substantial underestimates of complete adoption costs. The study ignores likely individuals' behavioral responses to climate policy (e.g., people drive more miles when cars become more fuel efficient), implementation costs, and the costs of accelerating capital retirement, but assumes that individuals live in model houses, drive model cars, and purchase products manufactured in model factories. The economic literature on technology adoption indicates that the actual net costs of energy efficient technologies are much greater than predicted by engineering studies like this study. *Scenarios of U.S. Carbon Reductions* is an engineering study, not an economic study. Given these inadequacies, neither CEA nor Treasury has signed off on the report.

pre-Kyoto
Comment on
President's GCC
Statement

MEMORANDUM

TO: Jon Gruber
FROM: Joe Aldy
DATE: 12/8/97
RE: Umbrella Annex I Trading with neither EU nor Eastern European Participation

If neither the EU nor Eastern European countries participate in full Annex I permit trading market, the total cost for Annex I countries to comply with a target and timetable increases, but the U.S., Japan, and Canada are all better off with a smaller Annex I "Umbrella" (trading between U.S., Japan, Canada, Australia, and FSU countries). Australia has roughly the same costs (domestic abatement costs plus transfers for emissions reductions abroad) under this umbrella as under full Annex I trading. Eastern Europe actually benefits under a regime where it does not participate in the umbrella but it does sell permits with the EU (a European-only trading regime) relative to full Annex I trading. As the only seller of permits to the EU, Eastern Europe does not have to compete with cheap permits from FSU countries, and thus can sell more permits at higher permit prices than under full Annex I trading. The three major buyers of permits in the Umbrella, U.S., Canada, and Japan, benefit, because as buyers of permits, the loss of a major competitor means they can buy more emissions reductions in EEFSU at lower permit prices.

Former Soviet Union countries and the EU are worse under this scenario of two trading blocks (the Umbrella and the European-only trading) than under full Annex I trading. The cost for the EU increases under European-only trade relative to full trading because it cannot take advantage of low cost emissions reductions in FSU countries, such as Russia. Former Soviet Union countries are worse off even though they don't have to compete with Eastern European countries in the sellers market because the EU would be the second largest buyer of permits under full Annex I-wide trading. Losing a major buyer decreases total demand for their permits and thus the price more so than losing competitors contracts the supply and pushes up the permit price.

To illustrate the effects of EU non-participation, I assessed country-specific marginal abatement cost curves derived from SGM outputs for the 1990 in 2010 target and timetable. The first chart illustrates the difference in the total economic effects of these two trading regimes. The two charts that follow show permit prices, domestic emissions abatement, purchases and transfers of permits on the Annex I market, and total costs of Annex I trading with EU participation and a trading regime without EU participation.

Umbrella: U.S, Canada, Japan, Australia, FSU
European-Only Bloc: EU, Eastern Europe

Winners with Two Trading Blocs Relative to Full Annex I Trading: U.S, Canada, Japan, Eastern Europe

Losers with Two Trading Blocs Relative to Full Annex I Trading: EU, FSU

No Difference Between the Trading Blocs: Australia

Difference in Economic Costs of Trading Regimes with and without EU, Eastern European Participation

Country/Region	Total Costs under Full Trading (abatement cost + transfers)	Total Costs under Trading without EU, Eastern Europe (abatement cost + transfers)	Change in Costs (- means costs decrease w/o EU, Eastern Europe participation)
U.S.	\$12.0b	\$10.2b	-\$1.8b
Australia	\$0.8b	\$0.8b	0
Canada	\$1.9b	\$1.5b	-\$0.4b
Japan	\$3.5b	\$2.9b	-\$0.6b
Former Soviet Union	net gain: \$12.3b	net gain: \$9.7b	\$2.6b
Russia ¹	net gain: \$7.9b	net gain: \$6.2b	\$1.7b
Eastern Europe	net gain: \$3.7b	net gain: \$5.8b	-\$1.9b
EU ²	\$8.1b	\$10.6b	\$2.5b
ANNEX I, total abatement cost	\$10.3b	\$12.2b	\$1.9b

Annex I Trading with Full Participation

Country/ Region	Permit Price	Domestic Reductions	Reductions Purchased Abroad	Domestic Abatement Cost	Capital Flow	Total Cost
U.S.	\$41.3	177	202	\$3.7b	-\$8.3b	\$12.0b
Australia	\$41.3	11	15	\$0.2b	-\$0.6b	\$0.8b
Canada	\$41.3	13	39	\$0.3b	-\$1.6b	\$1.9b
Japan	\$41.3	21	75	\$0.4b	-\$3.1b	\$3.5b
Former Soviet Union	\$41.3	168	-382	\$3.5b	+\$15.8b	net gain: \$12.3b
Russia ¹	\$41.3	109	-248	\$2.3b	+\$10.2b	net gain: \$7.9b
Eastern Europe	\$41.3	27	-105	\$0.6b	+\$4.3b	net gain: \$3.7b
EU ²	\$41.3	83	156	\$1.7b	-\$6.4b	\$8.1b

Annex I Trading without EU or Eastern Europe Participation

Country/ Region	Permit Price	Domestic Reductions	Reductions Purchased Abroad	Domestic Abatement Cost	Capital Flow	Total Cost
U.S.	\$33.6	151	228	\$2.5b	\$7.7b	\$10.2b
Australia	\$33.6	9	17	\$0.2b	\$0.6b	\$0.8b
Canada	\$33.6	12	40	\$0.2b	\$1.3b	\$1.5b
Japan	\$33.6	18	78	\$0.3b	\$2.6b	\$2.9b
Former Soviet Union	\$33.6	149	-363	\$2.5b	-\$12.2b	net gain: \$9.7b
Russia ¹	\$33.6	97	236	\$1.7b	-\$7.9b	net gain: \$6.2b
Eastern Europe	\$59.7	40	-118	\$1.2b	-\$7.0b	net gain: \$5.8b
EU ²	\$59.7	121	118	\$3.6b	\$7.0b	\$10.6b

Notes:

1. Russia is calculated as 65% of FSU because its economy in 1995 was 65% the size of the economies of all FSU countries.

2. SGM models the Western Europe region including 19 countries, 4 of which are not in the EU bubble. However, the 15 countries in the bubble comprised about 93% of CO₂ emissions in 1990 of the 19 countries in the modeled region. See the attached list of countries to review the distinctions between the Western Europe region modeled in SGM and the EU bubble.

EU Bubble Countries:

Austria
Belgium
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
Sweden
United Kingdom

Western Europe in SGM:

EU bubble countries plus
Iceland (1990: 0.6 MMTCE CO₂)
Norway (1990: 14.3 MMTCE CO₂)
Switzerland (1990: 11.6 MMTCE CO₂)
Turkey (1990: 39.7 MMTCE CO₂)

MEMORANDUM

TO: Jon Gruber
FROM: Joe Aldy
DATE: 12/8/97
RE: Annex I Trading without EU Participation

If the EU does not participate in an Annex I permit trading market, the total cost for Annex I countries to comply with a target and timetable increases, but the U.S., Japan, Australia, and Canada are all better off without EU participation. The EU and Eastern European and Former Soviet Union countries are all made worse off by EU non-participation. The cost for the EU increases if it does not participate because it must achieve all of its emissions reductions at home, instead of in lower cost countries such as Russia. Eastern European and Former Soviet Union countries are worse off because the EU would be the second largest buyer of permits under full Annex I-wide trading. Losing a major buyer decreases total demand for their permits, resulting in EEFSU countries selling fewer permits at lower prices. All other Annex I countries benefit, because as buyers of permits, the loss of a major competitor means they can buy more emissions reductions in EEFSU at lower permit prices.

