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## MEMORANDUM

DRAFT

TO: Distribution

SUBJECT: Nordhaus's arguments against strict action.

**Executive Summary and Key Findings**

- Nordhaus finds that the optimal policy, given the current state of knowledge and ignoring uncertainty, is to do very little in the short term (a \$6/ton tax in 2005) and only marginally more in the long term. While his mild long-term policy suggestion helps to inform the basis of his short term recommendations, Nordhaus only intends to propose a short-term strategy and emphasizes that policies should change as we learn more.
- Recognizing wide-ranging uncertainties and the possibility of calamity, Nordhaus investigates optimal policy choices over a reasonable distribution of possible states of the world. He shows that while the median optimal carbon tax is on the order of \$6/ton in 2005, the mean optimal carbon tax is somewhat larger, at \$18/ton in 2005.
- His conclusions are viewed with skepticism by some critics, who believe some or all of the following: he overstates control costs, he understates control benefits, and his choice of a positive pure rate of time preference is indefensible. Others find his results and methodology more robust.

**Introduction**

In a 1994 book<sup>1</sup>, Nordhaus calculates an optimal policy response to the problem of climate change. A distinguishing feature of this work is that it aims to uncover a truly optimal policy — that is, one that maximizes *net* benefit as opposed to one that merely minimizes the cost of achieving an *ad hoc* CO<sub>2</sub> concentration target.

**Basic Results**

*Ignoring uncertainty* and with a best guess of costs and benefits (based on a wide purview of existing studies) Nordhaus finds that the optimal policy is to do close to nothing. With the optimal policy, carbon taxes rise from \$6 per ton in 2005 to \$20 per ton (1989 dollars) in 2100. Global average temperature under this policy increases 3.2°C — only 0.2°C less than in the baseline case. On net, the world economy under this scenario enjoys a small net benefit relative to the baseline case. See Table 1.

Restricting emissions of greenhouse gases to 1990 levels, on the other hand, inflicts relatively large net costs. Carbon taxes rise to \$400/ton in 2100, and the increase in global average temperature is limited to only 2.4°C — a full degree less than in the baseline.

Given that the optimal policy is much closer to doing nothing than to restricting to 1990 levels, it appears that literally doing nothing in the short term is superior to current proposals oriented on 1990 emissions levels.

**Table 12**

	Global Net Benefit <sup>3</sup>			Carbon Tax (\$/ton)		
	NPV (\$billions)	Annualized (\$billions)	NPV as % of PV of baseline output	2005	2055	2105
Optimal Policy (no uncertainty)	271	11	0.04	6	15	21
Restrict to 1990 levels	- 7,069	- 283	- 0.98	50	230	400
Stabilize at 1.5°C increase	- 40,980	- 1,639	- 5.94	200	700	800

It is worth emphasizing that Nordhaus's result is not simply a matter of delaying controls. While the typical *cost-minimization* exercise also shows that carbon emissions should be allowed to follow a near-baseline path at first, Nordhaus's result goes further: he finds that relatively little should be done even over the long term. In his optimal scenario, carbon concentrations are allowed to grow without apparent bound.

*Incorporating uncertainty*, Nordhaus's results change though the basic message of modest short-term measures does not.

- Nordhaus examines how the optimal policy changes when key parameter values vary from his best guess and finds that the mean optimal policy calls for higher carbon taxes than he finds for the best-guess case. The mean optimal policy calls for a carbon tax of \$18/ton in 2005 and \$53/ton in 2045.
- The "mean" result differs from the "best guess" result because the distribution of outcomes is skewed so that favorable climate change scenarios are similar to the best-guess case and occur with high probability while extremely unfavorable scenarios occur with low probability.
- Nordhaus finds that only 2% of possible scenarios -- the least favorable -- would call for a carbon tax in 1995 of over \$100/ton.

### **Basis for Results**

Nordhaus's results derive from three key assumptions:

- that the *costs* of reducing carbon emissions are relatively high;
- that the *benefits* of carbon control (in the form of averted damages) are relatively low; and
- that the social rate of discount is greater than zero.

Critics have attacked Nordhaus on all three points, and it is worth examining each point in greater detail.

### *1. Costs*

The cost of reducing carbon emissions is determined by the responsiveness of the economy to a given level of carbon-control effort. For example, if a \$10 carbon fee elicits a large response in terms of lower carbon emissions, the cost of carbon control will be low. Conversely, if a \$10 carbon fee elicits a small response, program cost will be high.

The impact on the economy of a carbon-control program in Nordhaus's model is determined by two key assumptions — one concerning the “static” response, given current technologies and carbon use, the other concerning the “dynamic” response, reflecting induced changes in carbon use and advances in technology.

- Nordhaus bases his assumption about static responses on existing empirical studies. His assumptions here are not particularly contentious.
- Nordhaus attempts to capture dynamic responses by assuming that technology will improve at about the same rate in the future as it has done in the past. Importantly, the trend rate of improvement is not allowed to vary depending on the price of carbon permits or the level of a carbon tax. Critics find fault with this approach, since his model thus assumes that carbon taxes will in no way accelerate the development of non-carbon technologies — in stark contrast to the “technologist” view.

Nordhaus notes that his results are sensitive to assumptions about technology, but he does not document the extent of that sensitivity in isolation from other uncertainties.

### *2. Benefits*

The benefits of carbon control are determined by the magnitude of damages averted -- that is, damages that would have occurred in the absence of a control program. Nordhaus calculates that these damages would be relatively modest. For example, he estimates that a 3°C temperature increase results in only a 1.3 percent loss of output per year.

Some critics feel that damages averted will be greater than Nordhaus assumes. They note that SO<sub>2</sub> and particulate emissions will be reduced, biodiversity will be better maintained, and negative health effects will be avoided.

In a survey of experts, Nordhaus finds that the median cost prediction for a 3°C rise in temperature is 1.9 percent of output annually -- 40% higher than his own. The mean prediction is much higher, at 3.6 percent.

### *3. The social rate of discount*

Given that costs are borne up front and benefits accrue mainly in the distant future, assumptions about the social rate of discount are crucial. Nordhaus assumes that the social rate of discount is 3 percent per year; this rate is sufficiently large as to significantly reduce the present value of the distant and already modest benefits.

Many critics (mainly non-economists) feel that a social rate of discount greater than zero is indefensible on ethical grounds. However, mainstream economists strongly endorse the approach to discounting which Nordhaus uses and find it difficult to understand very low rates of time preference in the context of observed behavior.

Nordhaus re-evaluates the optimal policy when the pure rate of time preference is only 1 percent and finds that the optimal carbon tax in this case is considerably greater (see Table 2).

**Table 2**

Rate of Time Preference	Optimal Carbon Tax (\$/ton)		
	1995	2045	2095
3%	5.3	13.7	21.0
1%	23.6	52.6	77.5

### **Conclusion**

Nordhaus's analysis implies that little should be done either in the short term or in the long term. His results hinge on assumptions about technology improvements, appropriate discount rates, and the size of potential damages. Critics feel that Nordhaus may be:

- overestimating mitigation costs because he ignores the possible influence of higher energy prices in spurring the development of new technology; and
- underestimating damages from climate change.

While both would tend to cause Nordhaus to be too lax in his policy recommendations, it is not clear that such criticisms can be sustained far enough to overturn Nordhaus's basic point that strict action is inappropriate in the short term. The discount rate issue, while crucial, is difficult to settle.

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	IA1	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 1	auction	lump-sum	no LDC part.	IA1	P1	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.	IA1	P1	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.	IA1	P1	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 1	auction	lump-sum	no LDC part.	IA1	P1	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 1	auction	lump-sum	no LDC part.	IA1	P1	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 1	auction	lump-sum	no LDC part.	IA1	P1	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 1	auction	lump-sum	LDC stabilizes at 2030 in 2030	IA1	P1	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 1	auction	lump-sum	LDC BAU to 2030, equal per capita in 2050	IA1	P1	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	IA1	P1	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.	IA1	P1	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.	IA1	P1	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	IA1	P1	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.	IA1	P1	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.	IA1	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	IA1	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	IA1	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.	IA1	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.	IA1	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.	IA1	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.	IA1	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.	IA1	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.	IA1	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.	IA1	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.	IA1	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.	IA1	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.	IA1	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	IA1	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	AEEL	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	AEEI	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	P1	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	\$559	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 (b:\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



Joseph E. Aldy  
09/04/97 04:00:15 PM

Record Type: Record

To: Jeffrey A. Frankel/CEA/EOP

CC:

Subject: Toman's write-up

Courtesy of Zach, here is Toman's IA write-up.



TOMAN\_IA.WPC

✓  
~~REVISIONS~~ of section 2  
of T+T paper

Appendix 2

## 2. Cost-benefit analysis in "Integrated Assessment" models

Integrated Assessment (IA) analyses try to bring together assessments of the physical, ecological, economic, and social impacts of climate change with assessments of policies for responding to climate change and their socioeconomic consequences. Generally speaking, the models can be described schematically as linking economic decisions in the energy (and agriculture) sectors that give rise to GHG emissions (and changes in carbon sequestration), models of atmospheric composition, climatic change, and changes in oceans, and models that describe the potential impacts of climate change on health, natural resources, coastal areas, and other factors of socioeconomic interest. Different components of various IA frameworks are represented in differing degrees of detail and sophistication. A few models contain the capacity to be used for a benefit-cost analysis, in which it is possible to evaluate changes in the long-term path of GHG emissions that maximizes the net benefits of GHG control (these benefits are the avoided damages of climate change less the costs of control). A larger number of IA models can evaluate the benefits and costs of specified policies but are unable to indicate what emissions reductions maximize net benefits. IA frameworks are inherently more "top-down" in their characterization of economic decisionmaking, though some models contain a fair amount of energy sector detail.

A very striking feature of IA models is that they tend to indicate the desirability – from the perspective of maximizing net benefits over time -- of emissions continuing to rise well into the next century, if not beyond. (For a recent comparison of IA model results, see Manne 1996. [JEFF: Do you want cites of individual models too?]) By 2100, the models indicate only small deviations downward from a business as usual (BAU) path (see also IPCC 1996b, Chapter 10). In some cases the emissions do stabilize toward the middle of the next century, but in other cases they continue rising (though more slowly than with business as usual) even beyond 2100. These emissions paths clearly imply increases in atmospheric concentrations of GHGs well beyond the kinds of targets that have been considered in current policy debates (e.g., 550 ppm). One important consequence is that the models indicate costs of near-term emissions stabilization well in excess of the avoided damage costs.

As noted in PCF,

A number of criticisms have been levelled at these IA results. These criticisms include:

Failure to consider the possibility of unlikely but catastrophic events that could result from climate change (e.g., catastrophic sea level rise from melting of the Antarctic ice sheet, runaway global warming from frozen methane releases, or relocation of the Gulf Stream – see IPCC 1996a, Chapter \_\_\_\_).

Failure to give adequate consideration to the scale of potential damages, even in the absence of catastrophe. Cline (1992), for example, argues that damages are much higher than is incorporated in most IA models (see also IPCC 1996a, Chapter 6 for various estimates). One specific concern that has been raised is that the IA models do not account adequately for the costs of a less stable climatic and ecological systems in the face of GHG accumulations.

Failure to consider the adverse consequences of less aggressive abatement policies for future generations – in the context of IA models themselves, the criticism is that discounting of future generations' well-being is excessive. Cline (1992) also raises this concern, as does Howarth (199\_).

Failure to consider how uncertainty about all these effects affects the “optimal” decision (Pizer 1997).

Failure to consider how lack of early action will jeopardize the achievement of any longer-term mitigation by signalling a lack of political will ([NEED CITE]), or how lack of early action will retard induced technical progress that is needed to make mitigation affordable (Grubb 1995).

(a few)

Sensitivity analyses carried out with IA models suggest that at least some of these criticisms are not major concerns; others may be serious concerns, but empirical judgments are not possible given the current state of knowledge. The Manne (1996) survey referred to above considered scenarios in which the climate's sensitivity to accumulating GHGs was greater than is typically assumed, or the damages are larger (by a factor of almost 8) for a given change in the atmosphere. In either case emissions should (from the perspective of maximizing net benefits) be lower, but the extra degree of emissions reductions required by 2010 is significant (on the order of 25 percent or more) only if climate damages are much higher than expected (the sensitivity of the atmosphere to GHG emissions seems much less important in these analyses). And even in this case, emissions still will be higher than 1990 levels unless the atmosphere and the ecological-economic systems both are quite sensitive. (Broadly similar conclusions follow if, instead of looking at higher damages, one looked at damages that grew proportionately faster as atmospheric GHG concentrations grew [CETA cite]). Thus, the IA models give little support for a policy of near-term emissions stabilization unless damages turn out to be much higher than at least some experts expect.

It is also true that the results of IA models are sensitive to the choice of discount rate used to compare consumption today and in the future. A very low discount rate will imply greater weight on damages accruing over time to future generations, and thus the need for a more aggressive abatement strategy. This tradeoff is influenced by the rate of economic growth, since growth will make future generations better off and thus better able to afford and respond to the damages of climate change (Schelling 1995). However, there are numerous economic and ethical controversies surrounding the appropriate way to discount future damages in IA models, and no clear consensus has emerged. One important point that is often ignored in this debate is how much *today's* generation is willing to sacrifice to provide for the increased protection of future generations through GHG abatement; this is a critical unknown since it is today's generation that must necessarily decide to pay the bill. All that can be said analytically, therefore, is that intergenerational equity *might* be an argument for more aggressive abatement.

Uncertainty about future damages or other influences on the costs and benefits of abatement can make a difference. However, Pizer's (1997) analysis suggests that the most important

source of uncertainty concerns the nature of our preferences for consumption and environmental protection. (Unlike the Manne (1996) analysis, Pizer considers the possibility that damages may be lower as well as larger.) A recent paper by Gjerde et al (1997) considers the risk of a sudden loss of economic output and well-being on the scale of the Great Depression from climate change. While their analysis indicates more aggressive abatement than other IA analyses without this risk, the introduction of the risk has little relative effect on the desirable level of emissions reduction by 2010, and little effect for a number of years thereafter (unless the loss is much larger even than the Depression).

This leaves the issues of political credibility and induced technical change. As for the latter, it is true that sending a less strong signal to energy markets will slow up technical progress. However, there is great uncertainty about how much of a loss this would be in practice, and the loss would have to be greater than most models seem to indicate before the substantial costs of near-term stabilization could be justified. This does *not* mean, however, that *no* actions are justified on cost-benefit grounds to reduce emissions or stimulate technical progress. Aside from initial steps to curb emissions growth, which signal the need for technical change, longer-term measures to promote the development of new technology are warranted. Political credibility is a more complicated issue to which we return below.

### 3. Estimates of optimal paths to stabilize GHG concentration levels

Much of the debate about GHG stabilization takes as given that simply allowing emissions to continue to grow for a long period, albeit more slowly, puts the biosphere at too much risk and is not credible politically. An alternative strategy...[continue with current text]

Comments on political credibility to be inserted somewhere in the text

Political credibility arises frequently in the discussion of intertemporally flexible approaches to GHG mitigation. It is argued, that allowing emissions reductions to be deferred to a more distant future invites noncompliance with our domestic obligations, and risks sending a signal to countries not in line for immediate emissions targets that curbing emissions is not a serious matter. Several other points do not seem to surface in this debate and are important to put the issue in context.

(1) A proposed agreement that demonstrably imposes much higher costs than an alternative more measured approach, and thereby invites substantial domestic political opposition, will also suffer from credibility problems both here and abroad.

(2) The concern about emissions reductions agreements being shirked rather than postponed is a legitimate one, but there are a variety of ways it might be addressed. [Add options here – they should include performance bonds that require carbon debts to be paid back, and (less efficient but more straightforward) simply a backloading of emissions reductions goals in the targets/timetables. The latter may not be credible, but there is little that can be done if a country really sees the burden of successively greater emissions reductions as greater than the cost of noncompliance.]