To illustrate the effects of EU non-participation, I assessed country-specific marginal abatement cost curves derived from SGM outputs for the 1990 in 2010 target and timetable. The first chart illustrates the difference in the total economic effects of these two trading regimes. The two charts that follow show permit prices, domestic emissions abatement, purchases and transfers of permits on the Annex I market, and total costs of Annex I trading with EU participation and a trading regime without EU participation.

Difference in Economic Costs of Trading Regimes with and without EU Participation

Country/Region	Total Costs under Trading with EU (abatement cost + transfers)	Total Costs under Trading without EU (abatement cost + transfers)	Change in Costs (- means costs decrease w/o EU participation)
U.S.	\$12.0b	\$7.6b	-\$4.4b
Australia	\$0.8b	\$0.5b	-\$0.3b
Canada	\$1.9b	\$1.1b	-\$0.8
Japan	\$3.5b	\$2.0b	-\$1.5b
Eastern Europe	net gain: \$3.7b	net gain: \$1.9b	\$1.8b
Former Soviet Union	net gain: \$12.3b	net gain: \$6.2b	\$6.1b
Russia ¹	net gain: \$7.9b	net gain: \$4.0b	\$3.9b
EU ²	\$8.1b	\$18.9b	\$10.8b
ANNEX I, total abatement cost	\$10.3b	\$21.9b	\$11.6b

Annex I Trading with EU Participation

Country/ Region	Permit Price	Domestic Reductions	Reductions Purchased Abroad	Domestic Abatement Cost	Capital Flow	Total Cost
U.S.	\$41.3	177	202	\$3.7b	-\$8.3b	\$12.0b
Australia	\$41.3	11	15	\$0.2b	-\$0.6b	\$0.8b
Canada	\$41.3	13	39	\$0.3b	-\$1.6b	\$1.9b
Japan	\$41.3	21	75	\$0.4b	-\$3.1b	\$3.5b
Eastern Europe	\$41.3	27	-105	\$0.6b	+\$4.3b	net gain: \$3.7b
Former Soviet Union	\$41.3	168	-382	\$3.5b	+\$15.8b	net gain: \$12.3b
Russia ¹	\$41.3	109	-248	\$2.3b	+\$10.2b	net gain: \$7.9b
EU ²	\$41.3	83	156	\$1.7b	-\$6.4b	\$8.1b

Annex I Trading without EU Participation

Country/ Region	Permit Price	Domestic Reductions	Reductions Purchased Abroad	Domestic Abatement Cost	Capital Flow	Total Cost
U.S.	\$23	101	278	\$1.2b	\$6.4b	\$7.6b
Australia	\$23	7	19	\$0.08b	\$0.4b	\$0.5b
Canada	\$23	8	44	\$0.09b	\$1.0b	\$1.1b
Japan	\$23	12	84	\$0.1b	\$1.9b	\$2.0b
Eastern Europe	\$23	15	-93	\$0.2b	-\$2.1b	net gain: \$1.9b
Former Soviet Union	\$23	118	-332	\$1.4b	-\$7.6b	net gain: \$6.2b
Russia ¹	\$23	77	-216	\$0.9b	-\$4.9b	net gain: \$4.0b
EU ²	\$158	239	0	\$18.9b	0	\$18.9b

Notes:

1. Russia is calculated as 65% of FSU because its economy in 1995 was 65% the size of the economies of all FSU countries.

2. SGM models the Western Europe region including 19 countries, 4 of which are not in the EU bubble. However, the 15 countries in the bubble comprised about 93% of CO₂ emissions in 1990 of the 19 countries in the modeled region. See the attached list of countries to review the distinctions between the Western Europe region modeled in SGM and the EU bubble.

EU Bubble Countries:

Austria
Belgium
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain
Sweden
United Kingdom

Western Europe in SGM:

EU bubble countries plus
Iceland (1990: 0.6 MMTCE CO₂)
Norway (1990: 14.3 MMTCE CO₂)
Switzerland (1990: 11.6 MMTCE CO₂)
Turkey (1990: 39.7 MMTCE CO₂)

T&T:

U.S., Japan, Canada: 2% below 1990

Australia: 5% above 1990

FSU, Eastern Europe: 1990

EU: 10% below 1990

Full Annex I Trading

Country/ Region	permit price	domestic reductions	reductions purchased abroad	domestic abatement cost	transfers	total cost
U.S.	\$51.6	215	191	\$5.5b	\$9.9b	\$15.4b
Canada	\$51.6	16	38	\$0.4b	\$2.0b	\$2.4b
Japan	\$51.6	26	75	\$0.6b	\$3.9b	\$4.6b
Australia	\$51.6	13	5	\$0.3b	\$0.2b	\$0.6b
FSU	\$51.6	415	0	\$5.2b	-\$21.4b	net gain: \$16.2b
EU	\$51.6	105	218	\$2.7b	\$11.2b	\$13.9b
Eastern Europe	\$51.6	112	0	\$0.9b	-\$5.8b	net gain: \$4.9b

Two Permit Trading Blocs: Annex I Umbrella and Europe-Only

Country/ Region	permit price	domestic reductions	reductions purchased abroad	domestic abatement cost	transfers	total cost
U.S.	\$36.6	159	247	\$2.9b	\$9.0b	\$11.9b
Canada	\$36.6	13	41	\$0.2b	\$1.5b	\$1.7b
Japan	\$36.6	19	82	\$0.3b	\$3.0b	\$3.3b
Australia	\$36.6	10	8	\$0.2b	\$0.3b	\$0.5b
FSU	\$36.6	378	0	\$3.0b	-\$13.8b	net gain: \$10.8b
EU	\$101	178	145	\$9.0b	\$14.6b	\$23.6b
Eastern Europe	\$101	145	0	\$3.4b	-\$14.6	net gain: \$11.2b

Two Permit Trading Blocs: Annex I Umbrella and Europe-Only and 50% Constraint

Country/ Region	permit price (domestic)	domestic reductions	reductions purchased abroad	domestic abatement cost	transfers	total cost
U.S.	\$48	203	203	\$4.9b	\$3.0b	\$7.9b
Canada	\$101	27	27	\$1.4b	\$0.4b	\$1.8b
Japan	\$119	50	51	\$3.0b	\$0.8b	\$3.8b
Australia	\$32	9	9	\$0.1b	\$0.1b	\$0.2b
FSU	\$15	289	0	\$0.5b	-\$4.3b	net gain: \$3.8b
EU	\$101	178	145	\$9.0b	\$14.6b	\$23.6b
Eastern Europe	\$101	145	0	\$3.4b	-\$14.6b	net gain: \$11.2b

Two Permit Trading Blocs: Annex I Umbrella + Global JI and Europe-Only (no JI)

Country/ Region	permit price	domestic reductions	reductions purchased abroad	domestic abatement cost	transfers	total cost
U.S.	\$12	50	356	\$0.3b	\$4.4b	\$4.7b
Canada	\$12	4	50	\$0.02b	\$0.6b	\$0.6b
Japan	\$12	7	94	\$0.04b	\$1.2b	\$1.2b
Australia	\$12	4	14	\$0.02b	\$0.2b	\$0.2b
FSU	\$12	280	0	\$0.4b	-\$3.5b	net gain: \$3.1
EU	\$101	178	145	\$9.0b	\$14.6b	\$23.6b
Eastern Europe	\$101	145	0	\$3.4b	-\$14.6b	net gain: \$11.2b
China	\$12	170	0	\$1.1b	-\$2.1b	net gain: \$1.0b
India	\$12	21	0	\$0.1b	-\$0.3b	net gain: \$0.2b
Korea	\$12	2	0	\$0.01b	-\$0.02b	net gain: \$0.01b
Mexico	\$12	11	0	\$0.07b	-\$0.1b	net gain: 0.03b
ROW	\$12	30	0	\$0.2b	-\$0.4b	net gain: 0.2b