(3) Demonstrating willingness to reduce our emissions may not make much difference to the willingness of other countries to reduce their emissions anyway, particularly in developing countries for whom climate change is a low-priority issue. It might be much more effective to take some of the substantial cost savings from shifting emissions reductions into the future and use them to help develop and diffuse low-emissions technologies that those countries will want to adopt for their own reasons.



toman @ rff.org  
08/25/97 09:43:00 AM

Record Type: Record

To: Jeffrey A. Frankel

cc:

Subject: text on IA models with catastrophe

One of the criticisms of many integrated assessments (IAs) is that they do not incorporate the possibility of catastrophe. Recent extensions of the IA literature include the possibility of a major, discontinuous jump in the damages caused by climate change. For example, a European paper by Gjerde et al (1997) incorporates the risk that climate change will suddenly cause damages equal to a significant share of global GDP. The risk is assumed to rise with an increase in temperature from global warming; following Nordhaus (1994), the benchmark risk scenario assumes a 12% chance of a loss equal to 25% of GDP (the scale of the great depression) in 2090 if climate has warmed by 3 degrees C. Incorporating this risk into the IA framework causes the optimal path for global emissions to be reduced, but not by that much in the early years. By 2060, optimal emissions are only somewhat over half what they would have been without the risk of catastrophe, but the reduction by 2020 is on the order of 15% below the no-catastrophe case and still above emissions in 1990. (The no-catastrophe optimal path is substantially below BAU in this analysis, an artifact of the assumptions of low abatement cost and high damage cost.) Even sharper emissions reductions are implied if the catastrophe is truly shattering (on the order of the entire GDP), or if the discount rate is extremely low (high intergenerational egalitarianism.)

Jon Gjerde, Sverre Grepperud, and Snorre Kverndokk, "Optimal Climate Policy Under the Possibility of Catastrophe," presented at the 1997 EAERE meetings, Tilburg. [WARNING: NOT PEER\_REVIEWED and may be unreliable as a consequence. The only peer-reviewed analyses I could find had technical drawbacks, mainly oversimplified models of damages.]

William Nordhaus, "Expert Opinion on Climate Change," AMERICAN SCIENTIST vol 82, 1994, 45-51.

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with domestic oil. On balance, removing U.S. energy subsidies could significantly reduce CO<sub>2</sub> emissions according to one study.

- Top down models that assume limited substitution, slow technological change and limited response to price signals and low availability of non-fossil energy sources predict high costs.
- **Extent to which market and policy distortions create opportunities for low-cost (or no-cost) improvements in energy efficiency**
- **Rate of technological innovation and responsiveness of such change to price signals.** Hard to reach consensus on AEEI but value is critical. For example, a change from 0.5% to 1.0% cuts projected 2100 emissions levels by half and markedly affects the cost of meeting a CO<sub>2</sub> target. Induced technological change in response to price increases is a distinct possibility.
- **Availability and likely future cost of non-fossil backstop energy sources** (hydroelectricity, nuclear power, wind and solar energy and biomass) Alternative, low carbon energy sources exist but aren't currently cost-effective. They will become increasingly so as carbon energy sources rise in price and technology makes them less expensive. The availability of these backstop non-carbon energy technologies has a large impact on the costs of meeting whatever emission reduction goal is chosen.
- **Number of years available to achieve a specified CO<sub>2</sub> reduction.** Merely stabilizing emissions rates will allow concentrations to continue rising for centuries. Recent analysis shows that **adopting an explicit long-term target for atmospheric concentrations and then choosing policies to achieve the most efficient time path for emissions reductions to meet the target could significantly lower the economic impact.** A target for concentrations is like a carbon budget limiting CO<sub>2</sub> emissions within a specified period of years. Under some circumstances, it is cheaper to use more of the budget early on and postpone cutbacks because the capital stock is so durable. In a system of emissions trading, **there should be banking and borrowing of permits to allow flexibility over time.** When time is allowed for capital stock to be replaced, overall abatement costs could be reduced. Also, R&D will yield new technologies so postponing costs reduces them. Flexibility in timing of global reductions could lower costs by more than 35% compared to a less flexible program to achieve the same concentration.
- Under some assumptions, we should adopt a carbon tax now to encourage early development of energy efficient and low-carbon technologies and

discourage long-lived investments in carbon-intensive energy facilities. **Realistically, action today is likely to be necessary to induce investors to make commitments and not just the expectation of a tax in a decade or more.** To quell doubts, a credible policy signal is necessary at the outset--e.g., a carbon tax introduced at a low level that rises, perhaps significantly, in future years.

- **Potential for international joint implementation.** This would allow a utility in Norway to achieve reduced emissions by contracting to pay a factory in Poland to install more fuel-efficient furnaces. Finding the lowest cost abatement possibilities is cost effective. JI cannot be used more widely until countries have set binding emissions reduction targets. But getting countries to agree on the baselines that should apply to each, from which emissions reductions will be measured is a formidable task. Monitoring and verification and a mechanism to enforce contractual obligations is essential if JI is to work. The potential savings are substantial.
- **Recycling to reduce economically burdensome tax rates or lump sum rebates.** Without recycling the carbon tax is highly deflationary, lowering GDP substantially. Lump sum recycling enables a modeler to separate the economic impact arising from climate abatement from that arising from other tax cuts. However, it would be possible to reduce taxes that distort economic activity--payroll taxes, on investment earnings. Some economists have argued that there could be a double dividend--a gain purely from substituting an energy tax for a more distorting tax on labor or capital income. This is questionable. etc.
- **Benefits in form of avoided economic damages from climate change and other pollution reduction damages.** Can avoid pollution associated with auto emissions and higher medical expenditures.
- Under a reasonable standardized set of assumptions, most models predict a small macroeconomic effect of a carbon tax to stabilize emissions and potentially favorable outcomes.
- **The IAT baseline policy of 1990 by 2010 implies about 26% reduction below baseline emissions in 2020.** Looking at all the models we find that, under unfavorable assumptions, GDP would be 2.4% lower in 2020 than under baseline and under favorable assumptions, 2.4% higher. The 4 key influences are (whether there are significant short term adjustments--macro model; whether JI; whether recycling of revenues via reducing other taxes; whether benefits from abating pollution. Under reasonable assumptions, the predicted GDP impact would be neutral or even favorable.

- A carbon tax might have a disproportionate impact on low income households but it could be offset through other taxes reductions.
- The impact of a tax on coalmining and coal carrying railway lines would be substantial. However, the baseline predicts a substantial expansion in coal mining in the western U.S.
- Reduced energy demand in the U.S. would help hold down world oil prices, improving our terms of trade.
- **Impact on competitiveness.** If the U.S. alone imposes a significant carbon tax, international trade and investment in some energy intensive industries might shift abroad. However, evidence suggests that differential environmental policies have a weak impact on trade and investment flows and many nonOECD countries have raised energy prices unilaterally. Coordinated international action could avoid these trade effects.

**MAJOR POINTS:**

- **2000 economists** endorsed taking measures to reduce the threat of climate changes on the grounds of the Intergovernmental Panel on Climate Change finding that “the balance of evidence suggests a discernible human influence on global climate.” The economists concluded that global climate change carries with it significant environmental, economic, social and geopolitical risks, and that preventive steps are justified. They concluded that proper policies can significantly reduce greenhouse gas emissions without harming the American economy. Some policies could even improve U.S. productivity in the longer run. Market based policies (such as carbon taxes or emissions permits) would lower the costs of control substantially. They said that there are many policies with total benefits in excess of costs. Revenue could be used to lower the deficit or reduce existing taxes. Nations need to cooperate to achieve climactic objectives at minimum costs--international emissions trading.
- A great deal of controversy surrounds the issue of climate change with some saying that climate change is one of the greatest threats facing humankind and others saying the risks are weakly documented. The same kinds of divides arise in discussing costs and benefits of various policy options. The President believes there is a risk so that policy action is needed, but will look for policy actions that are sensible, cost effective and consistent with continued economic growth and job creation.
- It is particularly difficult to measure the benefit of climate change action especially when one takes a broad interpretation and thinks about the value of reducing risk related to ecological impacts.
- Economists differ in their views about emissions policies, some advocating a “broad, then deep” approach in which we begin with a broad but low cost agreement and others favoring a deep, then broad perspective, by first establishing a narrow coalition of developed nations and then reaching out to developing countries to join later via evolution. The problem with the latter approach is that costs rise for a narrow coalition of countries leading carbon intensive industries to migrate and making nonparticipant countries even more carbon dependent.
- Any agreement without the cost flexibility provided by international trading or JI will at least double the US costs.
- Models are helpful in understanding implications of climate change policies--give orders of magnitude and sensitivities to assumptions. There is no single correct set of assumptions or appropriate model. It is a mistake to offer just a best guess assessment of either costs or benefits. One should think about ranges of possible outcomes

**DISCUSSION PAPER**  
**THE ROLE OF TECHNOLOGICAL CHANGE**  
**TO ADDRESS GLOBAL CLIMATE CHANGE**

July 30, 1997 Draft

*PREDECISIONAL DRAFT \*\* DO NOT QUOTE OR CITE\*\**

**DISCUSSION PAPER ON THE ROLE OF TECHNOLOGICAL CHANGE  
TO ADDRESS GLOBAL CLIMATE CHANGE**

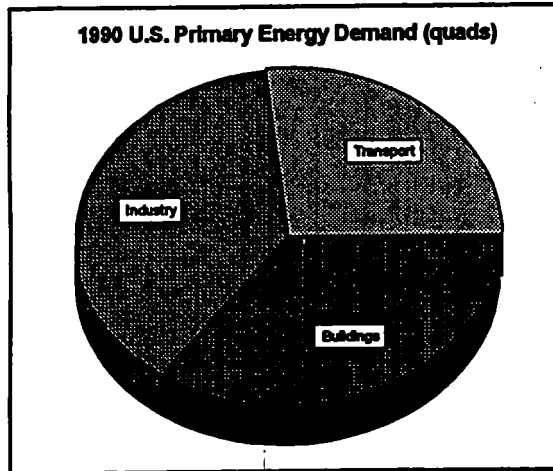
**“In order to reduce greenhouse gases and grow the economy, we must invest more in the technologies of the future. I am directing my Cabinet to work to develop them. Government, universities, business and labor must work together. All these efforts must be sustained over years, indeed, over decades.”**

**President Clinton  
Address to the United Nations  
June 26, 1997**

**Context for this paper:**

- **The U.S. position on global climate change has consistently been that any action program should be centered on a market-based approach. Given the proper market signals, the private sector will find the most efficient means to make changes in technologies, business practices, and patterns of energy use to reduce greenhouse gas emissions.**
- **A properly-designed, capped domestic emissions trading system would provide strong market signals to that end**
- **There are also a variety of other technology supporting actions that the federal government could undertake to supplement such an emissions trading system to stimulate R&D and market development in specific areas, where market barriers exist or where changes might be restrained for various reasons.**
- **This paper first provides a perspective on the degree of change in energy usage and key technologies that would be needed in key sectors of the economy in order to begin reducing greenhouse gas emissions from energy use.**
- **Then, the paper identifies a menu of policy options, for discussion and further evaluation, from which specific elements could be selected to support a technology strategy to both reduce greenhouse gases and continue to grow the economy. This paper provides an initial identification of the options without providing a thorough evaluation of feasibility, impacts, or costs.**
- **Additional detailed papers are available from the Department of Energy and others on these technological opportunities.**

**PROFILE OF U.S. CARBON EMISSIONS IN THE ECONOMY**

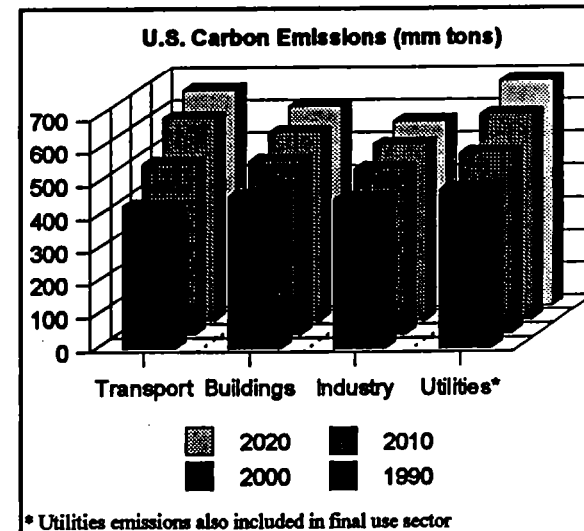


**Energy Profiles**

- Three sectors account for approximately one-third of U.S. primary energy demand — transportation, commercial and residential buildings, and industry
- The electric utility sector supplies about one-third of this demand, virtually all in the buildings and industrial sectors, and consumes fuels to generate that power. In the buildings sector, two-thirds of the energy usage is from electricity, and in industry the share is just over 10%
- Growth in U.S. energy consumption changed dramatically after the 1973 energy crisis, but is projected to continue growing steadily in the absence of new policies:
  - the 1960s +52%
  - the 1970s +14%
  - the 1980s +11%
  - the 1990s +12% (already +9% by 1997)
  - the 2000-2010 decade +12%
  - in total, 2010 will be 26% above 1990

**Carbon Emissions Trends — 1990 - 2020**

- The profile in U.S. carbon emissions parallels the pattern of energy demand — the three sectors, transportation, buildings, and industry, each account for approximately equal shares
- Electric utility emissions are double-counted in the sector in which the electricity is used and can only be lowered by reducing electricity demand, by switching to lower carbon content fuels or by carbon sequestration
- Growth projections for emissions parallel the pattern of energy growth. DOE's Energy Information Administration (EIA) projections show:
  - Total emissions up 28%, or 377 million tons, from 1990 to 2010
  - Transportation up 43%, or 184 million tons
  - Buildings up 24%, or 111 million tons
  - Industry up 18%, or 82 million tons
  - Utilities, included in the other sectors, up 30%, or 146 million tons



## LONG-TERM TECHNOLOGY STRATEGY

In the long-term, over several decades, reductions in carbon emissions will require two fundamental changes, (1) shifts to low-carbon and zero carbon forms of energy, and (2) significant improvements in the efficiency of our energy usage. Appropriate technologies are the only way to achieve these goals without forcing consumers to give up the services and lifestyles they want. A technology strategy, in combination with appropriate pricing policies, can achieve both goals and provide a strong worldwide position for the U.S. as a technology leader and exporter by advancing improvements such as the following:

Transportation	Buildings	Industry	Electric Utilities
<ul style="list-style-type: none"> <li>o Hydrogen fuels</li> <li>o Fuel cell vehicles</li> <li>o Electric vehicles</li> <li>o Biofuels</li> <li>o Full PNGV 80 mpg vehicles</li> </ul>	<ul style="list-style-type: none"> <li>o Fuel cells</li> <li>o Control systems</li> <li>o Materials and structures</li> <li>o Efficient "plug load"</li> <li>o Lighting and equipment</li> <li>o Renewable energy</li> </ul>	<ul style="list-style-type: none"> <li>o High efficiency motors</li> <li>o Advanced processes</li> <li>o Materials recycling</li> <li>o Combined heat and power</li> <li>o Bioproducts/biofuels</li> </ul>	<ul style="list-style-type: none"> <li>o Renewable energy systems — solar, wind, biomass</li> <li>o Distributed power</li> <li>o Advanced gas generation</li> <li>o Superconducting cables, transformers and generators</li> </ul>

### Long-term Market and Economic Uncertainties

- Electricity deregulation, international competitiveness, increased concern over other emissions and waste reduction
- Lifestyle trend changes (eg, telecommuting, consumer preferences for large vehicles)
- Commercial transport shifts in modes, speed, and the role of short- and long-range transportation of goods and people

### Cost Issues

- Currently, the federal government spends only 1% of its R&D budget, or \$600 million/year on long-term energy technologies
- To achieve these major advances will require significant public and private investment
- In the long run, it is uncertain whether such technological changes will produce net costs or savings to the U.S. economy

### Policy Issues

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• Federal and private R&amp;D funding</li> <li>• Public/private partnerships</li> <li>• Financing programs</li> </ul> | <ul style="list-style-type: none"> <li>• Information and education</li> <li>• Federal procurement</li> <li>• Regulations</li> </ul> |
|--|---|

## **IN THE MEDIUM-TERM, TECHNOLOGY AND EMISSIONS TRADING PROVIDE A BRIDGING STRATEGY**

In the medium-term, deployment of currently available, under-utilized technology, or nearly available technology, can serve a “bridging” function to reduce emissions sufficiently to allow time for the long-term R&D developments and the commercialization of various new technologies to reach significant levels.

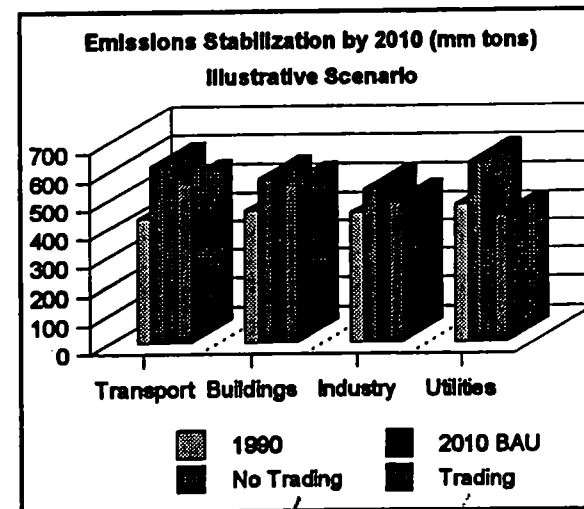
Emissions trading and joint implementation are critical to a technology strategy in providing timing flexibility to deploy efficient technologies at rates close to normal capital stock turnover cycles, and to provide a “safety valve” if the required rates of technological change cannot be achieved fast enough. Both of these steps will help keep costs significantly lower than they otherwise would be.

The DOE “Labs Study”, the IAT computer modeling, and other studies suggest ambitious rates of change in energy consumption, fuels mix, and technology would be needed to reduce U.S. carbon emissions significantly. For example, the implications of the most commonly evaluated scenario, reducing U.S. carbon emissions to 1990 levels by 2010, would lead to the following:

- Overall, emissions growth of 28%, or 377 million tons, would have to be avoided or offset
- If reductions were limited to the U.S., unless large-scale fuel-switching occurred, energy growth would probably have to drop to half its present rate, to about 10 to 12% over the 20-year period, and it’s already about 9% above 1990 levels in 1997
- With emissions trading and joint implementation, the models suggest that up to 40% of the 2010 emissions reduction might be achieved abroad, at U.S. expense, to buy time for a more orderly technological transition here
- The key in the latter case would be to encourage, through pricing and other means, the utilization of the most efficient or low-carbon technologies when capital stock is being installed or replaced on its regular cycle

### **Transportation**

- In the absence of international emissions trading, growth in energy usage by 2010 would have to drop to about half its projected growth rate of 30% to 40%, down to 15% to 20%
- On-road fuel economy for all cars and trucks (new and existing) would have to reach 25 mpg by 2010, from its present level of 20 mpg
- Through PNGV, government is partnering with automakers and expects to develop new automotive technology that can triple the fuel efficiency of a



*these numbers include*

**MEDIUM-TERM.....continued**

*When are new models expected?  
Is this contingent on Govt. funding?*

typical family sedan while meeting stringent emissions and safety standards and maintaining affordability, performance and utility. Production prototypes are expected by 2004

- One pathway to achieve an on-road fuel economy of 25 mpg would require about 30% of new light duty vehicles to meet the PNGV goal by 2010. Alternatively, all new cars and light trucks could incorporate 30% of the improvements represented by the PNGV goal by the 2010 model year....for 45 mpg new automobiles
- Currently projected higher costs of PNGV improvements would pay for themselves in fuel savings within 4 to 5 years
- With international emissions trading, the pace of improvements could be slower, but would likely still need to show significant improvement in fuel economy over present vehicles

**Commercial and Residential Buildings**

- Without emissions trading, growth in energy usage in buildings would have to be cut in half, to a rate of about 10% by 2010
- Technologies needed to achieve these savings largely exist today. No major breakthroughs are needed. Over the next decade, most buildings could be cost-effectively improved to use 30% less energy while delivering the same comfort.
- To achieve the needed efficiency savings by 2010, approximately 35% of the equipment that normally would be installed or replaced in buildings by then needs to be cost effective, high efficiency equipment
- Technology deployment programs such as EPA's and DOE's Energy Star labeling, Rebuild America, and Green Lights programs, are currently working to inform consumers and businesses of efficiency and cost savings opportunities

**Industry**

- Without emissions trading, energy growth would have to be almost flat at 1990 levels, instead of increasing about 20% by 2010
- Increased use of heat recovery, cogeneration, and more efficient motors offer the greatest generic opportunities, with other specific technologies also available in individual industrial sectors, such as those detailed in DOE's "Industries for the Future" cooperative program with seven major energy-intensive industries

- With emissions trading, modest emissions and energy growth of around 7% by 2010 could be possible
- Industrial energy efficiency has improved since 1972, now requiring just 67% as much energy per unit of output

### Electric Utilities

- Without international emissions trading, utilities would likely have to make absolute reductions on the order of 30% in carbon emissions below 1990 levels, in order to offset the increases above with even substantial reductions in energy growth rates in buildings and industry, while at the same time supplying more electricity to customers
- Renewable energy sources would increase by 25%
- Combined cycle natural gas plants today can generate electricity while emitting about 2/3 less carbon than many existing coal plants. Natural gas would roughly double its 1990 usage in the industry
- Coal usage would have to drop to about one-third to one-half the 1990 level, while natural gas use would increase from 50% to three times its 1990 level *appear inconsistent*
- With emissions trading, the coal-to-gas shift could be less severe, but electricity demand would also rise faster. Overall, emissions would still probably have to be about 10% below 1990 levels in 2010
- Shifts in the utility sector would offer other substantial air quality benefits. For example, fuel shifts and increased use of advanced technologies could reduce Nox emissions by over 1/3.

### Costs

- How much these changes would cost the U.S. economy is uncertain. In some recent experiences, such as with the Montreal Protocol on ozone depletion and the sulfur dioxide emissions trading system under the Clean Air Act, actual experience has turned out to be substantially less costly than expected because market incentives were used
- The interagency economic modeling analysis indicates that the economic incentives needed to reduce emissions to 1990 levels by 2010 would be in the range of \$100 per ton if all of the reductions were made domestically, about \$50 per ton with international emissions trading among developed countries, and as low as \$20 per ton if both international trading and joint implementation were available
- DOE's "Labs Study" identified those technological changes that were estimated to be cost effective at an emission allowance price of approximately \$50 per ton *→ needs to note that they achieved 1990 = 2010*

*e \$50/ton*

***\*\*PREDECISIONAL DRAFT\*\* DO NOT QUOTE OR CITE***

- The true, net cost of such emissions reductions would depend significantly on how the revenues from any emission allowance sales were recycled into the economy, and upon the degree of cost savings experienced due to reduced energy costs. The DOE "Lab Study" projected that the majority of costs would be offset by energy savings, with net costs as low as \$10b annually in 2010

**Policy Issues**

- A commitment to cap carbon emissions would provide an immediate incentive to invest in energy efficiency, but because of market imperfections, some additional measures could be needed to stimulate R&D, commercialize new technologies, and purchase and use advanced technologies as capital stock turns over in the economy

## DOE'S 'Labs Study'

### "SCENARIOS OF U.S. CARBON REDUCTIONS The Potential Impact of Energy-Efficient and Low-Carbon Technologies"

This study of the  
net cost of  
energy efficiency  
technologies  
is < 0.  
/

#### THE REPORT'S CONCLUSION

Technology can lower the net cost of stabilizing carbon emissions at 1990 levels in the medium term (i.e., 2010) to less than \$10 billion a year or less (0.1% of GDP). International trading or flexibility in meeting a stabilization target, considered by other studies, could reduce costs by another 50% or more. The study assumes penetration of technologies from expanding Administration initiatives, such as the PNGV, natural gas technologies, the Climate Change Action Plan and renewable energy such as wind and biomass.

#### BACKGROUND

Five DOE national laboratories, led by Oak Ridge and Lawrence Berkeley National Laboratories, have conducted a comprehensive, extensively peer-reviewed, 1 year "bottom-up" analysis of the role technology can play in stabilizing U.S. carbon emissions. It is the most authoritative and documented study of this subject since the National Academy of Sciences report and the Office of Technology Assessment Report in 1991. The study documents in detail how four key sectors of the economy—buildings, transportation, industry, and electric utilities—could respond to a climate treaty if launched in the year 2000 with a goal of stabilizing emissions in 2010 and a U.S. cap and trade system is phased in with gradually rising permit prices. The National Laboratories study examined what effect an aggressive program of research, development, and development of clean technologies could have if combined with alternative marginal permit prices of \$25/ton and \$50/ton of carbon (the average permit price is much lower).

#### RESULTS

The study concludes that energy efficiency and low-carbon technologies have a very large potential to cost-effectively reduce U.S. carbon emissions while meeting the full energy needs of U.S. businesses and families. Many consumers and businesses will save money.

Under moderate technology and market assumptions, energy efficiency technologies alone can reduce emissions in 2010 by 120 MMT (of the 380 MMT needed to stabilize at 1990 levels). This level of carbon reduction is estimated to be possible at little or no net cost - that is, the energy bill savings far exceed the investments required to achieve the carbon savings. Under more aggressive assumptions motivated in part by a \$25/ton carbon permit price, a combination of energy efficiency, low-carbon technologies and relatively inexpensive coal power plant conversions to natural gas can reduce 2010 emissions by a total of 225 MMT. Under a \$50/ton carbon permit price, technology investments reduce 2010 emissions by a total of 380 MMT. The analysis also suggests that substantial additional savings are available if permit prices were to begin to rise above the \$50/ton level.

The annual investment costs of reductions of this magnitude are estimated to be \$50 to \$80 billion per year, but result in substantial energy bill savings. The resulting net costs are on the order of -\$25 to +\$10 billion per year in 2010.

#### **METHODOLOGY**

In contrast to the top-down economic modeling of the Administration's interagency team, the five laboratory study uses a bottom-up technology-by-technology assessment as well as top-down engineering-economic modeling approach. It draws upon a wide variety of technology cost and performance information to assess potential impacts. It has been peer-reviewed by industry and academic experts. Analysis of the buildings, industry and transportation sectors quantifies the impacts of end-use energy efficiency improvements on carbon emissions. A utility sector analysis estimates the impacts of those improvements on utility carbon emissions, and quantifies additional emissions reductions through changes in operations and conversion of a number of coal power plants to natural gas. Finally, a number of promising very low carbon technologies are examined to determine their potential for emissions reductions, including advanced gas turbines in industry, biomass power, transportation biofuels and improved aluminum smelting.

#### **TOTAL BENEFITS EXCEED TOTAL COSTS**

In the long term, these climate change mitigation actions will provide additional benefits not fully considered in the study - reductions in criteria air pollutants (i.e., ozone and fine particles), decreased dependence on foreign oil, greater industrial productivity, and U.S. leadership in technologies are likely to be a major source of international trade and jobs in the next century. This report provides details on the technologies that can potentially achieve the energy usage and carbon emissions reductions necessary if the U.S. commits to a scenario like the one outlined in the sections above, which would return U.S. carbon emissions to 1990 levels by 2010.

## **POLICY OPTIONS FOR A U.S. TECHNOLOGY STRATEGY**

### **GOALS**

To develop a set of policy options that can help establish the appropriate price signals in the economy, and then provide a set of supplemental actions that will help overcome market barriers and otherwise facilitate an efficient response in the private sector:

- encouraging manufacturers, builders, etc. to produce high efficiency equipment, systems, materials, etc.
- stimulating consumers and purchasers to accelerate their acquisition and use of those technologies
- encouraging the development of financial, service, and other infrastructure to support those technologies

### **A MENU OF POLICY OPTIONS**

- **Prices in the economy**
  - Valuing carbon emissions rights, through a “cap and trade” system, which should be more efficient and less costly than individual subsidies and incentives
  - Investment tax credits, special depreciation treatment, differential fuel taxes (such as the ethanol tax credit), or other financial incentives through the tax system
  - Feebates, or complementary product fees and rebates depending upon product energy efficiency
- **Financing**
  - Enhance availability of financing through partnerships and innovative instruments with financial organizations
  - Incorporate incentives into federal loan, loan guarantee, and grant programs to promote high efficiency technologies
- **Federal R&D policy**
  - National public/private initiatives in key technologies, modeled after the Partnership for a New Generation of Vehicles, eg:
    - in DOE’s 7 “Industries of the Future” programs for Pulp and Paper, Chemicals, Petroleum Refining, Glass, Aluminum, Iron and Steel, and Metal Casting
    - in DOE’s “Buildings for the 21<sup>st</sup> Century” program for residential and commercial buildings
  - Increased federal funding for R&D, pilot projects and demonstrations leading to commercialization and/or wider availability of new technologies — current federal funding is just over \$600 million annually
  - “Bonus Emissions Credits” under a cap and trade system to reward development and deployment of advanced technologies
  - Incentives for utility sector technology R&D incorporated into utility industry restructuring at the Federal and State levels

Continued.....

**POLICY OPTIONS.....continued**

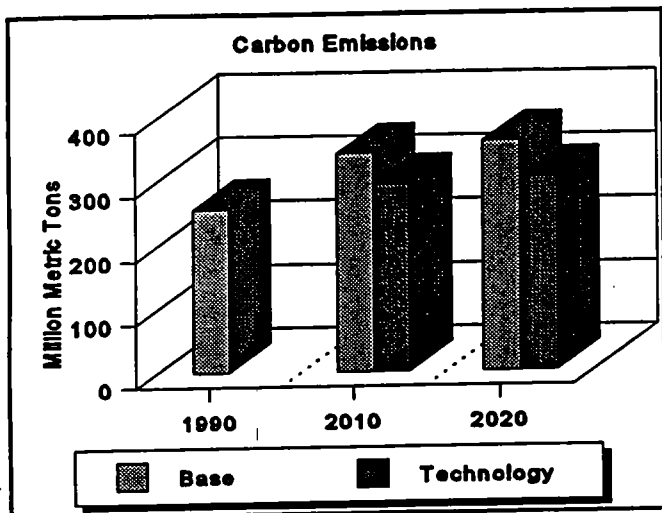
- **Market transformation**
  - Market aggregation, for local governments and companies to coordinate purchases for greater influence
  - Business-government partnerships to provide information, demonstrations, and technical assistance
  - Field verification of advanced technologies
  
- **Federal leadership through procurement**
  - Federal agencies “lead by example” by adopting aggressive policies to implement energy savings and renewable energy technologies at federal facilities, and to acquire and use more efficient and alternative-fuel vehicles in federal fleets
  - Broaden the participation in Federal Energy Savings Performance Contracts which DOE is implementing to leverage private sector financing through third party energy services companies to reduce the federal government’s \$8 billion annual energy bill
  - Executive Orders to provide clear direction and management flexibility for greenhouse gas emission reductions within agency plans and programs
  - Green Power Purchasing, by which agencies can negotiate contracts to supply a fraction of their electricity from renewable energy sources
  
- **Regulation and standards**
  - Appliance efficiency standards, negotiated with the industry and public, such as the recent refrigerator standards
  - Building energy efficiency codes, implemented at the local, state, and federal levels, as appropriate
  - Expedited environmental permitting for highly efficient or low carbon technologies
  - Coordinated implementation of National Ambient Air Quality Standards with climate change policies
  - Restructuring of the electric utility industry in a way that facilitates investment in new and renewable technologies
  
- **Information and education**
  - Voluntary or mandatory energy performance labels to internalize the asset value of energy efficiency, such as efficiency labels on appliances, vehicles, computers, equipment, and commercial and residential heating and air conditioning systems
  - Federally-supported multi-media materials development for use in schools and the mass media
  
- **International market development**
  - Special focus on bilateral trade agreements, export assistance, and financial assistance in support of U.S.-produced advanced technologies for energy efficiency, renewable energy supplies, etc.

## **BACKGROUND ON KEY SECTORS**

The material on these pages provides brief, thumbnail sketches of six key sectors of the economy, listed below. For each, the information profiles the sector's current energy and carbon emissions profile and trends, the types and extent of technological improvement needed under the scenario in which U.S. emissions are returned to 1990 levels by the year 2010. These descriptions assume no emissions trading or joint implementation, in order to provide a benchmark for further examination.

- 1. Autos and Light Trucks**
- 2. Freight, Aircraft and Rail**
- 3. Residential and Commercial Buildings**
- 4. Electric Utilities**
- 5. Renewable Energy**
- 6. Industrial Emissions**

## Autos and Light Trucks



Source: Markal-Macro 1.25 Stabilization Case

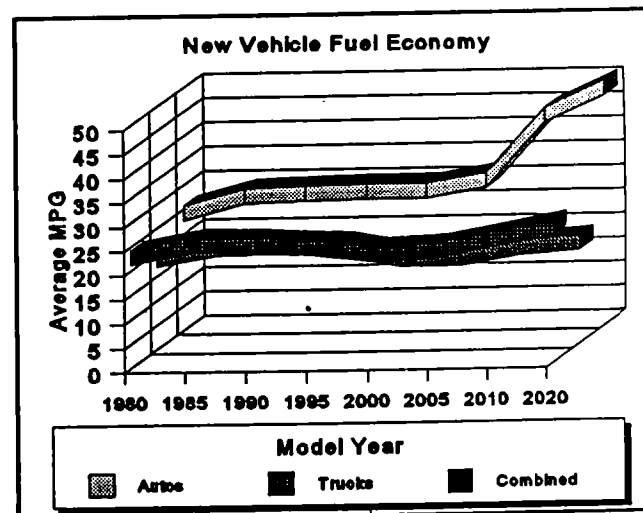
*Since we only explain 5 Labs Study, this may not come across as clear*

### Key Trends — 1990-2010

- The transportation sector generates one-third of all energy-related carbon emissions in the United States. Moreover, this is the fastest growing end-use sector. Cars and light trucks (light duty vehicles) alone account for 58 percent of the total transportation emissions.
- Average fuel economy for new automobiles has been regulated at a minimum 27.5 mpg since 1985. It is projected to grow to 31 mpg in 2010. New minivans, sports utility vehicles, and other “light trucks” now get 21 mpg and are projected to get 23 mpg in 2010.
- Light trucks were 20 percent of the personal vehicle market in 1974, 44 percent in 1996, and are projected to be 50 percent by 2010. Assuming no change in this trend, this will result in a declining overall fuel economy for all light duty vehicles.
- Vehicle miles traveled have been growing 2-3 percent per year for the past 30 years and are expected to grow 1.4 to 2 percent or more per year through 2010. Improved fuel economy will help maintain desired levels of vehicle miles traveled.