US									2010 GDP	9185
Required Cut Under Kyoto	Sinks	Elect Res	Scenario	Permit Price (92\$)	Domestic Reductions (MMTCE)	Permits Purchased Abroad	US Abatement Cost	US Capital Outflow	US TC (\$b)	TC/GDP
600	0	0	Dom Only	171	600	0	51.3	0.0	51.3	0.005585
600	52	0	Dom Only	146	548	0	40.0	0.0	40.0	0.004355
600	52	33	Dom Only	130	515	0	33.5	0.0	33.5	0.003645
600	104	33	Dom Only	105	463	0	24.3	0.0	24.3	0.002646
600	0	33	Dom Only	155	567	0	43.9	0.0	43.9	0.004784
497	-55	0	10/97 position	148	552	0	40.8	0.0	40.8	0.004447
600	104	0	Dom Only	121	496	0	30.0	0.0	30.0	0.003267
600	0	0	Annex I	48	281	319	6.7	15.3	22.1	0.002401
600	52	0	Annex I	26	187	361	2.4	9.4	11.8	0.001287
600	104	0	Annex I	11	95	401	0.5	4.4	4.9	0.000537
600	0	0	Umb - EU	26	187	413	2.4	10.7	13.2	0.001434
600	52	0	Umb - EU	11	95	453	0.5	5.0	5.5	0.000599
600	104	0	Umb - EU	0	0	496	0.0	0.0	0.0	0
600	0	0	Umb - EU, EE	43	258	342	5.5	14.7	20.3	0.002205
600	52	0	Umb - EU, EE	20	157	391	1.6	7.8	9.4	0.001022
600	104	0	Umb - EU, EE	5	51	445	0.1	2.2	2.4	0.000256
600	0	0	A1 + JI	19	150	450	1.4	8.6	10.0	0.001086
600	52	0	A1 + JI	12	102	446	0.6	5.4	6.0	0.000649
600	104	0	A1 + JI	5	51	445	0.1	2.2	2.4	0.000256
600	0	0	Umb - EU + JI	10	84	516	0.4	5.2	5.6	0.000608
600	52	0	Umb - EU + JI	4	45	503	0.1	2.0	2.1	0.000229
600	104	0	Umb - EU + JI	0	0	496	0.0	0.0	0.0	0
600	0	0	Umb - EU, EE + JI	14	116	484	0.8	6.8	7.6	0.000826
600	52	0	Umb - EU, EE + JI	8	66	482	0.3	3.9	4.1	0.000449
600	104	0	Umb - EU, EE + JI	2	27	469	0.0	0.9	1.0	0.000105
600	0	0	A1 w/ Key LDC	20	150	450	1.5	9.0	10.5	0.001143
600	52	0	A1 w/ Key LDC	12	102	446	0.6	5.4	6.0	0.000649
600	104	0	A1 w/ Key LDC	5	51	445	0.1	2.2	2.4	0.000256
600	0	0	Umb - EU w/ Key LDC	12	102	498	0.6	6.0	6.6	0.000717
600	52	0	Umb - EU w/ Key LDC	5	51	497	0.1	2.5	2.6	0.000284
600	104	0	Umb - EU w/ Key LDC	0	0	496	0.0	0.0	0.0	0

Required Cut Under Kyoto	Sinks	Elect Res	Scenario	Permit Price (92\$)	Domestic Reductions (MMTCE)	Permits Purchased Abroad	US Abatement Cost	US Capital Outflow	US TC (\$b)	TC/GDP
600	0	0	Umb - EU, EE w/ Key LDC	16	130	470	1.0	7.5	8.6	0.000932
600	52	0	Umb - EU, EE w/ Key LDC	9	72	476	0.3	4.3	4.6	0.000502
600	104	0	Umb - EU, EE w/ Key LDC	2	27	469	0.0	0.9	1.0	0.000105
600	0	0	A1 + 20% JI	36	229	371	4.1	13.4	17.5	0.001903
600	52	0	A1 + 20% JI	21	164	384	1.7	8.1	9.8	0.001065
600	104	0	A1 + 20% JI	9	72	424	0.3	3.8	4.1	0.000451
600	0	0	Umb - EU + 20% JI	20	157	443	1.6	8.9	10.4	0.001136
600	52	0	Umb - EU + 20% JI	9	72	476	0.3	4.3	4.6	0.000502
600	104	0	Umb - EU + 20% JI	0	0	496	0.0	0.0	0.0	0
600	0	0	Umb - EU, EE + 20% JI	30	204	396	3.1	11.9	14.9	0.001627
600	52	0	Umb - EU, EE + 20% JI	16	130	418	1.0	6.7	7.7	0.000841
600	104	0	Umb - EU, EE + 20% JI	4	45	451	0.1	1.8	1.9	0.000206
600	0	0	A1 w/ Key LDC + 20% JI	20	157	443	1.6	8.9	10.4	0.001136
600	52	0	A1 w/ Key LDC + 20% JI	12	102	446	0.6	5.4	6.0	0.000649
600	104	0	A1 w/ Key LDC + 20% JI	5	51	445	0.1	2.2	2.4	0.000256
600	0	0	Umb - EU w/ Key LDC + 20% JI	11	95	505	0.5	5.6	6.1	0.000662
600	52	0	Umb - EU w/ Key LDC + 20% JI	5	51	497	0.1	2.5	2.6	0.000284
600	104	0	Umb - EU w/ Key LDC + 20% JI	0	0	496	0.0	0.0	0.0	0
600	0	0	Umb - EU, EE w/ Key LDC + 20% JI	15	123	477	0.9	7.2	8.1	0.000879
600	52	0	Umb - EU, EE w/ Key LDC + 20% JI	9	72	476	0.3	4.3	4.6	0.000502
600	104	0	Umb - EU, EE w/ Key LDC + 20% JI	2	27	469	0.0	0.9	1.0	0.000105

The Effects of Annex I Trading and Ideal Global JI on Russia

Scenario	Permit Price (\$/ton)	FSU Permit Sales (MMTC)	FSU TR (billions \$)	Russia TR (billions \$)	FSU TC (billions \$)	Russia TC (billions \$)	Russia TR-TC (billions \$)
100% Paper Tons*	\$15.8	294	\$4.65	\$3.02	\$0.63	\$0.41	\$2.61
50% Paper Tons	\$20.3	215	\$4.36	\$2.84	\$1.10	\$0.71	\$2.13
No Paper Tons*	\$25.9	130	\$3.37	\$2.19	\$1.68	\$1.09	\$1.10

Model: SGM

* From model runs. 50% paper tons case based on interpolations from constructed marginal abatement cost curves.

Russian revenues and costs are assumed to be 65% of FSU revenues and costs, given that the Russian economy was approximately 65% the size of all FSU countries' economies in 1995.

Total costs are calculated assuming that the marginal abatement cost curve is linear in those sections of the curve.

All dollars are expressed in 1992 \$.

These analyses assume that there are no constraints on the ability of other Annex I countries to purchase emissions reductions abroad.

The Effects of Annex I Trading Alone on Russia

Scenario	Permit Price (\$/ton)	FSU Permit Sales (MMTC)	FSU TR (billions \$)	Russia TR (billions \$)	FSU TC (billions \$)	Russia TC (billions \$)	Russia TR-TC (billions \$)
100% Paper Tons*	\$41.3	382	\$15.8	\$10.27	\$3.5	\$2.28	\$7.99
50% Paper Tons	\$55	319	\$17.5	\$11.38	\$5.8	\$3.77	\$7.61
No Paper Tons*	\$71.6	251	\$18.0	\$11.70	\$9.0	\$5.85	\$5.85

Model: SGM

* From model runs. 50% paper tons case based on interpolations from constructed marginal abatement cost curves.

Russian revenues and costs are assumed to be 65% of FSU revenues and costs, given that the Russian economy was approximately 65% the size of all FSU countries' economies in 1995.

Total costs are calculated assuming that the marginal abatement cost curve is linear in those sections of the curve.

All dollars are expressed in 1992 \$.

These analyses assume that there are no constraints on the ability of other Annex I countries to purchase emissions reductions abroad.

The Effects of Annex I Trading and Ideal Global JI on Russia

Scenario	Permit Price (\$/ton)	FSU Permit Sales (MMTC)	FSU TR (billions \$)	Russia TR (billions \$)	FSU TC (billions \$)	Russia TC (billions \$)	Russia TR-TC (billions \$)
100% Paper Tons*	\$15.8	294	\$4.65	\$3.02	\$0.63	\$0.41	\$2.61
50% Paper Tons	\$20.3	215	\$4.36	\$2.84	\$1.10	\$0.71	\$2.13
No Paper Tons*	\$25.9	130	\$3.37	\$2.19	\$1.68	\$1.09	\$1.10

Model: SGM

* From model runs. 50% paper tons case based on interpolations from constructed marginal abatement cost curves.

Russian revenues and costs are assumed to be 65% of FSU revenues and costs, given that the Russian economy was approximately 65% the size of all FSU countries' economies in 1995.

Total costs are calculated assuming that the marginal abatement cost curve is linear in those sections of the curve.

All dollars are expressed in 1992 \$.

These analyses assume that there are no constraints on the ability of other Annex I countries to purchase emissions reductions abroad.

The Effects of Annex I Trading Alone on Russia

Scenario	Permit Price (\$/ton)	FSU Permit Sales (MMTC)	FSU TR (billions \$)	Russia TR (billions \$)	FSU TC (billions \$)	Russia TC (billions \$)	Russia TR-TC (billions \$)
100% Paper Tons*	\$41.3	382	\$15.8	\$10.27	\$3.5	\$2.28	\$7.99
50% Paper Tons	\$55	319	\$17.5	\$11.38	\$5.8	\$3.77	\$7.61
No Paper Tons*	\$71.6	251	\$18.0	\$11.70	\$9.0	\$5.85	\$5.85

Model: SGM

* From model runs. 50% paper tons case based on interpolations from constructed marginal abatement cost curves.

Russian revenues and costs are assumed to be 65% of FSU revenues and costs, given that the Russian economy was approximately 65% the size of all FSU countries' economies in 1995.

Total costs are calculated assuming that the marginal abatement cost curve is linear in those sections of the curve.

All dollars are expressed in 1992 \$.

These analyses assume that there are no constraints on the ability of other Annex I countries to purchase emissions reductions abroad.

MEMORANDUM

TO: Ray Squitieri
FROM: Joe Aldy
DATE: December 3, 1997
RE: Constraints on Annex I Permit Trading: Paper Tons and Purchase Caps

To assess the effects of constraining the percentage of paper tons EEFSU countries can sell as well as the percentage of emissions reductions occurring abroad other Annex I countries can buy, I reviewed model outputs from SGM. Both of these constraints can increase the price of a carbon permit, depending on the stringency of the constraint.

In most cases, a stringent purchase cap (e.g., no country can buy more than 10% of its emissions reductions abroad) drives the U.S. permit price (see attached table). For the scenarios with paper tons and 10% purchase caps, EEFSU countries cannot even sell all of their paper tons. For the scenarios with paper tons and 25% purchase caps, EEFSU countries do sell all of their paper tons, and some tons representing actual emissions reductions relative to BAU.

However, constraints on the extent of allowable paper ton sales and loose purchase caps (e.g., 50%) are driven by the paper ton constraint. In the case of a 50% paper ton constraint and a 50% purchase cap, non-EEFSU countries buy 49% of their emissions reductions from EEFSU countries. In the case of no paper tons and a 50% purchase cap, non-EEFSU countries buy 38% of their emissions reductions from EEFSU countries.

Constraints	U.S. Permit Price (\$/ton)	Permits Purchased Abroad by U.S. (MMTCE)
100% paper tons, no purchase caps (no constraints)	\$41*	202
50% paper tons, no purchase caps	\$55	149
no paper tons, no purchase caps	\$72*	97
100% paper tons, 10% purchase cap	\$93	38
100% paper tons, 25% purchase cap	\$72	95
100% paper tons, 50% purchase cap	\$45	190
50% paper tons, 10% purchase cap	\$93	38
50% paper tons, 25% purchase cap	\$72	95
50% paper tons, 50% purchase cap	\$55	151
no paper tons, 10% purchase cap	\$93	38
no paper tons, 25% purchase cap	\$72	95
no paper tons, 50% purchase cap	\$72	97

*From model runs. All other estimates are derived from assessing the constructed marginal abatement cost curves depicted in attached graphs.

MEMORANDUM

TO: Ray Squitieri
 FROM: Joe Aldy
 DATE: December 2, 1997
 RE: The Effects of Trading Constraints on Permit Prices and Income Flows

To assess the effects of trading constraints on U.S. permit prices and income flows, I reviewed several model runs from SGM. While unconstrained trading would result in minimizing the compliance costs with binding targets, some have proposed constraining the amount of emissions reductions allowed to be achieved through international permit trading and joint implementation. The following table presents the permit prices and the quantity of permits purchased abroad under various percentage-based constraints.

U.S. Permit Prices for Meeting 1990 in 2010 under Various Trading Constraints

% of Reductions Allowed to be Purchased from Other Countries	Annex I Trading Only (permits purchased abroad)	Annex I Trading + Joint Implementation (permits purchased abroad)
100% (no constraint)	\$41/ton (202 MMTCE)	\$16/ton (312 MMTCE)
0% (no trading, no JI)	\$108/ton (0 MMTCE)	\$108/ton (0 MMTCE)
10%	\$93/ton (38 MMTCE)	\$93/ton (38 MMTCE)
25%	\$72/ton (95 MMTCE)	\$72/ton (95 MMTCE)
50%	\$45/ton (190 MMTCE)	\$45/ton (190 MMTCE)

model: SGM

Constraints on Trade

This analysis provides four interesting points. First, in an unconstrained world, the U.S. buys 53% of its emissions reductions abroad with Annex I trading and 82% of reductions with JI and Annex I trading. Note in the second table that the U.S. buys less as a share of reductions than other Annex I countries (however, EEFSU countries are sellers). Second, any split between JI and Annex I trading (e.g., no more than 5% through trading, no more than 5% through JI) is irrelevant to the U.S. permit price so long as the total constraint (e.g., 10%) is less than the percentage of emissions reductions the U.S. would buy under no constraints. Third, Russia sells more permits than China under JI (but less than it would with an Annex I trading only world) because it has so many paper tons. Fourth, any constraint less than 60% implies that EEFSU countries would not be able to sell all of their paper tons.

Percent of Emissions Reductions Purchased Abroad with No Constraints on Trading and JI

Country/Region	Annex I Trading Only	Annex I Trading + Joint Implementation
Canada	75%	88%
Japan	78%	91%
Western Europe	65%	86%
Australia	58%	81%
U.S.	53%	82%

model: SGM

Income Flows

Not only do constraints on trade negatively impact the buyers of permits by increasing permit prices, but they also decrease the flows of income to countries that sell. In a no-constraint world, the sellers of permits would receive \$20 billion in 2010 under Annex I trading and more than \$10 billion in 2010 under Annex I trading and JI. However, a constraint of 10% emissions reduction through foreign purchases would result in income transfers of only \$600 million under Annex I trading and \$200 million under Annex I trading plus JI. This 10% constraint results in EIT and developing countries receiving only 2-3% of the income they would have received without the constraint.