### Needed Technological Improvements

- By 2010, about 30 percent of new light duty vehicles would have to meet the Partnership for a New Generation of Vehicles (PNGV) goal of a tripled fuel economy (e.g., 80 mpg for automobiles) to help reduce overall carbon emissions to 1990 levels. On the other hand, all new cars and light trucks would have to embody 30 percent of the improvement represented by the PNGV goal (e.g., 45 mpg for automobiles).
- On-Road fuel economy for all cars and trucks (including both new and existing vehicles) would need to reach 25 mpg by 2010 and 31 mpg by 2020 compared to 20 mpg in 1995.
- Key technologies needed are vehicle weight reduction through advanced materials and



Source: DOE Labs; Markal-Macro 1.25 Stabilization Case

design, hybrid/electric drivetrains, and improved aerodynamics.

#### **Costs**

- If PNGV goals are met, the more efficient light duty vehicles will have no increased cost for consumers.
- At currently anticipated technology costs, new autos in 2010 would have an incremental price of \$800-1,200. At gasoline prices forecasted for the year 2010, these higher costs would pay for themselves in fuel savings within 3.5-5.3 years.
- PNGV is currently funded at \$263 million (Federal share).

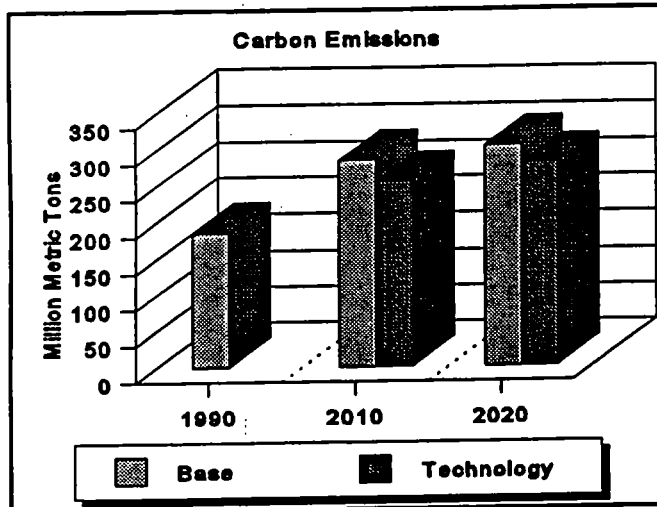
*Create scenario*

#### **Policy Challenges**

- Achieve successful demonstration production prototype of PNGV vehicle by 2004.
- Ensure that PNGV technologies fully penetrate all markets for all new light-duty vehicles by 2010 and continue through the period 2020.
- Devise new commercialization strategies, including new approaches to fuel economy standards and market incentives (e.g., Green Machine Challenge, financing packages, bonus emission credits).

## Freight, Aircraft and Rail

*74 construction vehicles p  
58%, plus...*



Source: DOE Labs Study, 1997

### Key Trends: 1990-2010

- Freight, aircraft and rail together accounted for 185 million tons of carbon dioxide emissions in 1990, nearly 40 percent of all emissions from transportation.
- All modes of freight transport have improved their energy efficiency. However, increased freight tonnage and shifts toward more energy-intensive modes have meant a 60 percent increase in the amount of energy used to haul freight since 1972-1995, although about three times as much freight was transported.
- Opportunities to reduce carbon emissions from freight are expected to come mainly from trucking and air transport.

### Needed Technological Improvements

- Key technologies to reduce energy intensity in truck freight in the next 10-15 years include vehicle weight reduction through materials substitution (which could allow for heavier loads and thus fewer trucks, improved tires, electronic engine and transmission controls). Larger reductions are possible beyond 2010 if hydrogen-powered, fuel cell powertrains are developed and commercialized for truck transport. Also, a more aggressive technology scenario might include advanced diesel engines, rapid penetration of diesel trucks that are 25 percent more efficient than current diesel engines.
- NASA programs have helped to reduce energy intensity in air transport for over 20 years. NASA's high performance turbine engine technology program aims to achieve a 40 percent increase in fuel efficiency by 2003, and such engines could conceivably be on commercial aircraft within 15 years.

**Costs**

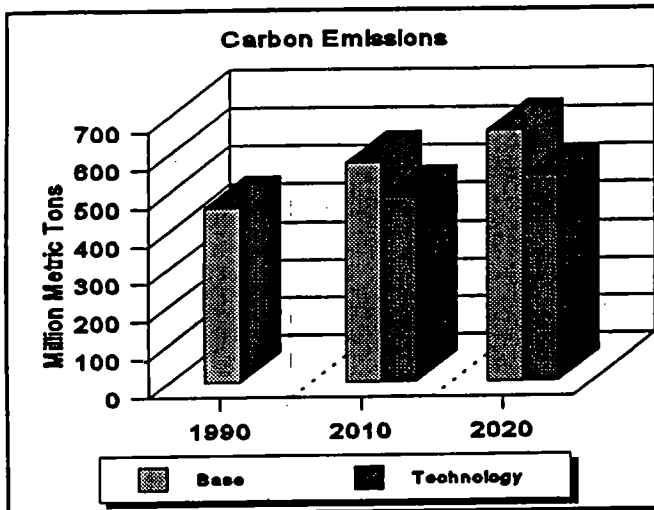
- The DOE Labs Study estimates that annual costs needed to achieve emissions reductions in 2010 in freight transportation range from \$20-25 billion, and could save ~~\$27-40~~ billion annually in fuel costs.

what happened to \$35

**Policy Challenges**

- Technology R&D is key to reducing energy intensity in trucks in the medium and long term. Hybrid powertrains could likely be significantly advanced with increased R&D funding.
- To achieve a high efficiency/low carbon technology scenario, R&D programs might need to be increased substantially.

## Residential and Commercial Buildings



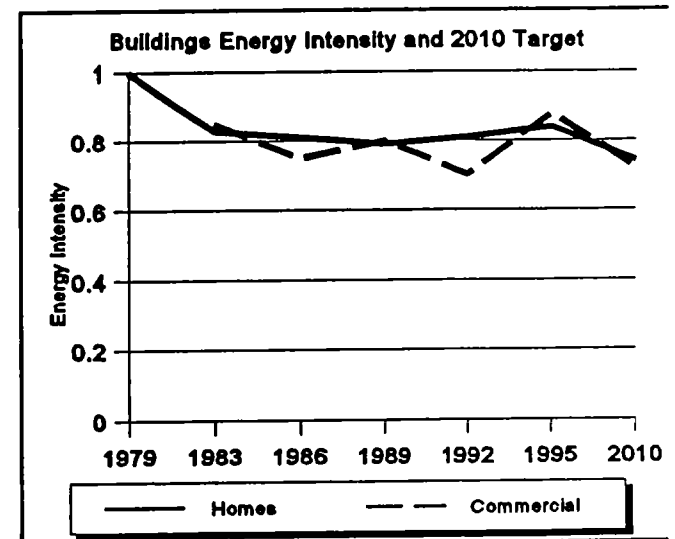
Source: EIA, Markal-Macro, DOE Labs Study, 1997

### Key Trends - 1990-2010

- 35% of U.S. carbon emissions are from energy use in buildings, with homes emitting 19% and commercial buildings emitting 16%.
- Energy intensity in buildings has declined substantially since the late 1970s. Primary energy intensity in commercial buildings declined by 22% between 1979 and 1992, while residential primary energy intensity dropped by 15% since 1978.
- Buildings have become increasingly electrified - driven by rapid growth in office equipment, small appliances and other devices collectively known as "plug loads". From 1978 to 1992, commercial electricity consumption grew by 37%, while residential electricity grew by 36%.
- Due to continuing electricity growth, the EIA forecasts that future commercial energy intensity will decline by only 0.2% per year, and residential intensity by 0.5% per year. However, numerous studies identify substantial additional potential for cost-effectively reducing buildings energy consumption and greenhouse gas emissions.

### Needed Technological Improvements

- Technologies needed to achieve the emissions reductions above largely exist today.
- The large potential emissions reductions are not being achieved in current markets because of a number of market barriers that impede the diffusion of energy-efficient technologies - such as lack of reliable product information; higher up-front costs; split incentives between efficiency purchasers and beneficiaries; conflicting building codes; and lack of market expertise in efficiency design, construction and financing.
- To achieve the efficiency savings in 2010, the equipment that naturally turns over in about 35% of buildings is replaced with the most cost-effective technologies by 2010; these savings assume normal retirement of equipment at the end of its useful life.
- Energy efficiency improvements needed are 12% for residential buildings and 18% for commercial buildings by 2010 vs. no sustained improvement from 1980 to 1995.



Source: EIA, DOE Labs Study 1997

- Integrated renewable technologies in buildings can cut heating and cooling loads while directing cutting emissions.

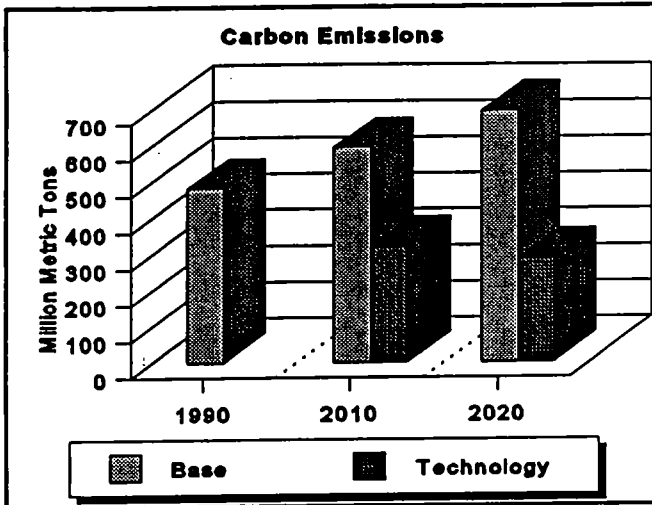
#### **Costs**

- The DOE Labs Study estimates investments to achieve these 2010 savings are \$7-\$14 billion per year and result in 2010 energy bill savings of \$18-33 billion - a net savings of \$10-19 billion and a 20% return on investment.
- DOE estimates costs of Federal programs to accelerate the use of energy efficient technologies in buildings are \$300 million per year.

#### **Policy Challenges**

- Federal, state and local policies that accelerate technology deployment and energy efficient building design, construction and operation.
- Partnerships with states, local government and industry to improve efficiency of existing buildings and remove market barriers.
- Research and development of a portfolio of advanced buildings technologies.

## Electric Power



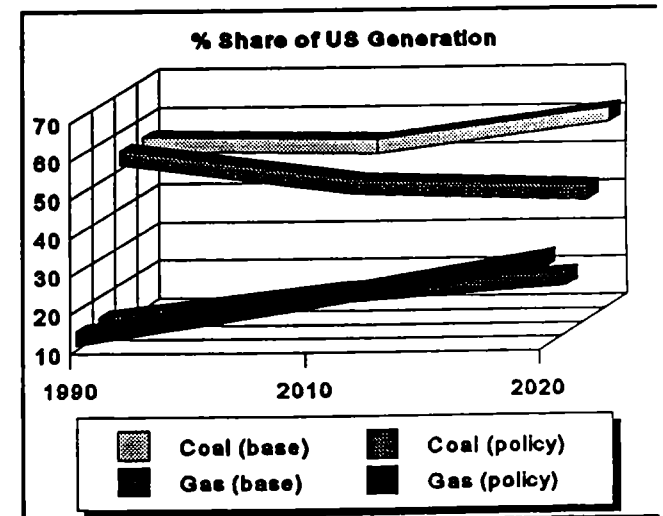
Source: Markal-Macro 1.25 Stabilization Case

### Key Trends – 1990-2010

- 36% of US carbon emissions are in the electric utility sector, primarily from burning of coal and natural gas.
- Coal and natural gas together are projected to increase from 63% of energy inputs to 70% by 2010, increasing the carbon intensity of this sector.
- Demand for electricity is projected to rise by 20 percent per decade compared to 30% from 1980 by 1990.
- Renewable power (other than hydroelectricity) is projected to rise from 1.5% of generation currently to 1.8% in 2010.

### Needed Technological Improvements

- No breakthroughs are projected in generation technology. Continued improvements will be possible from combined cycle turbines, gasification for biomass fuels, wind turbines and system improvements (such as transmission efficiency).
- First, end use electricity demand growth must slow -- efficient technologies can reduce demand to 23% above 1990 levels by 2010, vs. a business as usual forecast of over 40% growth.
- Second, those reductions must primarily reduce coal-fired generation.
- Third, remaining coal-fired generation must be reduced in favor of natural gas, through gas co-firing, conversions to gas, and increased use of combined cycle gas turbines.
- Beyond 2010, nuclear plant life extensions may be an economically viable option.
- Renewables such as solar, wind, geothermal and biomass must be promoted for the long term, and must be accelerated to make a larger contribution.



Source: DRI 1.25 Stabilization Case

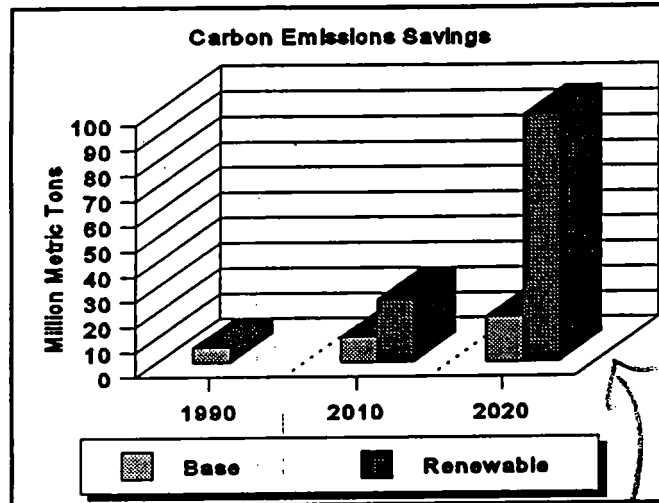
**Costs**

- **Cost estimates for the needed changes in the utility industry are under development at this time.**

**Policy Challenges**

- **Aggressive R&D and marketing for energy efficiency sectors is essential.**
- **Integrate climate policy with competitive trends and air quality regulation.**
- **Incentives for shifting power to lower-emitting fuels -- pricing, emissions trading credits, promotion, regulation, and financing.**
- **Incentives to develop emissions sequestration alternatives such as the capture and combustion of methane from landfills for power generation.**

## Renewable Energy



Source: DOE Labs Study, 1997

*13 this constant w/ electric power*

### Key Trends - 1990-2010

- Today, roughly 12% of the country's electricity generating capacity is from renewable energy - with 85% of this from hydropower. Newer renewable technologies - including wind, biomass, photovoltaics, solar thermal and geothermal - are increasingly economic and have large potential.
- Costs have dropped dramatically - photovoltaic cells have dropped from \$0.90/kilowatt-hour in 1980 to under \$0.20/kWh today, while wind power has dropped from \$0.25/kWh to \$0.05/kWh.
- Cost reductions will continue because of R&D advances and as manufacturing process improvements and production rates decrease costs.
- Cost performance improvements have resulted in several technologies being competitive in selected markets today and others will be competitive in broader markets in the near future.
- Several major international companies such as Royal/Dutch Shell, expect these technologies to be dominant global energy sources and are substantially investing in their development.

### Needed Technological Improvements

- The contribution of renewable electric technologies to emissions reductions could be substantially higher than projected in the base case.
- Costs and performance of these technologies continue to improve, but additional advances in wind, biomass, photovoltaics, geothermal, solar thermal and transportation biofuels are needed - such as: wind turbine design for moderate wind speeds, photovoltaics conversion efficiency improvements, geothermal drilling technology and resource verification, large-scale cellulosic biomass fuels production, and biomass combustion and integrating renewable technologies into building designs.
- Non-hydro renewable energy generation capacity could grow from 9 gigawatts (GW) today to 21-24 GW in 2010 and 77-108 GW by 2020.