August 19, 1997

Comments on "Additionality in the Context of Joint Implementation", August 13 Draft
Office of Economic Policy, Treasury Department

1) The central problem with this paper is that it does not sufficiently acknowledge the *fundamentally difficult task of establishing that emissions reductions are incremental*. Each of the approaches proposed involves comparisons to a counterfactual that is not observed, only modelled. As such, the guarantee of additionality is only as good as the models themselves. The memo presents no evidence on the quality of the predictions from these types of models, nor a sufficiently rich discussion of the technical difficulties inherent in applying these types of modelling exercises in the context of JI.

To see this, compare the approaches listed in this paper to the best possible approach: JI with binding developing country commitments on emissions levels. This simply amounts to international trading with developing countries included. In such a world, we are guaranteed incrementality: to claim credit for a unit of emissions reduction, a company in the U.S. will have to buy a permit in the developing country for one unit of emissions. This will by definition guarantee that emissions in the developing country drop by one unit, since there is a fixed total of emissions credits in that country. Thus, additionality is assured, since there is now one fewer units of total emissions from other sources in the developing country.

Now, compare to this the best possible modelling approach. Under this approach, engineering specialists draw up a prediction about the future path of generation power sources (for example) in the developing country. But any prediction is just that, and as such will have some error. In some cases, the prediction will understate the pace of technological advance in the developing country, so that companies will get credit for building a type of plant that would have been built anyway. In some cases, the prediction will overstate the pace, so that companies will not build a plant because they are not getting credit. In any case, given that all models make prediction errors, there will be resulting error rates in our ability to assign JI credit. So there is *no way to guarantee additionality without binding developing country commitments*.

This is not to say that there is JI is completely non-additional under the proposed approaches. Indeed, the methodologies suggested are clever and are probably the best that we can do without commitments from developing countries. But while the paper acknowledges potential problems such as those described above in the fourth paragraph, it then immediately turns into the fifth to "assuring additionality". A footnote in that paragraph offers the appropriate caveat, but the implication is that additionality can be assured nonetheless.

This problem can be partially addressed by making three straightforward changes:

a) A new fourth paragraph on the first page should discuss the benchmark case: international trading. It should bring out the key points made above: that any JI approach which revolves around modelling baselines can only approach, and can never achieve, the additionality that would be guaranteed if developing countries were brought into an international trading regime.

b) Footnote 4 should be brought into the text and amplified.

c) Terms like “high accuracy” should be prefaced by “relatively”; these options are the highest accuracy of those listed, but may be very low accuracy relative to the ideal benchmark of international trading.

2) Do we have any evidence on how accurate the forecasts of counterfactual technology paths are likely to be? If we had done forecasts based on available data for the U.S. or some other country 10 years ago, would we have predicted anything like our current pattern of technology adoption for generation and other activities? This goes to the heart of these type of modelling approaches to establishing additionality.

3) As CEA and Treasury highlighted in their comments on an earlier draft, different approaches to modelling the processes of technological diffusion are likely to yield very different answers for the counterfactual. How will this uncertainty be resolved? This is a particularly salient question given the “all or nothing” aspect of JI. If there is some penetration of a particular type of generation, but it has not fully diffused, the company might get no credit at all. This will provide a particularly strong incentive for firms to promote the engineering estimates that support their case. How will these pressures be resisted, given the true uncertainty in the estimates?

One particular logistical difficulty will be deciding which country will be responsible for determining the counterfactual. If we let the developing countries themselves model the counterfactual, one could imagine an “engineering bidding war”, where each of several countries engineers compete to make their baseline look the least advanced (thus making their country more attractive for investment by presenting more opportunity for additionality). This could be rectified by an objective U.S. or third party engineer, but this might raise a difficult set of sovereignty issues.

4) Option 3 provides the closest alternative to true additionality through developing country commitments, by measuring changes in sector specific emissions patterns. But once again, it must be recognized that emissions are projected based on out of sample modelling. How accurate are our models? Once again, it would be constructive to assess how well existing models would do at predicted observed emissions history based on data that ended 10 years ago.

5) Options 4 and 5 strike us as the most problematic, since they are the most subjective. Any option which is strongly influenced by the type of proposal made by the firm, rather than by objective evidence to support additionality, will simply reward firms that are best at making their case, not those that are guaranteeing the most additionality. This will lead to huge inefficiencies (“rent-seeking losses”) as firms devote substantial resources to making a case look as good as possible, rather than devoting those resources to the investment itself.

ID	Scenario	Model	Modelers	Target	Timetable	Trading	Permit Allocation	Revenue Recycling	Burden Sharing	BAU Emissions Path Assumption	Paper Tons or Corresponding Reductions	AEEI	Ramp-up	Time Path	Outputs PDV (5%; 2000-2050) Foregone Consumption	GDP in 2010 (deviation from BAU)
SGM1	BAU	SGM, MAGICC	Battelle	n/a	n/a	n/a	n/a	n/a	n/a	IAT	n/a	1.0	n/a	-->2050, -->2100 (climate)	\$121,650 billion (BAU consumption)	\$9,185 billion (BAU GDP)
SGM9	-10% of 1990 in 2010	SGM, MAGICC	Battelle	-10% 1990 emissions level	stabilize in 2010	Annex I	auction	lump-sum	no LDC part.	IAT	PT	1.0	no	-->2050, -->2100 (climate)	\$485 billion	\$9,155 billion (-\$30 billion)
SGM8	-10% of 1990 in 2010	SGM, MAGICC	Battelle	-10% 1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	PT	1.0	no	-->2050, -->2100 (climate)	\$980 billion	\$9,149 billion (-\$36 billion)
SGM10	-10% of 1990 in 2010	SGM, MAGICC	Battelle	-10% 1990 emissions level	stabilize in 2010	worldwide	auction	lump-sum	no LDC part.	IAT	PT	1.0	no	-->2050, -->2100 (climate)	\$50 billion	\$9,171 billion (-\$14 billion)
SGM36	1990 in 2020	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2020	Annex I	auction	lump-sum	no LDC part.	IAT	PT	1.0	yes	-->2050, -->2100 (climate)	\$195 billion	\$9,179 billion (-\$6 billion)
SGM39	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	Annex I	auction	lump-sum	no LDC part.	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$230 billion	\$9,172 billion (-\$13 billion)
SGM3	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	Annex I	auction	lump-sum	no LDC part.	IAT	PT	1.0	no	-->2050, -->2100 (climate)	\$225 billion	\$9,172 billion (-\$13 billion)
SGM18	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	Annex I	auction	lump-sum	LDC stabilizes at 2030 in 2030	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$255 billion	\$9,172 billion (-\$13 billion)
SGM21	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	Annex I	auction	lump-sum	LDC BAU to 2030, equal per capita in 2050	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$260 billion	\$9,172 billion (-\$13 billion)
SGM17	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	LDC stabilizes at 2030 in 2030	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$740 billion	\$9,164 billion (-\$21 billion)
SGM2	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	PT	1.0	no	-->2050, -->2100 (climate)	\$665 billion	\$9,165 billion (-\$20 billion)
SGM38	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$740 billion	\$9,164 billion (-\$21 billion)
SGM20	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	LDC BAU to 2030, equal per capita in 2050	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$740 billion	\$9,164 billion (-\$21 billion)
SGM40	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	worldwide	auction	lump-sum	no LDC part.	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$5 billion	\$9,180 billion (-\$5 billion)

ID	Scenario	Model	Modelers	Target	Timetable	Trading	Permit Allocation	Revenue Recycling	Burden Sharing	BAU Emissions Path Assumption	Paper Tons or Corresponding Reductions	AEEI	Ramp-up	Time Path	PDV (5%; 2000-2050) Foregone Consumption	GDP in 2010 (deviation from BAU)
SGM4	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	worldwide	auction	lump-sum	no LDC part.	IAT	PT	1.0	no	-->2050, -->2100 (climate)	\$5 billion	\$9,180 billion (-\$5 billion)
SGM22	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	worldwide	auction	lump-sum	LDC BAU to 2030, equal per capita in 2050	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$25 billion	\$9,180 billion (-\$5 billion)
SGM19	1990 in 2010	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2010	worldwide	auction	lump-sum	LDC stabilizes at 2030 in 2030	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$20 billion	\$9,180 billion (-\$5 billion)
SGM35	1990 in 2020	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2020	domestic only	auction	lump-sum	no LDC part.	IAT	PT	1.0	yes	-->2050, -->2100 (climate)	\$660 billion	\$9,172 billion (-\$13 billion)
SGM37	1990 in 2020	SGM, MAGICC	Battelle	1990 emissions level	stabilize in 2020	worldwide	auction	lump-sum	no LDC part.	IAT	PT	1.0	yes	-->2050, -->2100 (climate)	-\$1 billion	\$9,183 billion (-\$2 billion)
SGM6	1995 in 2010	SGM, MAGICC	Battelle	1995 emissions level	stabilize in 2010	Annex I	auction	lump-sum	no LDC part.	IAT	CR	1.0	no	-->2050, -->2100 (climate)	\$380 billion	\$9,175 billion (-\$10 billion)
SGM5	1995 in 2010	SGM, MAGICC	Battelle	1995 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	CR	1.0	no	-->2050, -->2100 (climate)	\$425 billion	\$9,174 billion (-\$11 billion)
SGM7	1995 in 2010	SGM, MAGICC	Battelle	1995 emissions level	stabilize in 2010	worldwide	auction	lump-sum	no LDC part.	IAT	CR	1.0	no	-->2050, -->2100 (climate)	\$30 billion	\$9,179 billion (-\$6 billion)
SGM33	1995 in 2020	SGM, MAGICC	Battelle	1995 emissions level	stabilize in 2020	Annex I	auction	lump-sum	no LDC part.	IAT	CR	1.0	yes	-->2050, -->2100 (climate)	\$410 billion	\$9,176 billion (-\$9 billion)
SGM32	1995 in 2020	SGM, MAGICC	Battelle	1995 emissions level	stabilize in 2020	domestic only	auction	lump-sum	no LDC part.	IAT	CR	1.0	yes	-->2050, -->2100 (climate)	\$445 billion	\$9,176 billion (-\$9 billion)
SGM34	1995 in 2020	SGM, MAGICC	Battelle	1995 emissions level	stabilize in 2020	worldwide	auction	lump-sum	no LDC part.	IAT	CR	1.0	yes	-->2050, -->2100 (climate)	-\$40 billion	\$9,180 billion (-\$5 billion)
SGM12	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	Annex I	auction	lump-sum	no LDC part.	IAT	PT	1.0	no	-->2050, -->2100 (climate)	\$55 billion	\$9,185 billion (\$0 billion)
SGM30	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	Annex I	auction	lump-sum	no LDC part.	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$75 billion	\$9,185 billion (0 billion)
SGM24	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	Annex I	auction	lump-sum	LDC stabilizes at 2030 in 2030	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$75 billion	\$9,185 billion (0 billion)

ID	Scenario	Model	Modelers	Target	Timetable	Trading	Permit Allocation	Revenue Recycling	Burden Sharing	BAU Emissions Path Assumption	Paper Tons or Corresponding Reductions	AEEI	Ramp-up	Time Path	PDV (5%; 2000-2050) Foregone Consumption	GDP in 2010 (deviation from BAU)
SGM27	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	Annex I	auction	lump-sum	LDC BAU to 2030, equal per capita in 2050	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$75 billion	\$9,185 billion (0 billion)
SGM11	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	domestic only	auction	lump-sum	no LDC part.	IAT	PT	1.0	no	-->2050, -->2100 (climate)	\$235 billion	\$9,185 billion (\$0 billion)
SGM29	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	domestic only	auction	lump-sum	no LDC part.	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$270 billion	\$9,184 billion (-\$1 billion)
SGM26	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	domestic only	auction	lump-sum	LDC BAU to 2030, equal per capita in 2050	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$270 billion	\$9,184 billion (-\$1 billion)
SGM23	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	domestic only	auction	lump-sum	LDC stabilizes at 2030 in 2030	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$270 billion	\$9,184 billion (-\$1 billion)
SGM25	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	worldwide	auction	lump-sum	LDC stabilizes at 2030 in 2030	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	-\$3 billion	\$9,185 billion (0 billion)
SGM31	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	worldwide	auction	lump-sum	no LDC part.	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	-\$5 billion	\$9,185 billion (0 billion)
SGM13	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	worldwide	auction	lump-sum	no LDC part.	IAT	PT	1.0	no	-->2050, -->2100 (climate)	-\$8 billion	\$9,185 billion (\$0 billion)
SGM28	Peak in 2015	SGM, MAGICC	Battelle	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	worldwide	auction	lump-sum	LDC BAU to 2030, equal per capita in 2050	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$1 billion	\$9,185 billion (0 billion)
SGM15	+10% of 1990 in 2010	SGM, MAGICC	Battelle	+10% 1990 emissions level	stabilize in 2010	Annex I	auction	lump-sum	no LDC part.	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$95 billion	\$9,181 billion (-\$4 billion)
SGM14	+10% of 1990 in 2010	SGM, MAGICC	Battelle	+10% 1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$460 billion	\$9,174 billion (-\$11 billion)

ID	Scenario	Model	Modelers	Target	Timetable	Trading	Permit Allocation	Revenue Recycling	Burden Sharing	BAU Emissions Path Assumption	Paper Tons or Corresponding Reductions	AEI	Ramp-up	Time Path	PDV (5%; 2000-2050) Foregone Consumption	GDP in 2010 (deviation from BAU)
SGM16	+10% of 1990 in 2010	SGM, MAGICC	Battelle	+10% 1990 emissions level	stabilize in 2010	worldwide	auction	lump-sum	no LDC part.	IAT	PT	1.0	in 2005	-->2050, -->2100 (climate)	\$1 billion	\$9,184 billion (-\$1 billion)
MM1	BAU	Markal	DOE	n/a	n/a	n/a	n/a	n/a	n/a	IAT	n/a	~1.0	n/a	-->2025	n/a	\$9,205 billion (BAU GDP)
MM2	1990 in 2010	Markal	DOE	1990 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	n/a	~1.0	n/a	-->2025	n/a	\$9,137 billion (-\$68 billion)
MM3	1995 in 2010	Markal	DOE	1995 emissions level	stabilize in 2010	domestic only	auction	lump-sum	no LDC part.	IAT	n/a	~1.0	n/a	-->2025	n/a	\$9,152 billion (-\$53 billion)
MM4	1990 in 2020	Markal	DOE	1990 emissions level	stabilize in 2020	domestic only	auction	lump-sum	no LDC part.	IAT	n/a	~1.0	n/a	-->2025	n/a	\$9,197 billion (-\$8 billion)
MM5	Peak in 2015	Markal	DOE	2010 BAU emissions in 2015; 1990 level in 2040	stabilize in 2040	domestic only	auction	lump-sum	no LDC part.	IAT	n/a	~1.0	n/a	-->2025	n/a	\$9,201 billion (-\$4 billion)