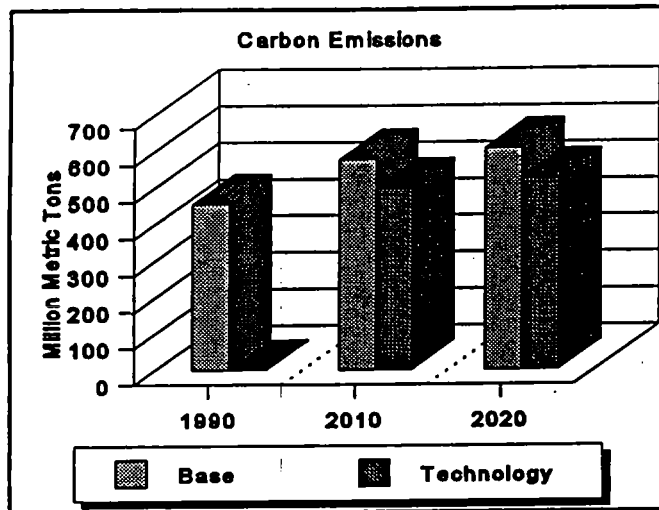
### **Costs**

- According to the DOE Labs Study, the incremental capital investment in renewable power systems needed to achieve the above results is \$2-3 billion in 2010 and \$15-25 in 2020 - although fuel cost savings in 2020 will result in net incremental costs that are low or negligible.
- As estimated by DOE, the incremental production cost of renewable electricity is estimated to be \$2-3 billion/yr in 2010 and negligible in 2020 as multiple renewable technologies are widely competitive with gas technologies.

### **Policy Challenges**

- Expand technology R&D to lower costs and increase performance.
- Conduct cost-shared technology diffusion with industry to increase utility system experience and increase U.S. renewable energy production capacity.
- Conduct R&D on key support systems such as power storage, power conversion systems, controls and superconducting power equipment.
- Encourage use of U.S. renewable technologies abroad to tap the huge global market for renewable energy.

## Industrial Emissions



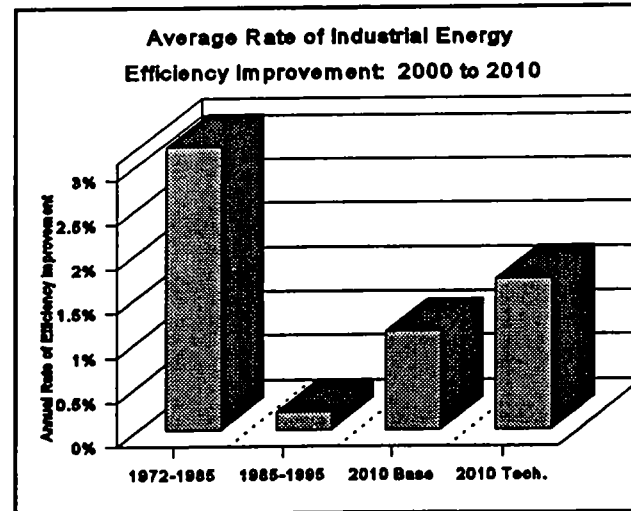
Source: Markal-Macro Technology Investment Case

### Key Trends -- 1990-2010

- Based upon EIA data for 1995, the industrial sector uses 37 percent of the nation's energy, or 34 out of a total 91 quads. Carbon emissions are now at about 33 percent of total emissions in the United States, or 464 of 1424 million metric tons (MMT). The industrial sector is second only to transportation in the growth of carbon emissions.
- Electricity accounts for 34 percent of the total industrial carbon emissions.

### Needed Technological Improvements

- With normal rates of capital stock turnover, the industrial energy intensity is expected to decline at a rate of 1.2 percent in base case forecast for the period 1997-2015. Historically, energy intensity has decreased by an average of 1.8 percent annually from 1972 to 1995. During this period, average energy intensity declined by 3 percent between 1972 and 1985, and then remained relatively unchanged from 1985 to 1995.
- The industry sector is also responsible for most of the non-energy related emissions of carbon dioxide (21 MMT) and other greenhouse gases (219 MMT of carbon equivalent). Although industrial emissions of these gases are far smaller than energy-related carbon emissions by weight, they have global warming potentials (GWP) that range from 21 for methane to 23,900 for sulfur hexafluoride (SF6).



Source: Markal-Macro Technology Investment Case

- The industrial sector has the potential to reduce energy use by 10-15 percent over 2010 baseline forecasts through cost effective investments in energy efficient technologies, and in some cases, low carbon technologies.
- The use of heat recovery and combined heat and power (i.e., cogeneration) systems such as the Advanced Turbine System, can reduce industrial carbon emissions by up to 35 MMT/year in 2010 with electricity costs that are 10 percent lower than current systems.
- Motor systems account for 70 percent of industrial electricity use (about 120 MMT). Better designed energy-efficient motor systems could reduce electricity use by up to 40 percent. Better maintenance of compressed air systems can also save 40 percent of the energy used in such systems.
- In addition, there are important longer term opportunities to reduce the carbon intensity of industrial operations through changes in the fuel mix, and by using lower-carbon fuels.

#### **Costs**

- There are readily-available but underutilized technologies with two to four-year paybacks that can reduce industrial energy use by 10 percent or more. As referenced above, these technologies include more efficient motor systems, air compressors, and process efficiency improvements.
- DOE estimates that the cumulative investment necessary to reduce industrial carbon emissions to 1990 levels by 2010 is on the order of \$47 to \$58 billion in the period 1998-2010. On an annual basis, this is about 3-4 percent of the total investments made by the manufacturing sector in 1995. By 2010, annual energy savings are estimated at \$8-10 billion (with all values in 1995 dollars) -- approximately a 17% to 20% return on investment.
- Many of the most successful technologies have multiple benefits, including environmental- or productivity-enhancing may actually improve the competitive position of many industries.

#### **Policy Challenges**

- Policies to encourage the more rapid diffusion of existing technologies include: (1) incentives to accelerate the investment in new capital stock and equipment; (2) increased RD&D to facilitate the development of improved technologies as well as the development of a new generation of industrial technologies; (3) incentives to increase the use of recycled feedstocks; (4) expediting the use of combined heat and power systems through improved environmental permitting and by incorporating provisions into the ongoing utility restructuring that facilitate the sale of excess power by industrial plants; and finally (5) a life cycle approach to environmental permitting and regulations.

Executive Office of the President  
Council of Economic Advisers

MAY 19, 1997

MEMORANDUM FOR: JASON SHOGREN  
CC: TOM RHOADS  
FROM: MIKE TOMAN  
SUBJECT: "JOINT IMPLEMENTATION" -- SOME DISCUSSION POINTS

You asked me to prepare some general points that could help guide CEA's thinking on how joint implementation should be structured. Here are some general issues that need to be emphasized, in my view:

(1) Transactions costs. On the one hand, it is true that the potential cost savings from JI for US emitters are high enough that some transactions costs can be borne; and that some should be borne to develop a system that is environmentally and politically acceptable. On the other hand, past experience with emissions trading programs indicates that transactions costs can cripple trading when there is no effective way to manage them. In this regard, for example, it would be very counterproductive to require too many reviews of JI proposals and performance from too many parties, especially third parties who may have idiosyncratic interests and bear no costs for frivolous challenges. There is simply no way to manage that kind of risk, and the rational response of both investors and hosts will be to eschew many if not most possible projects. It makes a lot more sense to have the project reviewed at the proposal stage, and then again after a number of years (perhaps with random spot-checking; annual review is too burdensome and doesn't provide scope for inevitable fluctuations in performance). If projects are found to be in default, then whoever is responsible could be required to make restitution. The simplest way to do this would be to require the emitter to retire an offsetting number of other carbon credits plus a penalty, though putting all the burden on the credit buyer creates its own adverse incentive problems (presumably insurance mechanisms could develop; this was a major point of contention in the development of EPA's Open Market Trading Rule for O3 and VOCs).

(2) Additionality: these issues are in some ways extensions of the points above. There is considerable concern about how to determine whether certain emissions reductions wouldn't have happened anyway, leading some to conclude that there should be no JI (trading should only take place within Annex 1 countries with national caps), or at least that JI should be restricted in various ways. Additionality is a practical concern, but we have a lot of time (several years) to work out some sensible, transparent, easily implemented protocols. Analysts at the IEA and OECD, among others, already are engaged in this process, and it should be allowed to run its

course. We should not let our current uncertainty about how to address the problem freeze us into a very restrictive posture toward JI in the long term. In particular, we need to watch out in trying to early to establish an "approved" list of JI project types that qualify for additionality, since this is the way de facto design standards get created. (We do need to think about sequestration differently from emissions reduction, but that is a specific narrower question.)

(3) "Paper Credits" and "Leakage." A related question is whether it makes sense to have trading involving non-Annex 1 countries, since their emissions are likely to be growing anyway. This view reflects a basic misunderstanding of what JI is supposed to do. It is supposed to provide a way to reduce the cost of achieving whatever emissions reductions targets are negotiated, and in the process, it can provide a valuable spillover benefit by introducing climate-friendlier and economically beneficial technologies into developing countries, reducing their baseline emissions growth. If emissions reductions are additional, they necessarily are making emissions growth slower than would otherwise have occurred.

(4) Discounting credits: some arguments have been made that JI credits should be discounted to reflect a variety of factors, including uncertainty about additionality and monitoring, leakage, and the desire to get non-Annex 1 countries into the Annex 1 trading system. As suggested above, I think the leakage argument is specious. Discounting for uncertainty is possible, but it needs to be handled with great care lest any incentives to improve performance be taken away, or that discounting introduce an untoward bias in favor of some technology types over others. Better to just get people to improve monitoring. Finally, discounting to induce participation in Annex 1 trading has it all backwards -- these countries are supplying a valuable service to us with JI, not the other way around, and we should not be impeding the supply of that service. They do not at this point have much incentive to opt into a national cap and trade system just because we shoot ourselves in the foot by discounting JI credits.

I hope these thoughts are useful. Please contact me with any questions or comments.



RESOURCES  
FOR THE FUTURE

### Facsimile Transmittal

To: **Jay Shogren**

Fax: **93956853**

**CEA**

Voice:

Date: **Monday, May 19, 1997 4:15 p.m.**

---

From: **Toman, Michael**

Fax: **202-939-3460**

Number of pages, including this cover sheet: **3**

Mary -- I'd appreciate it if you could get this to Jay and Tom at your earliest convenience. Thanks.

If you do not receive all pages noted above, please contact sender.

RFF Form 29 (rev. 7/96)

1616 P Street, NW • Washington, DC 20036 • Telephone 202-328-5000 • Fax 202-939-3460

3/19/98

To: JA, RL, AM, JY

From: JF

Re: Proposal to phase out trading

Did you all see this? Did we know that this view was out there? Does the e-trading paper address this view? If not, I think it should, as a first step to countering it if it comes up in international negotiations.

## Emissions Trading In Warming Pact May Be Phased Out

By JOHN J. FIALKA

Staff Reporter of THE WALL STREET JOURNAL

WASHINGTON — The emissions trading that the U.S. pushed to be a permanent feature of last year's global warming treaty may phase out after eight years, according to the head of the United Nations commission that negotiated the pact.

The practice will eventually discourage the involvement of developing nations, which worry that emissions trades would perpetuate pollution by industrial countries, said Ambassador Raul Estrada-Oyuela, an Argentinian who heads the U.N. agency in Bonn that is preparing for the Kyoto, Japan, treaty's implementation. "We want to make sure we're not creating a new crop for nations to sell," he added.

Trading and compliance details are to be included in negotiations set for this November in Buenos Aires. Enforcement of limits for developed nations is scheduled to begin in 2008.

Through trading, industrialized nations can reduce the economic impact of global controls on emissions of carbon dioxide and other man-made "greenhouse gases" thought to be warming the earth's atmosphere.

A company could receive credit against its country's limits by buying emissions rights from companies that have reduced warming-related gases below their limits. Or the company could get credits by helping developing nations reduce their emissions, which might be cheaper than meeting its country's limits.

The treaty, which would reduce the average industrialized nation's emissions by 5% from the base year 1990, was opened for signature yesterday at the U.N. Small island nations and European Union countries are expected to be among the first to sign. The U.S. is likely to wait until after details are hammered out in Buenos Aires.

The White House hasn't submitted the treaty for Senate ratification because of strong congressional opposition. The Senate has tied its approval to the application of emissions controls to China and other major developing nations not subject to treaty controls.

THE WALL STREET JOURNAL  
TUESDAY, MARCH 17, 1998

Exhibit 3 illustrates the results for model runs for the U.S. that select only cost-effective carbon reduction options—those that are cheapest on the basis of life-cycle costs. By definition of the models, these emission reductions has zero or negative costs associated with them. Most of the studies indicate that emissions can be kept at or below base year levels for about 20 years. The OTA and MARKAL studies indicate steadily rising emissions while the AEC study indicates steadily falling emissions thereafter; the difference reflects different assumptions about technology opportunities in the future. The EIA study considers only energy efficiency improvements and is unable to match the others in terms of identified cost-effective opportunities.

Exhibit 4 illustrates the lowest-carbon run undertaken by each U.S. study. The EIA study results in only modest additional reductions in carbon emissions. All of the other studies are able to reduce emissions below the base year. AEC reduces carbon emissions by 40 percent by the year 2010. Exhibit 5 indicates the assumptions and cost-results for these studies. Only the most aggressive carbon reduction case is included. For all but the MARKAL study, the investments include a mix of those that save more than they cost ("no regrets") and those that cost more than they save (for MARKAL, all measures have positive costs). The resulting average costs may be positive (OTA, ICF, MARKAL) or negative (AEC, OTA). Marginal costs — the cost of the last ton of carbon saved -- tend to be significantly higher than average costs, indicating that costs rise as the stringency of the carbon limit increases. (Average costs actually fall in the AEC study as the stringency increases, even though marginal costs rise. This is due to "no regrets" investments being brought in faster in the more stringent scenario.)

Economy-wide cost estimates. The Energy Modeling Forum at Stanford University brought together a number of economic modelers to analyze carbon taxes, and they differed by a factor of 5 in their conclusions as to how large a tax would be required to achieve specific emissions goals. To the extent possible, key assumptions were standardized across models. Most of the scenarios examined in the models assume initial reduction steps beginning in 1990. Scenarios in which emissions reductions do not begin until 2000, and begin from the higher base level projected at that time, would likely engender higher costs.

Exhibit 6 tabulates model estimates of U.S. GDP costs of emissions reductions. Stabilizing emissions at their 1990 levels is generally estimated to reduce GDP by .2 to .7 percent in the year 2010, a \$20-70 billion loss for that year. One macro study, however, estimates the costs to be approximately 3% of GDP. These estimates assume a lump sum redistribution of tax revenues, with no incentives effects on marginal tax rates. GDP losses increase as the emissions target gets more stringent: estimated GDP losses in 2010 with a 20 percent reduction from 1990 range from .9 to 1.7 percent of GDP. Estimates range from \$20 to \$150 per ton for the carbon taxes required to hold emissions at 1990 levels in 2010. To achieve a 20 percent reduction, model estimates range from \$50 to \$330 per ton. High carbon taxes were required in models that assumed a low price responsiveness to higher energy prices and slow adjustment of the capital stock.

Note however, that the above estimates are based on a pre-specified set of economic assumptions imposed upon the modelers. When modelers are free to choose the economic assumptions they consider most likely to materialize, the range of cost estimates is much wider. For example, Montgomery, Hughs, and Yanchar (Global Climate Coalition) estimate that even a \$200 per ton tax, causing a 4.3% GDP loss, would be insufficient to attain the 20 percent reduction goal by 2010. This same point applies to OECD and world estimates.

**Exhibit 8: GDP and Carbon Taxes in Carbon Emissions Reductions  
in Economy-wide Models**

Model	Model Type	% GDP loss		Carbon tax level (per ton of carbon)	
		Stabilize emissions at 1990 levels by 2010	Reduce emissions 20% below 1990 levels by 2010	Stabilize emissions at 1990 levels by 2010	Reduce emissions 20% below 1990 levels by 2010
<b>United States</b>					
CRTM (Rutherford)	Disaggregate econ equil	0.2	1	150	280
DGEM (Jorgenson/Wilcoxon)	Disaggregate econ equil	0.6	1.7	20	50
ERM (Edmonds/Rally)	Energy sector equil	0.4	1.1		
Fossil2 (Belanger/Nail)	Energy sector equil	0.2	1.4	80	250
Gemini (Cohan/Scheraga)	Energy sector equil			120	330
Global 2100 (Manne/Richels)	Aggregate econ equil	0.7	1.5	110	240
Global Macro (Pepper)	Energy sector equil			20	50
Goulder	Disaggregate econ equil	0.3	1.2	20	50
Green (Martin/Burniaux)	Disaggregate econ equil	0.2	0.9	80	170
MWC (Mintz)	Energy sector equil	0.5	1.1	70	180
DRI (Horowitz)	Macro	3		150	
<b>Other OECD</b>					
ERM		0.5		80	
Green		0.3		40*	
Global 2100		0.5		80	
<b>World</b>		% GDP loss		% GDP loss for other reduction levels	
		Stabilize at 1990 levels by 2020		% reduction below 1990 levels by 2020	% GDP loss
ERM		1.1			
Green		1.5			
Global 2100		2.2			
CRTM		0.8			
Burniaux				17	1.8
Edmonds / Barnes				22	1.9
Manne				13	2.9
Rutherford				15	1.5

\*Has lower baseline & assumes rapid phase-in of backstop technologies.

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		Stabilize at 1990 levels by 2020		% reduction below 1990 levels by 2020	%GDP loss
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Green		1.5			
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CRTM		0.8			
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Rutherford				15	1.5

\*Has lower baseline & assumes rapid phase-in of backstop technologies.

## OUTLINE FOR EMISSIONS TRADING STUDY

- I. The Challenge of Global Climate Change
  
- II. Reducing Economic Impacts Through a Cost Effective Approach - Comparison of Command and Control versus Market-Based Approaches
  
- III. Evolution of Emissions Trading Programs - Netting, Bubbles, Recent Experience
  
- IV. Characteristics of a Cost Effective Emissions Trading Program
  - A. Flexibility in When and Where Reductions Occur
    1. Reducing Costs through Timing of Reductions
      - a. Potential for Cost Reductions
      - b. Mechanisms for Improving Flexibility in Timing
        - (1) Banking
        - (2) Borrowing
    2. Reducing Costs through Choice of Location: Potential for Cost Reductions
  - B. Incentives for Innovation and Diffusion
  - C. Low Transactions Costs and Broad Participation: Issues in Market and Permit Design
  - D. Equitable Distribution of Effects of Program
  - E. Monitoring and Enforcement Costs
  - F. Impact on Ancillary Benefits and Costs
    1. Effect on Costs on Other Environmental Programs
    2. Leakages
  
- V. Estimated Costs
  
- VI. Issues:
  - A. Other Market Based Approaches
  - B. Domestic versus International Trading

C. Allocation Formula or Auction

D. Where in the Product Cycle to Impose Controls

E. Hybrid Approaches

F. Sinks

G. CO<sub>2</sub> versus Greenhouse Gas Trading

Climate Change Agenda  
September 5, 1997

622-0563 J. Gruber

I. The big picture

Targets &  
Timetables →  
↓

- A. What are the scientific uncertainties? SQUITIERI memo done, attaching article from *Science*
- B. What obligations should we argue for in Kyoto? - FRANKEL paper in process
- C. How would we implement a program domestically to attain obligations that might be agreed upon in Kyoto?
  - 1. Domestic emissions trading paper Ray S.
  - 2. Why are we so staunchly opposed to CAFE-type regulation? Ray S.
- D. What role might we expect technology to play in helping us to meet any obligations we might assume in Kyoto? What is the proper role of government in fostering the development of that technology? GILLINGHAM —
- E. How and when will developing countries participate? } dev. country data
- F. How would any international agreement be enforced? - state
- G. What if Kyoto blows up? (Would we take unilateral action?)

*Would another meeting between Yellen, Summers, and associates be warranted to touch base on their vision of the big picture?*

## I. Domestic Emissions Trading

We are now working with EPA on a paper that will cover four options, representing the convolution of upstream/downstream and auction/allocation (SQUITIERI).

*upstream*

1. Heavily revise EPA's version of the two upstream options (target: 9/5)
2. Receive EPA's version of the two downstream options (target: COB 9/4), and provide comments (target: COB 9/8). These comments probably only need to state our objections, and hit the low points.
3. Develop a clear written explanation of why we oppose tradable credits. Key points should include the inefficiencies of CAFE-like approaches (doesn't penalize intensity of use, impacts only market for new units, not existing); should draw on empirical literature concerning the cost of the CAFE standards relative to a gasoline tax (target: COB 9/8).
4. Gardiner wants to talk things through face-to-face (especially our visceral opposition to downstream options) after we've had a chance to look at the downstream stuff. After that we can decide whether we need to append a statement to the effect that "the downstream options are vigorously opposed by the economics agencies."
5. Wrap-up (target: COB 9/10?)

## II. Technology

- A. GILLINGHAM and ALDY to draft stand-alone technology paper.

[Might include an argument along the following lines, supplied by Summers: Even if you accept the 5labs report lock, stock and barrel, you get only  $X$  percent of the way there without raising price. To get all the way there, you have to raise price by  $Y$  percent. This would have the following implications for energy prices— $x$  for coal,  $y$  for gasoline, etc.—and would be roughly  $Z$  times as large as the BTU tax that was proposed early in the first term.]

Transmit to D. WILLIAMS and B. BOORSTIN for comment

- B. GILLINGHAM and ALDY(?) to lead the effort in commenting on technology options paper when it arrives late next week

## III. Targets and Timetables

- A. FRANKEL & CO have produced draft. WILCOX has provided comments. Paper currently under revision at CEA.

*See a previous paper for background*

B. JONES memo near completion.

#### IV. Other Analytics

- Laura*
- A. MULDOON to work on effects of policies on the typical family. (*Rough draft expected COB Friday, Sept 5*)
- B. GRUBER and JONES to work on incidence across income groups (*Rough draft by Sept ?*)
- C. ALDY (CEA) has completed memo on size of financial flows; has this been transmitted upward?
- D. MULDOON to work on political economy lessons BTU tax (*Draft exists?*)
- E. MULDOON to work on political economy lessons of Carter oil allocation scheme. (*Rough draft by Sept ?*)

\*\*\*\*\*

- F. SCHOLZ to work on incidence as between households and firms. (Might the paper by Poterba, Rotemberg, and Summers be relevant here for shedding light on degree of pass-through?)
- G. SCHOLZ to work on revenue recycling. How does the prescription of academic public finance theory translate into the real world? Why do simulations of empirical models suggest that deficit reduction might be a better way to go than recycling? (Do they?)

*Baselines for LDC's*  
*check on CEA activity*  
*Randy*

H. GILLINGHAM to work on spelling out emissions baselines for developing countries that would not involve either excessive restraint on growth nor large transfers of resources. (Frankel recommends consulting his comments on State Dept papers. Gruenspecht may also have ideas on this.)

*Do they always involve transfers.*

I. GRUBER and GILLINGHAM to work on developing principals for climate change.]

J. GRUBER, WILLIAMS, and BOORSTIN to work on the political economy of climate change.

K. SQUITIERI has written a short memo on scientific uncertainties, and attached a copy of the recent article from *Science*.

#### V. Papers in the Interagency process

- A. We believe that the one-page summary from State is now a sufficient statistic for where the process is on developing country commitments.

B. Paper by Justice on relationship between international and domestic trading - August 12 version is still the latest - WILCOX will provide comments 9/5 (Jim Rubin; 514-9050)

C. Paper on escape clause - FRANKEL working on analytics of when we would need escape clause. (Would a Bill-Poole-style analysis be helpful here? The source of shocks matters. If most uncertainty derives from aggregate demand shocks, then we might not need (or even want) an escape clause. If most uncertainty derives from shocks to technology, escape clauses seem very important.)

D. Paper on competitiveness - (status?) Jon HAVEMAN (CEA) is writing a separate paper on this topic. *what are the odds? what are the sources of uncertainty? How many periods was growth over 2% over mean?*

E. Paper on negotiating implications of different targets and timetables (At last word, Jeffrey Hunker did not know that he and Pomerance had been tasked to write this paper. Status unknown)

F. Paper on federal undertakings - status?

G. Paper on early credit - revised version received 9/4

H. Paper on transition assistance - on hold.

#### VII. Briefing for Rubin - GILLINGHAM

*What happens if you have 5% growth rate in economy borrowing*

*Has Jon folded in Treasury comments? Get back to Treasury*

1ed

→ 11 labs study

Sequestration ← \$12 million  
efficiency \$10 million

1) capture & dispose

2) enhancing natural sinks  
~~3)~~ iron fertilization of ocean

more uncertainty

3) biomass mgt.

long range

genetic engineering to  
enhance CO<sub>2</sub> sequestration of  
plant life photosynthesis

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Difficult for new technologies in 1<sup>st</sup> budget period

- increased funding
  - Use coal more efficiently
  - almost double energy efficient of coal fired plant

5 labs study

- coal goes down 40%
- replace w/ nat gas

miners, coal transport,

Jay Hakes

202 586-4361

EIA director

Sectoral impacts - testified

Dan Reicher

Asst Sec for energy eff.

586-9220

Sept. 22nd, 1997

TO: ADELE MORRIS  
FROM: MARK LEVINE  
SUBJECT: Carbon tax effect on coal mining industry

Using data compiled by the Bureau of Economic Analysis for the period from 1969-1996, it is quite apparent that coal mining is an industry that has, since 1979, experienced consistent declines in its total number of employees (from roughly 260,000 workers in 1979 to just over 100,000 in 1996). However, this decline in employment has been met with a modest increase in absolute coal production over the same time period, particularly due to the increased mining of subbituminous coal and lignite, thus indicating an increase in worker productivity. Per capita real wages, which slowed down in 1979 after considerable growth in the ten years prior, have only recently begun to increase.

In the event of a substantial carbon tax, it is very likely that the coal mining industry would suffer greatly. With more than 80% of the workforce above the age of 35<sup>1</sup>, it is unlikely that any significant amount of displaced coal miners could be retrained for careers in other fields. The states that would be affected most greatly by a carbon tax are West Virginia, Kentucky, and Pennsylvania, which cumulatively account for 53% of all U.S. coal miners. The region that would be hit hardest is the Southeast, where almost 56% of all coal miners are employed.

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<sup>1</sup>According to estimates from the Bureau of Labor Statistics that cover the period from 1992-1996.

# Personal Income by Major Source and Earnings in the Coal Mining Industry, 1969-1996

(SOURCE: BUREAU OF ECONOMIC ANALYSIS)

All figures in thousands of dollars

State	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996		
Alabama	52020	63875	63643	77133	88902	122520	191282	212093	263551	314469	377779	433399	416998	468600	388868	424634	455494	417190	402298	361387	357777	400589	401004	379320	368508	378892	423749	432444		
Alaska	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	
Arizona	332	1668	1924	2458	3923	6924	9973	16141	26029	34210	39199	46036	48296	55262	51312	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Arkansas	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
California	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Colorado	16299	25061	23908	27004	34687	68266	80773	76418	131917	155103	184572	212716	242480	257905	208054	231144	221004	197554	163083	156541	160506	182024	170519	167707	191161	201095	210899	194498		
Connecticut	86	572	473	696	1193	3288	3801	2374	25741	27285	30655	37306	45158	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Delaware	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
D.C.	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Florida	77	291	384	581	745	2776	2731	2254	9261	8243	8608	10460	11099	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Georgia	38	107	183	778	777	2363	2684	2578	15303	12359	9687	9278	8852	9066	6950	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Hawaii	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
Idaho	144	363	364	491	622	1444	1590	894	1506	3463	3379	4015	3677	4022	2266	3628	3557	3523	3613	3533	3610	5759	5198	6582	3389	4452	5284	5363		
Illinois	122020	139920	142440	178219	197612	228554	291478	339995	409447	416343	575535	635649	601712	734302	666163	712311	685984	667134	649613	613855	575813	594690	615510	579075	490870	525347	468427	439683		
Indiana	32310	39639	40725	50434	58038	76854	103800	116713	179553	202822	242604	268777	293876	344870	305562	354208	318108	271413	(D)	241838	231814	278755	254249	236974	(D)	(D)	199798	205702		
Iowa	1749	2826	2462	3544	2541	4437	5185	3233	8302	6660	7559	7830	7714	8694	6599	9282	8303	8255	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Kansas	3124	3930	3968	5325	6846	6252	7988	9217	13672	19141	17459	20560	20025	20478	17045	20449	20489	18540	18410	(D)	18182	22764	24620	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Kentucky	201712	278621	314154	355449	409538	660452	820935	927633	1308301	1423653	1630650	1799413	1933621	2002506	1609039	1835028	1732092	1638224	1659638	1503272	1411500	1530103	1379759	1366919	1314337	1320632	1221945	1179738		
Louisiana	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Maine	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Maryland	2660	4641	4378	4645	6677	15532	20097	17975	38033	38299	48741	65743	69036	71144	49440	(D)	56497	50103	48118	47307	39763	40519	57039	44558	30658	26246	26226	26586		
Massachusetts	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Michigan	153	466	437	532	622	2231	3469	1941	5221	7327	6387	8662	8356	10631	4961	8352	6562	6551	5777	6325	6318	10117	8419	9898	9134	8137	9195	9265		
Minnesota	144	143	219	818	1762	4462	2708	2101	8204	8989	9499	9036	8916	11147	5789	9707	8101	7436	3552	8171	7190	13688	12094	4698	4832	6810	7760	7970		
Mississippi	515	558	364	527	414	1312	978	637	1508	1443	2028	2548	2418	2908	1442	2177	2588	2152	987	(D)	1504	2199	1834	2105	(D)	(D)	1571	1814	1843	
Missouri	10222	13662	14918	18581	22484	32175	41007	39754	60224	71020	75259	86747	74337	111064	94434	117088	114404	107338	84398	78711	59448	61465	82175	(D)	83767	50069	(D)	(D)	(D)	
Montana	1148	1743	2309	2848	7200	10431	16864	19983	24785	40840	48065	52571	58137	58213	58550	61948	64498	62845	50222	64584	82024	63949	84207	72298	63148	81646	84530	80311		
Nebraska	125	429	254	859	3163	7087	5012	7337	9038	7213	10364	13385	11631	14654	8240	12335	11263	10178	(D)	(D)	10530	17595	14305	(D)	(D)	7944	9440	9510		
Nevada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(D)	416	307	(D)	(D)	2106	2199	3354	4001	3698	2148	0
New Hampshire	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
New Jersey	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
New Mexico	5034	6368	7589	8643	12590	20605	26455	27121	40767	51184	63575	80218	89683	102835	88261	(D)	(D)	(D)	101895	96197	86256	97553	104150	113652	130355	130231	125299	114410		
New York	4133	4440	1505	2238	2191	4590	4565	5696	10541	11860	10740	13106	15133	17145	9732	16264	11858	11583	11249	10638	11131	13185	17281	(D)	(D)	(D)	8656	8748		
North Carolina	192	416	377	220	486	1857	4108	1785	11488	8947	11570	13092	14174	16434	11186	18342	12655	10968	4342	3456	2707	4399	4387	4926	8735	12784	13120			
North Dakota	2818	4172	4181	4401	4754	8373	9495	13552	17247	23407	30750	36811	43857	48531	53899	57262	63184	57687	55650	55683	54718	58656	57848	61809	66789	65018	68130	67139		
Ohio	95024	120334	128088	158649	173477	229762	320161	336919	437513	460545	530849	546293	510974	561486	488769	551134	514790	492398	(D)	401900	363060	378073	330732	300271	(D)	(D)	268377	274284		
Oklahoma	6682	10699	15361	11371	12156	21596	29959	24618	55167	68685	69467	85263	96145	105512	77394	98698	85500	(D)	40007	33489	30261	35650	38660	39247	37486	32257	33104	35962		
Oregon	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Pennsylvania	305308	362393	367810	427778	481888	645580	840979	884322	1179065	1245452	1422619	1491144	1475562	1548742	1255814	1376114	1250224	1175318	1153329	1106670	1054268	1151096	1068010	1084131	1021272	1008874	1027609	1062697		
Rhode Island	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
South Carolina	38	143	183	294	103	857	858	255	646	297	470	870	644	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	5438	6912	12765	4688	4150	1867	2136	2162	
South Dakota	48	222	296	284	1119	2026	2147	1222	1563	3760	3605	4709	3918	4609	2884	4535	4346	4500	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Tennessee	15736	19622	26987	30104	34674	67725</																								



**Coal Production, 1969-1994**

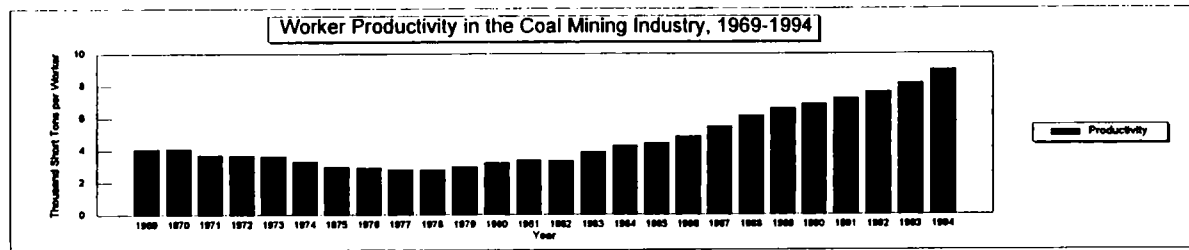
Values are in million short tons

1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
571	612.7	560.9	602.5	598.6	610	654.6	684.9	697.2	670.2	781.1	829.7	823.8	838.1	782.1	895.9	883.6	890.3	918.8	950.3	980.7	1029.1	996	997.5	945.4	1030.5