ID	Permit Prices: 2010	Permit Prices: 2025	Permit Prices: 2050	Conc. (ppmv) in 2050 (Deviation from BAU)	Conc. (ppmv) in 2100 (Deviation from BAU)	Year Conc. (550 ppmv) Reaches 2x Pre-Ind. Level (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2050 (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2100 (Deviation from BAU)	Emissions Peak, mmtce (year)	Year Returns to 1990	Intl. Trade of Permits, U.S., 2010 (MMTCE), (\$)	Intl. Trade of Permits, U.S., 2050 (MMTCE), (\$)	Date Received Run	File (h:\jaldy\)
SGM1	\$0	\$0	\$0	502	711	2065	1.06	2.36	no peak: 2245 (2050)	n/a	n/a	n/a	08/21/97	cea90_~1.xls
SGM9	\$91	\$137	\$238	481 (-21)	645 (-66)	2074 (+9)	0.97 (-0.09)	2.11 (-0.25)	1637 (2005)	never returns	-180, (-\$16.4 billion)	-332, (-\$79.0 billion)	08/21/97	cea90m_~1.xls
SGM8	\$175	\$304	\$924	481 (-21)	645 (-66)	2074 (+9)	0.97 (-0.09)	2.11 (-0.25)	1637 (2005)	2010	n/a	n/a	08/21/97	cea90m_~1.xls
SGM10	\$33	\$37	\$45	481 (-21)	645 (-66)	2074 (+9)	0.97 (-0.09)	2.11 (-0.25)	no peak: 2060 (2050)	never returns	-332, (-\$11.0 billion)	-845, (-\$38.0 billion)	08/21/97	cea90m_~1.xls
SGM36	\$23	\$86	\$150	486 (-16)	656 (-55)	2072 (+7)	0.99 (-0.07)	2.16 (-0.20)	no peak: 1714 (2050)	n/a	-180 (-\$4.14 billion)	-364 (-\$54.6 billion)	09/10/97	case20~1.xls
SGM39	\$41	\$84	\$149	486 (-16)	656 (-55)	2072 (+7)	0.99 (-0.07)	2.16 (-0.20)	no peak: 1714 (2050)	never returns	-202, (-\$8.3 billion)	-364, (-\$54.2 billion)	09/10/97	case10~1.xls
SGM3	\$42	\$84	\$149	486 (-16)	655 (-56)	2072 (+7)	0.99 (-0.07)	2.15 (-0.21)	no peak: 1714 (2050)	never returns	-202, (-\$8.5 billion)	-364, (-\$54.2 billion)	08/21/97	cea90_~2.xls
SGM18	\$39	\$83	\$150	478 (-24)	565 (-146)	2091 (+26)	0.96 (-0.10)	1.82 (-0.54)	no peak: 1712 (2050)	never returns	-209, (-\$8.2 billion)	-362, (-\$54.3 billion)	08/27/97	case2.xls, 9/4/97 fax
SGM21	\$39	\$83	\$150	n/a	n/a	n/a	n/a	n/a	no peak: 1712 (2050)	never returns	-209, (-\$8.2 billion)	-362, (-\$54.3 billion)	08/27/97	case3.xls
SGM17	\$108	\$188	\$582	476 (-26)	564 (-147)	2092 (+27)	0.95 (-0.11)	1.82 (-0.54)	1550 (2000)	2010	n/a	n/a	08/27/97	case2.xls, 9/4/97 fax
SGM2	\$110	\$191	\$582	485 (-17)	658 (-53)	2072 (+7)	0.99 (-0.07)	2.16 (-0.20)	1637 (2005)	2010	n/a	n/a	08/21/97	cea90_~2.xls
SGM38	\$108	\$188	\$582	484 (-18)	656 (-55)	2073 (+8)	0.98 (-0.08)	2.15 (-0.21)	1550 (2000)	2010	n/a	n/a	09/10/97	case10~1.xls
SGM20	\$108	\$188	\$582	n/a	n/a	n/a	n/a	n/a	1550 (2000)	2010	n/a	n/a	08/27/97	case3.xls
SGM40	\$16	\$23	\$33	486 (-16)	656 (-55)	2072 (+7)	0.99 (-0.07)	2.16 (-0.20)	no peak: 2101 (2050)	never returns	-312, (-\$5.0 billion)	-751, (-\$24.8 billion)	09/10/97	case10~1.xls

ID	Permit Prices: 2010	Permit Prices: 2025	Permit Prices: 2050	Conc. (ppmv) in 2050 (Deviation from BAU)	Conc. (ppmv) in 2100 (Deviation from BAU)	Year Conc. (550 ppmv) Reaches 2x Pre-Ind. Level (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2050 (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2100 (Deviation from BAU)	Emissions Peak, mmtce (year)	Year Returns to 1990	Intl. Trade of Permits, U.S., 2010 (MMTCE), (\$)	Intl. Trade of Permits, U.S., 2050 (MMTCE), (\$)	Date Received Run	File (h:\jaldy\)
SGM4	\$16	\$23	\$32	486 (-16)	655 (-56)	2072 (+7)	0.99 (-0.07)	2.15 (-0.21)	no peak: 2102 (2050)	never returns	-313, (-\$5.0 billion)	-752, (-\$24.1 billion)	08/21/97	cea90_~2.xls
SGM22	\$15	\$23	\$0	n/a	n/a	n/a	n/a	n/a	no peak: 2239 (2050)	never returns	n/a	n/a	08/27/97	case3.xls
SGM19	\$15	\$23	\$110	478 (-24)	565 (-146)	2091 (+26)	0.96 (-0.10)	1.82 (-0.54)	1883 (2040)	never returns	-316, (-\$4.7 billion)	-500, (-\$55.0 billion)	08/27/97	case2.xls, 9/4/97 fax
SGM35	\$71	\$192	\$582	484 (-18)	656 (-55)	2073 (+8)	0.98 (-0.08)	2.15 (-0.21)	1550 (2000)	2020	n/a	n/a	09/10/97	case20~1.xls
SGM37	\$9	\$24	\$33	486 (-16)	656 (-55)	2072 (+7)	0.99 (-0.07)	2.16 (-0.20)	no peak: 2101 (2050)	n/a	-246 (-\$2.21 billion)	-751 (-\$24.78 billion)	09/10/97	case20~1.xls
SGM6	\$74	\$119	\$202	483 (-19)	648 (-63)	2074 (+9)	0.98 (-0.08)	2.12 (-0.24)	1637 (2005)	never returns	36, (+\$2.7 billion)	-122, (-\$24.6 billion)	08/21/97	cea95_~1.xls
SGM5	\$62	\$131	\$317	483 (-19)	648 (-63)	2074 (+9)	0.98 (-0.08)	2.12 (-0.24)	1637 (2005)	never returns	n/a	n/a	08/21/97	cea95_~1.xls
SGM7	\$27	\$32	\$41	483 (-19)	648 (-63)	2074 (+9)	0.98 (-0.08)	2.12 (-0.24)	no peak: 2073 (2050)	never returns	-131, (-\$3.5 billion)	-593, (-\$24.3 billion)	08/21/97	cea95_~1.xls
SGM33	\$57	\$120	\$203	482 (-20)	648 (-63)	2074 (+9)	0.97 (-0.09)	2.12 (-0.24)	no peak: 1599 (2050)	n/a	20 (\$1.14 billion)	-119, (-\$24.16 billion)	09/10/97	case20~2.xls
SGM32	\$51	\$131	\$318	482 (-20)	648 (-63)	2074 (+9)	0.97 (-0.09)	2.12 (-0.24)	1550 (2000)	n/a	n/a	n/a	09/10/97	case20~2.xls
SGM34	\$21	\$33	\$41	482 (-20)	648 (-63)	2074 (+9)	0.97 (-0.09)	2.12 (-0.24)	no peak: 2072 (2050)	n/a	-122 (-\$2.56 billion)	-592 (-\$24.27 billion)	09/10/97	case20~2.xls
SGM12	\$0	\$47	\$155	491 (-11)	n/a	n/a	1.02 (-0.04)	n/a	1807 (2015)	never returns	0, (n/a)	-367, (-\$56.9 billion)	08/21/97	cea90_~1.xls
SGM30	\$11	\$56	\$153	489 (-13)	658 (-53)	2071 (+6)	1.00 (-0.06)	2.17 (-0.19)	1755 (2015)	never returns	-5, (-\$0.06 billion)	-367, (-\$56.2 billion)	08/27/97	case6.xls, 9/4/97 fax
SGM24	\$11	\$56	\$153	481 (-21)	568 (-143)	2089 (+24)	0.98 (-0.08)	1.84 (-0.52)	1755 (2015)	never returns	-5, (-\$0.06 billion)	-367, (-\$56.2 billion)	08/27/97	case4.xls, 9/4/97 fax