**Worker Productivity in the Coal Mining Industry, 1969-1994**

All values in thousand short tons per worker

1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
4.06	4.08	3.69	3.67	3.63	3.30	2.96	2.89	2.81	2.77	2.97	3.21	3.37	3.34	3.86	4.25	4.42	4.83	5.46	6.12	6.59	6.85	7.18	7.80	8.13	8.98





Department of Energy  
Germantown, MD 20874-1290

DATE: FEB 13, 1998

Office of Nuclear Energy, Science & Technology

ENGINEERING AND TECHNOLOGY DEVELOPMENT, NE-50

TO: Adele Morris, CEA FAX # 202/395-6870

FROM: John Herczeg, D/E e-mail Address: john.herczeg@hq.doe.gov

telephone: 301/903-9887

FAX 301/903-1510

Pages excluding cover: 5

NOTES: ① Brookhaven Nat'l Lab - CO<sub>2</sub>/Nuclear Power Study

contact person - U.S. Rohatgi 516/344-2475

② Attachments: ① Nuclear Energy Plant Optimization

② Nuclear Energy Research Initiative

PLEASE CONFIRM/NOTIFY MISSING PAGES. ③ Nuclear Energy Fact Sheet

(See Bulletin #4)

(301) 903-3456 OR 903-5447

(301) 903-1510 (FAX#)



John Horczeg (301) 903-9887

People to call about coal & nuclear

Sequestration:

Pittsburgh Energy Tech Project

(412) 892-6890

Steve Korman

(301) 403 - 4675

→ State's briefing materials

\* Charts

Phil Doherty	586-7950	DOE tech guy
- Coal	Joe Braitsch	<del>586-9676</del> ←
	Bob Porter	586-6503

Coal Technologies Ctr.  
 George Rudins 586-1650

nuclear. — talked to about

Nuclear { John Gutridge (301) 903-1632  
 John Herczeg (301) 903-9887  
 Bill Magwood 586-6630

Office of Nuclear Energy Science & Tech. 586-6450 ←  
 generalist

Office of Energy Efficiency

\*

Bill Melman

DOE Basic Energy Sciences (301) 903-5805



PETER.KARPOFF @ hq.doe.gov  
04/02/98 09:29:00 AM

Record Type: Record

To: Adele C. Morris

cc:

Subject: Following Em Trdg meeting at State Dept.

Dear Adelle,

It is always a bit frustrating to me at these meetings when we open a topic and then move on without concluding it. I wanted to say a bit more about your nomination of the pure seller liability option, but I couldn't get speaking space at the right time. At the end of the meeting Jonathan kept pure seller liability on the table, saying that he had heard some in favor and no fatal criticism. His motivation may have included the fact that some of the "big guys" have spoken favorably of pure seller liability and you can't go against the big guys. I assume that you defended the idea either because you favor it, or because you have not seen the group make a sufficient (dismissive) critique and you want to hold us to a high logical standard (perhaps as devil's advocate) or perhaps for other reasons.

Anyway, I think there are some important negatives about strict seller liability that have not yet been aired. So here is my view of pure seller liability.

From a simple feasibility perspective I think pure seller liability is tough to implement. The transaction may occur in year 1, but the final validity of the allowance sold may not be determined until year 5 or later. By the time the liability, if any, of the seller is known the sale is so distant that the proceeds may be gone and the liable seller may be unable or unwilling to pay. An escrow is not a perfect answer because the time period is so long. Escrow impounds are usually for fairly short periods while exposures are actively resolved, not for long periods. Surety bonds are not the right tool in this case either.

*Seller liability or firm?*

Next, for true versions of pure seller liability we need to have the seller liable, not the alternative form in which the buyer is liable with access to a legal remedy against the seller. That would impose too much of a burden on buyers by allowing them (i.e., forcing them) to pursue sellers to make good on promises to buyers. Chasing a seller and even getting a judgment is far different from getting payment on that judgment. Seller liability should mean that the FCC Secretariat undertakes to collect directly from the defaulting seller in the event of default. Can we really imagine the FCC Sec. going after defaulting Parties? Especially in light of the option that any Party has to quit the agreement?

In light of the long period between the sale and a potential default

finding, the questionable ability of the FCCC/Secr. to enforce against the selling Party no matter how quickly it can proceed, and the opportunity of any seller to simply quit rather than face an onerous penalty make seller liability a non-feasible choice. This door must be locked before the horse has escaped, not five years after. I think the only feasible choice is to make the sales proceeds reflect concurrent compliance probabilities, so that sellers get about the right revenues from the start so as to minimize the need for subsequent adjustments.

I think escrow and insurance schemes are also unworkable answers for this case. Insurance is defeated by the moral hazard aspects of this problem. In the dynamic, insurance charges have to be experience rated. Here, experience rating will tend toward a 100 percent premium for the worst issuers. at any lower premium they have an incentive to take the money from sales and default in the polar case. An the polar case is what you get since performance (or non-performance) is fully within the control of the insured. Control by the insured over the insured outcome is the classic hallmark of an uninsurable event.

Likewise for escrow, apart from the earlier point about the long duration of the escrow, for the big defaulters, if any, an escrow of less than 100 percent will create an incentive to default for a financial gain. But any large escrow interferes with use of the revenues for energy efficiency investment and monitoring costs and in a way increases the chances of default. For the bad guys any escrow will be too small; for the good guys any escrow will be too large. In either case revenues will be denied for valid purposes.

I come back to the same conclusion, that we need some way to limit revenues to the expected value of allowances at the time of the transactions. I still like the market verdict on sale prices with constant market review. I don't think the FCCC SEcr. will ever get the authority to make discretionary judgments against the sovereign Parties.

Peter Karpoff

Fax Cover Sheet



cc: RL  
JA  
JF  
AMeorig

**Please Deliver to:**  
Adele Morris

**Sent to Fax #:** 395-6958  
**Company:** CEA

**From:** SHARON SAILE  
**Fax #:** 000-0000  
**Voice:**

**Pages:** 4

**Message:**

Interagency Emissions Trading Workgroup

RE: Meeting at State (room to be determined)  
Tomorrow, Wednesday, April 1 (no fooling!)  
1:15-2:30pm

TOPIC: Further discussion of buyer seller liability issues

ATTACHMENT: DOE draft paper

This will be a working staff level meeting for discussion. The issue might be discussed further at the Assistant Secretary level meeting next week, among all the issues which need to be discussed at that time.

If you can't make it, please call me for a summary...sharon



## Emissions Trading; How to Apportion Liability for Compliance Failure

Compliance rules must be enforced to maintain integrity of the national emissions assignments. Trading in emission allowances involves a mix of characteristics from both commodity and bond market trading. Safeguarding the environmental values and the interests of trading participants requires a blend of practices from these two markets.

Trading raises the importance of enforcing compliance, since non-compliance is the route to financial profit and trading allows Parties to put into circulation some allowances that might lie dormant without the trading opportunity. Nevertheless, with trading the required compliance rules are the same ones needed for ordinary compliance. The integrity of emissions limits will be strengthened if Parties that fail to meet compliance requirements, especially if they are net sellers of allowances, can be held liable for their non-compliance.

In commodity trading, the concept is "what you see is what you get." Once the commodity specification is written, conforming delivery is secured by the certain prospect of secured cash penalty in the absence of conforming delivery. For trade in gold, for example, performance by the seller requires timely delivery of specification-grade gold. The delivered commodity itself is sufficient evidence of its own validity. By contrast, trading in bonds, representing a promise of the issuer's performance, requires continual assessment of the underlying promise to pay, in order to determine value and prices. Trading in emission allowances can be pushed to either model.

Emissions trading via instruments whose compliance value is guaranteed by the international authority is like commodity trading. So long as the guarantee is trusted, the allowances can trade as a commodity; what you see is what you get and a tonne is a tonne. The value of an allowance derives from its guaranteed compliance value. By contrast, if the authority reserves the right to adjust the compliance value of the allowance based on some subsequent occurrence, then trading is more like bond trading and the value of the instrument depends on market assessment of the promisor's likelihood of performance. How, and even whether, allowances will trade and be valued depends whether their compliance value is guaranteed or subject to adjustment for conditions outside the control of the holder

### **Seller vs. Buyer liability for non-compliance:**

Pure seller liability: A seller would unconditionally guarantee attainment of its adjusted emissions target in support of any allowance sale. This is a commodity market model, but unlike most commodity trades, compliance may not be determined until long after allowance sales; the power to compel subsequent cure of a compliance deficiency, or to exact indemnity from a sovereign Party that is unwilling or unable to cooperate, is lacking. Seller liability may be impossible to enforce.

Modified seller liability: All sellers would agree, in advance, to escrow a share of allowance sale revenues or provide 3rd party performance bonds for their end-of-period emission compliance obligations. This plan has the disadvantage that some net sellers will be counting on their

allowance sales proceeds to cover monitoring costs and the cost of investments to further improve energy efficiency and emission performance. Performance bonds may be costly for the Parties that need them most. Insurance is not viable because the insured event is too much subject to the control of the insured Party and the Party may, in the short-run, gain more from default than from compliance. The insurance cost will be unfairly high for those who comply and too low for those who default. The issue is akin to the 1980 S&L problem. The problem is summarized by the economic term "moral hazard" and creates incentives for a downward spiral toward progressive non-compliance and the parallel withdrawal of all insurers.

Pure buyer liability: Under this option, buyers of allowances can use (tender) them for emissions compliance (i.e., receive the anticipated value) only to the extent that sellers retrospectively, meet their emission commitments. This is a bond market model. The determination of compliance value is made long after some sales occur. Unless buyers can get effective guarantees of performance from the originator of purchased allowances or reliable assessments of risk, the buyer holds a very uncertain instrument. This risk, even in small doses, is unattractive to buyers and even less attractive to traders. Buyer liability for sellers' future emissions performance would likely be fatal to emissions trading, where, unlike the case of "full faith and credit" guarantees, secure guarantees of performance across national boundaries are unlikely.

Modified buyer liability: If the FCCC Secretariat held the power to deny compliance tender value to allowances not supported by emissions compliance of the first issuer (a bond market model), the direct compliance burden would fall on buyers, but an informed market could achieve substantial shifting of the compliance burden to sellers. For example, allowance trading could be conducted according to these rules:

- Traded allowances are identified as to original nationality and serially identified by date of their first recorded trade. For untraded allowances, the date of submission to the FCCC Secretariat for compliance determines the serial priority,
- In the event of a Party's non-compliance, some allowances originating from that Party would be invalidated, starting from the latest dated allowances and proceeding backward, until the remaining quantity matched the Party's compliance achievements (i.e., domestic emissions do not exceed retained allowances, and exchanged allowances do not exceed avoided emissions),
- Annual reports would reveal each Party's compliance progress (emissions) and AEU sales rate, thus permitting the market to assess how many allowances from each Party are likely to be valid, and a quality-adjusted price for each point in the serial sequence,
- Market prices for allowances would reflect expected probabilities of validity. Private tools, such as rating services, compliance consultants, derivative contracts, and portfolio syndications would arise to permit risk management strategies.
- Market information, both public and private, would permit shifting of risk exposure back to sellers through the market prices that informed buyers would offer for allowances of varying probable value. In the end, each allowance would be good or bad; all good allowances would have the same compliance value. Market information would permit a gradual sharpening, over the course of the budget period, of the price differential between expected good and bad allowances around the expected validity cut-point for each Party.

Direct imposition of compliance burdens on buyers, but with substantial information given to sellers, can create a hybrid system of liability that shifts a significant share of the compliance burden to sellers and creates a significant market incentive for seller compliance, even when the direct compliance process is administered on buyer/holders of allowances.

Private steps in the trading process following emission assignment under the FCCC with modified buyer liability rules:

- Parties may, at their option, assign some allowances to sub-national entities.
- Holders may offer to sell allowances, to be identified by nationality and serially numbered in ascending order.
- Buyers offer prices, based on assessment of end-of-period compliance of seller. Highest prices will be offered for first issuances, which are the first to be honored within each nationality class. Later issuances carry greater risk of non-compliance bumping and will generally command lower prices.
- Rating agencies could offer assessments of the likely validity cut-off point for each issuer.
- Prices of allowances traded would reflect market consensus of future validity with continual adjustment of perceptions as compliance expectations change.
- Parties that show credible compliance reports will get higher prices for larger proportions of their sales offerings. Poor reports will limit the opportunity to sell allowances except at very low prices and for limited quantities. Speculators might enter to buy cheap allowances to rehabilitate them prior to the compliance date.
- At the end of the compliance period, FCCC Secretariat announces which allowances are valid. Nations make compliance tender of valid units and added compliance, as needed, to complete compliance.
- Supplemental compliance methods, like borrowing from the second budget or an agreed "excess emissions fee" will be needed to permit national compliance in the event that insufficient valid allowances remain to permit first period compliance.

Official steps in the trading process under modified buyer liability rules:

- Emissions amounts assigned to Parties,
- Compliance authority agrees to permit allowance trading,
- Following any sale, the recording agent accepts joint order to record transfers;
- The recorder notes the nationality and places a serial number on newly-recorded allowances, and maintains the existing identifiers for previously traded allowances.
- At the end of the budget period, FCCC Secretariat announces which allowances are valid for compliance, based on the compliance showing of each issuer that traded.
- Parties supplement surviving allowances, if necessary, to complete compliance by borrowing, open market purchases, or pre-specified default payments.

Prelim. Draft: 3-28-98, for comment only  
Peter Karpoff

Fax Cover Sheet



Please Deliver to:  
Victoria Greenfield

Sent to Fax #:

647-5713

Company: State

From:

SHARON SAILE

Fax #: 000-0000

Voice:

Pages: 4

Message:

Interagency Emissions Trading Workgroup

RE: Meeting at State (room to be determined)  
Tomorrow, Wednesday, April 1 (no fooling!)  
1:15-2:30pm

Room 4325

TOPIC: Further discussion of buyer seller liability issues

ATTACHMENT: DOE draft paper

This will be a working staff level meeting for discussion. The issue might be discussed further at the Assistant Secretary level meeting next week, among all the issues which need to be discussed at that time.

If you can't make it, please call me for a summary...sharon



*Mark*

*Deter  
Kaf Poff  
wrote this*

## Emissions Trading; How to Apportion Liability for Compliance Failure

Compliance rules must be enforced to maintain integrity of the national emissions assignments. Trading in emission allowances involves a mix of characteristics from both commodity and bond market trading. Safeguarding the environmental values and the interests of trading participants requires a blend of practices from these two markets.

Trading raises the importance of enforcing compliance, since non-compliance is the route to financial profit and trading allows Parties to put into circulation some allowances that might lie dormant without the trading opportunity. Nevertheless, with trading the required compliance rules are the same ones needed for ordinary compliance. The integrity of emissions limits will be strengthened if Parties that fail to meet compliance requirements, especially if they are net sellers of allowances, can be held liable for their non-compliance.

*hot  
air*

In commodity trading, the concept is "what you see is what you get." Once the commodity specification is written, conforming delivery is secured by the certain prospect of secured cash penalty in the absence of conforming delivery. For trade in gold, for example, performance by the seller requires timely delivery of specification-grade gold. The delivered commodity itself is sufficient evidence of its own validity. By contrast, trading in bonds, representing a promise of the issuer's performance, requires continual assessment of the underlying promise to pay, in order to determine value and prices. Trading in emission allowances can be pushed to either model.

Emissions trading via instruments whose compliance value is guaranteed by the international authority is like commodity trading. So long as the guarantee is trusted, the allowances can trade as a commodity; what you see is what you get and a tonne is a tonne. The value of an allowance derives from its guaranteed compliance value. By contrast, if the authority reserves the right to adjust the compliance value of the allowance based on some subsequent occurrence, then trading is more like bond trading and the value of the instrument depends on market assessment of the promisor's likelihood of performance. How, and even whether, allowances will trade and be valued depends whether their compliance value is guaranteed or subject to adjustment for conditions outside the control of the holder

### Seller vs. Buyer liability for non-compliance:

*fr vs liable  
sde for  
vict. h. 2012*

Pure seller liability: A seller would unconditionally guarantee attainment of its adjusted emissions target in support of any allowance sale. This is a commodity market model, but unlike most commodity trades, compliance may not be determined until long after allowance sales; the power to compel subsequent cure of a compliance deficiency, or to exact indemnity from a sovereign Party that is unwilling or unable to cooperate, is lacking. Seller liability may be impossible to enforce. (?)