ID	Permit Prices: 2010	Permit Prices: 2025	Permit Prices: 2050	Conc. (ppmv) in 2050 (Deviation from BAU)	Conc. (ppmv) in 2100 (Deviation from BAU)	Year Conc. (550 ppmv) Reaches 2x Pre-Ind. Level (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2050 (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2100 (Deviation from BAU)	Emissions Peak, mmtce (year)	Year Returns to 1990	Intl. Trade of Permits, U.S., 2010 (MMTCE), (\$)	Intl. Trade of Permits, U.S., 2050 (MMTCE), (\$)	Date Received Run	File (h:\jaldy\)
SGM27	\$11	\$56	\$153	n/a	n/a	n/a	n/a	n/a	1755 (2015)	never returns	-5, (-\$0.06 billion)	-367, (-\$56.2 billion)	08/27/97	case5.xls
SGM11	\$0	\$84	\$539	489 (-13)	n/a	n/a	1.01 (-0.05)	n/a	1807 (2015)	2040	n/a	n/a	08/21/97	cea90_~1.xls
SGM29	\$12	\$99	\$563	489 (-13)	658 (-53)	2071 (+6)	1.00 (-0.06)	2.17 (-0.19)	1729 (2015)	2040	n/a	n/a	08/27/97	case6.xls, 9/4/97 fax
SGM26	\$12	\$99	\$563	n/a	n/a	n/a	n/a	n/a	1729 (2015)	2040	n/a	n/a	08/27/97	case5.xls
SGM23	\$12	\$99	\$563	481 (-21)	568 (-143)	2089 (+24)	0.98 (-0.08)	1.84 (-0.52)	1729 (2015)	2040	n/a	n/a	08/27/97	case4.xls, 9/4/97 fax
SGM25	\$4	\$16	\$111	481 (-21)	568 (-143)	2089 (+24)	0.98 (-0.08)	1.84 (-0.52)	1893 (2030)	never returns	-30, (-\$0.1 billion)	-500, (-\$55.5 billion)	08/27/97	case4.xls, 9/4/97 fax
SGM31	\$4	\$16	\$33	489 (-13)	658 (-53)	2071 (+6)	1.00 (-0.06)	2.17 (-0.19)	no peak: 2101 (2050)	never returns	-30, (-\$0.12 billion)	-751, (-\$24.8 billion)	08/27/97	case6.xls, 9/4/97 fax
SGM13	\$0	\$14	\$33	491 (-11)	n/a	n/a	1.02 (-0.04)	n/a	no peak: 2102 (2050)	never returns	0, (n/a)	-752, (-\$24.8 billion)	08/21/97	cea90_~1.xls
SGM28	\$4	\$16	\$0	n/a	n/a	n/a	n/a	n/a	no peak: 2241 (2050)	never returns	n/a	n/a	08/27/97	case5.xls
SGM15	\$17	\$56	\$113	489 (-13)	662 (-49)	2071 (+6)	1.00 (-0.06)	2.18 (-0.18)	no peak: 1824 (2050)	never returns	-172, (-\$2.9 billion)	-339, (-\$38.3 billion)	08/27/97	case1.xls
SGM14	\$60	\$128	\$310	488 (-14)	664 (-47)	2071 (+6)	0.99 (-0.07)	2.18 (-0.18)	1550 (2000)	never returns	n/a	n/a	08/27/97	case1.xls

ID	Permit Prices: 2010	Permit Prices: 2025	Permit Prices: 2050	Conc. (ppmv) in 2050 (Deviation from BAU)	Conc. (ppmv) in 2100 (Deviation from BAU)	Year Conc. (550 ppmv) Reaches 2x Pre-Ind. Level (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2050 (Deviation from BAU)	Change in Temp. (deg. C) from 1990 in 2100 (Deviation from BAU)	Emissions Peak, mmtce (year)	Year Returns to 1990	Intl. Trade of Permits, U.S., 2010 (MMTCE), (\$)	Intl. Trade of Permits, U.S., 2050 (MMTCE), (\$)	Date Received Run	File (h:\jaldy)
SGM16	\$7	\$16	\$25	489 (-13)	662 (-49)	2071 (+6)	1.00 (-0.06)	2.18 (-0.18)	no peak: 2128 (2050)	never returns	-219, (-\$1.5 billion)	-643, (-\$16.1 billion)	08/27/97	case1.xls
MM1	\$0	\$0	n/a	n/a	n/a	n/a	n/a	n/a	no peak: 2066 (2025)	n/a	n/a	n/a	08/26/97	8_26run1.wk4
MM2	\$148	\$192	n/a	n/a	n/a	n/a	n/a	n/a	1586 (2005)	2010	n/a	n/a	08/26/97	8_26run1.wk4
MM3	\$136	\$146	n/a	n/a	n/a	n/a	n/a	n/a	1600 (2005)	n/a	n/a	n/a	08/26/97	8_26run1.wk4
MM4	\$0	\$198	n/a	n/a	n/a	n/a	n/a	n/a	1749 (2010)	2020	n/a	n/a	08/26/97	8_26run1.wk4
MM5	\$0	\$99	n/a	n/a	n/a	n/a	n/a	n/a	1767 (2015)	2040*	n/a	n/a	08/26/97	8_26run1.wk4



c.maccracken @ pnl.gov
10/13/97 01:47:00 PM

Record Type: Record

To: joseph e. aldy
cc:
Subject: SGM Results

Joe -

I assume you're not at work today ...

I finished the \$50 Safety Valve runs that you requested on Friday. I have a disk waiting at the front desk to be picked up by your courier. I will be out Tuesday and Wednesday at the Technology Strategy Workshop (that I think Jeff Frankel and Adele Morris are attending on Tuesday). If, for some reason, there is a problem with the data on the disk or if you have any questions, give Ron Sands a call at 646-7791. He has copies of the results. Or you can leave me a voice mail message and I'll get back to you.

The runs on the disk are:

sv5s.xls \$10 tax on Annex I in 2005, \$30 in 2010, \$50 in 2015 and hold at \$50 thereafter (Non-Annex I BAU)

sv6s.xls \$10 tax on Annex I in 2005, \$30 in 2010, \$50 in 2015 and grow at same rate thereafter (Non-Annex I BAU)

sv7s.xls \$10 tax on Annex I in 2005. ramp to \$50 in 2020, and hold at \$50 thereafter (Non-Annex I BAU)

sv8s.xls \$10 tax on Annex I in 2005. ramp to \$50 in 2020, and grow at same rate thereafter (Non-Annex I BAU)

Enjoy!

Chris