*dismissed  
too quickly*

Modified seller liability: All sellers would agree, in advance, to escrow a share of allowance sale revenues or provide 3rd party performance bonds for their end-of-period emission compliance obligations. This plan has the disadvantage that some net sellers will be counting on their

*?*



Direct imposition of compliance burdens on buyers, but with substantial information given to sellers, can create a hybrid system of liability that shifts a significant share of the compliance burden to sellers and creates a significant market incentive for seller compliance, even when the direct compliance process is administered on buyer/holders of allowances.

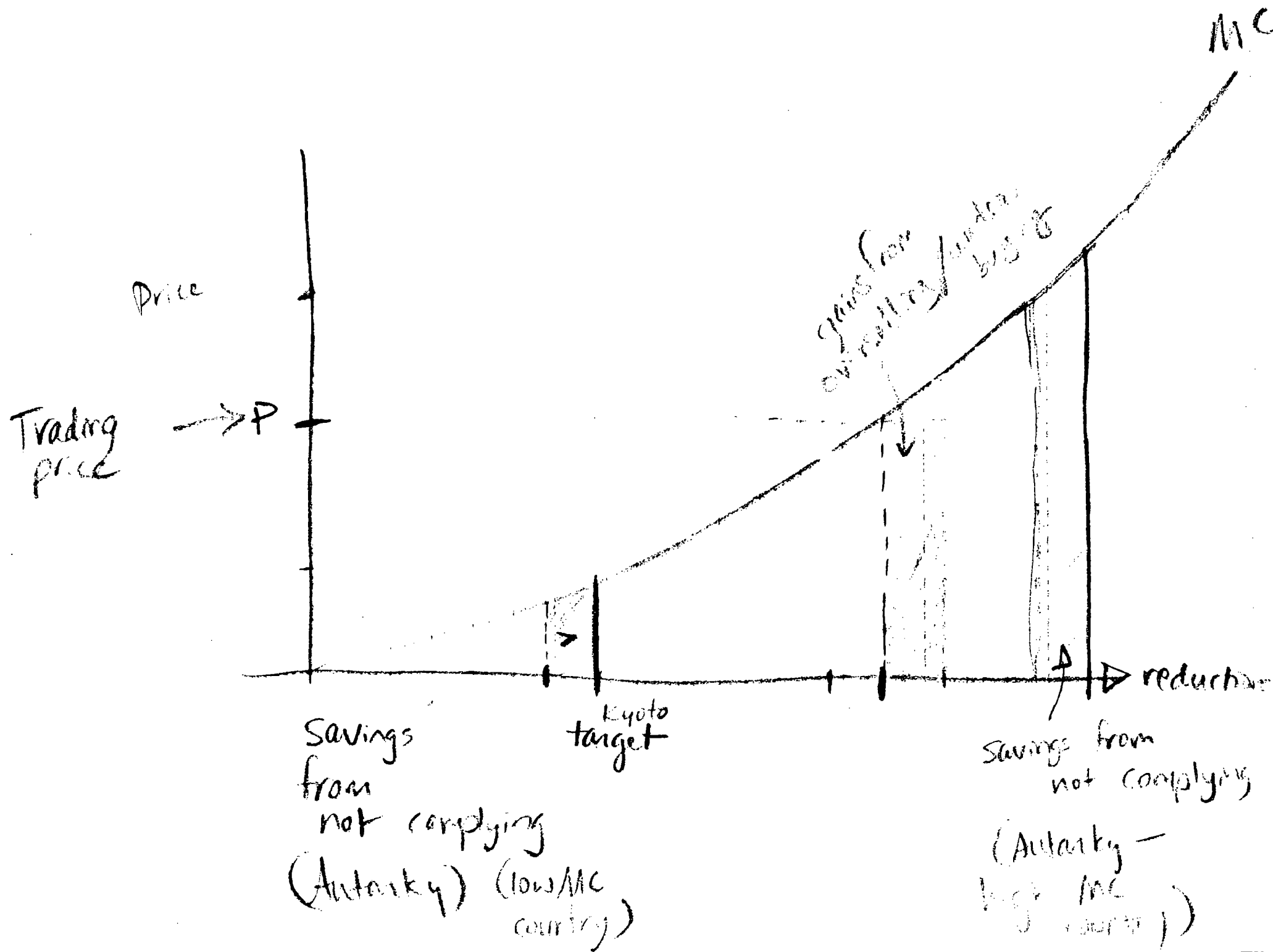
Private steps in the trading process following emission assignment under the FCCC with modified buyer liability rules:

- Parties may, at their option, assign some allowances to sub-national entities.
- Holders may offer to sell allowances, to be identified by nationality and serially numbered in ascending order.
- Buyers offer prices, based on assessment of end-of-period compliance of seller. Highest prices will be offered for first issuances, which are the first to be honored within each nationality class. Later issuances carry greater risk of non-compliance bumping and will generally command lower prices.
- Rating agencies could offer assessments of the likely validity cut-off point for each issuer.
- Prices of allowances traded would reflect market consensus of future validity with continual adjustment of perceptions as compliance expectations change.
- Parties that show credible compliance reports will get higher prices for larger proportions of their sales offerings. Poor reports will limit the opportunity to sell allowances except at very low prices and for limited quantities. Speculators might enter to buy cheap allowances to rehabilitate them prior to the compliance date.
- At the end of the compliance period, FCCC Secretariat announces which allowances are valid. Nations make compliance tender of valid units and added compliance, as needed, to complete compliance.
- Supplemental compliance methods, like borrowing from the second budget or an agreed "excess emissions fee" will be needed to permit national compliance in the event that insufficient valid allowances remain to permit first period compliance.

Official steps in the trading process under modified buyer liability rules:

- Emissions amounts assigned to Parties,
- Compliance authority agrees to permit allowance trading,
- Following any sale, the recording agent accepts joint order to record transfers;
- The recorder notes the nationality and places a serial number on newly-recorded allowances, and maintains the existing identifiers for previously traded allowances.
- At the end of the budget period, FCCC Secretariat announces which allowances are valid for compliance, based on the compliance showing of each issuer that traded.
- Parties supplement surviving allowances, if necessary, to complete compliance by borrowing, open market purchases, or pre-specified default payments.

Prelim. Draft: 3-28-98, for comment only  
Peter Karpoff



## **Annex I Expert Group on the UNFCCC**

### **Emissions trading paper: draft 1 April 1998**

#### ***Objectives***

At the March 1998 Annex I Expert Group meeting, "The Group agreed that for 1998 the first priority will be a product that will reflect delegates' views on principles, modalities, rules, and guidelines for emissions trading, with a focus on verification, reporting, and accountability. The objective of the product will be to underpin Annex I Parties' input to the UNFCCC meetings in June and November 1998. Where there is agreement in the Group on any issue, the paper will note the agreed view. For any issues where there is a range of views, the paper will note the different views....." (meeting report). The objectives of this draft paper are:

- i. to reflect views of Annex I Parties on principles, modalities, rules, and guidelines for emissions trading.
- ii. to underpin Annex I Parties' input to the June and November UNFCCC meetings.

#### ***Approach***

The paper aims to reflect Annex I Party views. It is concise, and is not analytical in nature. For this first draft paper, the secretariat has drawn on views expressed during the March 10 and 11 meeting, ideas from earlier work, and comments received on the outline that was presented at that meeting. This document will be revised in line with comments received by 10 April for discussion at the May 12 and 13 meeting in London.

#### ***Process***

Delegates are encouraged to post their comments and any papers or views they wish to contribute on the Annex I Expert Group password protected web site. Alternatively, please send your comments and papers in an electronic file to Fiona Mullins for inclusion on the web site. This web site provides an electronic discussion group that will greatly facilitate exchange of views. All delegates will be able to read (and respond to) the comments of other delegates as soon as they are posted.

The timing of draft papers and deadlines for comments and meeting schedule are as follows:

March 19	comments on the structure and the type of issues that should be covered in the new "principles, modalities, rules, and guidelines" emissions trading paper
March 31	first draft emissions trading paper
<b>April 10</b>	<b>substantive comments on this draft paper, reflecting views on the issues</b>
May 4	second draft emissions trading paper for discussion at the May meeting
May 12 & 13	Annex I Expert Group meeting in London to discuss next steps on emissions trading, including possible products for the June and November UNFCCC meetings.
Sept 10 & 11	Annex I Expert Group meeting in Paris to discuss products for COP4 and beyond.

## **Principles, Modalities, Rules and Guidelines for Emissions Trading (in particular for verification, reporting, and accountability)**

### ***PRINCIPLES***

#### **Consistency with Protocol and UNFCCC provisions**

1. Emissions trading should be fully consistent with and supportive of all provisions of the Kyoto Protocol.
2. Emissions trading should accord fully with UNFCCC principles.

*Note: the UNFCCC principles are referred to in the Kyoto Protocol preamble "Being guided by Article 3 of the Convention". The main points of these principles are noted below for information:*

- 3.1 ...protect the climate on the basis of equity ....common but differentiated responsibilities and respective capabilities.*
- 3.2 ... needs and special circumstances of developing country Parties...*
- 3.3 .... take precautionary measures... ....policies and measures should be cost-effective so as to ensure global benefits at the lowest possible cost. ... should take into account different socio-economic contexts, cover all relevant sources, sinks...*
- 3.4 .... policies ... should be appropriate for specific conditions of each Party*
- 3.5 .... promote a supportive and open international economic system... measures should not constitute a ... disguised restriction on international trade*

#### **Environmental effectiveness**

3. Emissions trading should not compromise the environmental objectives agreed to under the Kyoto Protocol. Any transfers or acquisitions should be verifiable, and emission estimates should be of good quality so that all Parties have confidence in the system.

#### **Economic efficiency**

4. Emissions trading should facilitate economic efficiency in the achievement of the Kyoto Protocol targets, and should have clear and simple rules, and low set up, administration, and transaction costs.

#### **Equity**

5. Implementation of emissions trading should not create any additional inequities, or give an unfair advantage to any one Party or group of Parties.
6. The market for transfers and acquisitions should be open, transparent, and competitive. *(this principle relates to both equity and economic efficiency).*

## ***MODALITIES, RULES AND GUIDELINES***

### **Eligibility criteria:**

1. Annex I Parties with commitments listed in Annex B of the Protocol that comply with Articles 5 and 7 and meet the further requirements [*reference relevant paras e.g. paras 7, 8, and 12 below*], and authorised legal entities in those Parties, shall be eligible to transfer or acquire parts of assigned amounts.

### **Public listing of participants:**

2. Parties and legal entities that are eligible to trade must be listed on a public bulletin board.

### **Market institutions for an open, competitive and transparent market:**

3. Transfers and acquisitions shall be carried out at an official international auction held periodically.

*or*

4. Parties shall notify the UNFCCC prior to any transfer, and the UNFCCC secretariat shall make information on the quantity and price of the transaction available to all Parties that are eligible to trade.

*or*

5. Transfers and acquisitions may be carried out through any brokers, exchanges, or auctions that are established to facilitate transfers.

### **Unit of transfer:**

6. The international unit of trade shall be metric tons of CO<sub>2</sub> equivalent calculated using the global warming potential value defined by decision 2/CP3, or as subsequently revised in accordance with Article 5.3.

### **Estimating emissions:**

7. Use of the IPCC guideline methods for estimating emissions and removals (as required by Article 5.2 and decision 2/CP3) shall be clarified for Parties that wish to transfer or acquire parts of assigned amounts according to adjustments to the guidelines that may be agreed by a COP/MOP to make data collection and estimation methods more comparable.

8. Parties that wish to transfer or acquire parts of assigned amounts shall agree to use consistent and transparent emission estimation methods, including data collection. (*note: this could be an eligibility requirement*)

9. Parties that wish to authorise legal entities to transfer or acquire parts of assigned amounts shall agree to meet enhanced requirements for monitoring the emissions of legal entities. (*note: this could be an eligibility requirement*)

**Accounting for units transferred:**

10. Accounting of tons of CO<sub>2</sub> equivalent transferred shall be consistent with any accounting and reporting requirements or guidelines that are elaborated under Article 7 of the Protocol.

**National recording:**

11. Governments shall record all transfers or acquisitions of CO<sub>2</sub> equivalent units that are carried out by government and by legal entities.

12. Information on emission reductions transferred by firms and projects shall be recorded by national governments at least annually.

13. Parties that wish to authorise their legal entities to transfer or acquire parts of assigned amounts shall have in place effective national systems for monitoring and enforcing legal entities' emission limits and tracking their transfers and acquisitions. (*note: this could be an eligibility requirement*)

**Reporting transfers and acquisitions:**

14. Information on quantity of CO<sub>2</sub> equivalent units transferred or acquired, including the country to which units were transferred to or from which units were acquired from, shall be submitted to the UNFCCC secretariat for each year, consistent with the frequency of reporting determined in accordance with Article 7.

**International recording:**

15. The UNFCCC secretariat shall record all transfers and acquisitions, and publish, on an annual basis, a tabulation of all transfers and acquisitions made in the previous year and the adjustments to assigned amounts required under Articles 3.10 and 3.11.

**International review:**

16. Parties that wish to transfer or acquire parts of assigned amounts shall be subject to enhanced review, additional to that required under Article 8 of the Protocol, of national emission inventories, projections, monitoring systems.

**Trading of assigned amounts of the six GHG and sinks:**

17. Any part of an assigned amount can be traded, including the sink categories that may be used to meet commitments under Article 3.

**New entrants:**

18. New entrants shall be subject to the same eligibility conditions as Parties already in the trading system.

**Non-compliance:**

19. Parties are responsible for national non-compliance with their assigned amounts at the end of the commitment period (even if sub-national entities make transfers).

Draft 1/04/98: please do not cite or quote

20. Annex I Parties that do not comply with rules and guidelines for emissions trading shall be subject to the non-compliance provisions agreed under Article 18.

21. Parties that wish to trade shall be subject to interim review of their progress towards compliance during commitment periods.

22. A Party whose emissions are in excess of its emissions budget in any commitment period may acquire, but not transfer, any part of its assigned amount.

23. If a question of possible non-compliance by an Annex I Party, or failure to implement the requirements of Articles 5 or 7, is identified in accordance with the provisions of Article 8, or if Parties fail to comply with any principles, modalities, rules, and guidelines for emissions trading, transfers and acquisitions may continue to be made after the question has been identified, provided that any such acquisitions may not be used by a Party to meet its commitments under Article 3 until any issue of compliance is resolved.

**Supplemental to domestic action:**

24. Parties shall not make acquisitions equivalent to more than x% of their assigned amount, including acquisitions made by authorised legal entities.

25. The supplementarity of trading shall be the subject of in-depth review with periodic assessment by a COP/MOP.

26. Parties shall not transfer, under Articles 6 and 17, any more than y% of their assigned amount, including transfers made by authorised legal entities.

**Changes (i.e. participants, trading rules etc.):**

27. Changes in the Parties that are eligible to trade, and changes in trading principles, modalities, rules, and guidelines shall apply in subsequent commitment periods *or* at least x years after the change is agreed.

Comment Draft

The middle, bulleted text is my view of the minimum provisions for trading. Comments invited.

### **Pre-requisites taken from the basic system of Targets and Underlying Compliance**

Party acceptance of targets (assignments) and compliance obligations,  
Definition and creation of allowances,  
Procedures for reporting and monitoring national emissions,  
Establishment of a compliance system.

Minimum compliance system: Harsh glare of public scrutiny on non-compliance at end of budget periods (or additionally at any interim checkpoints, or for anticipated defaults).

### **Minimum additional requirement to establish a trading system**

- AEU's transferable among holders
- AEU's of any national origin acceptable in international compliance
- Establish a recording system for international trades
- Impose responsible control over the supply of new AEU's and fungible substitutes (CDM)
- Establish credible sanctions for instances of compliance failure (may be no more than the spotlight of public opinion as noted above).

### **The Follow-on Role for the Market (if not pre-empted by exclusive government action):**

Establish a place (or virtual place) for trading to occur,  
Establish allowance prices, given the definition of allowance attributes,  
Establish broker communities to permit secure trading between private entities,  
Establish low-cost practices for recording temporary and/or unofficial trades,  
Devise derivative trading instruments (contracts) for futures and options trading,  
Provide private information about price-influencing aspects of various national allowances,  
Provide diversified portfolios and portfolio insurance to permit risk management.

Comment draft

protocol?

6. Could rules affect a

Message Sent To:

Adele C.  
Robert J  
greenfiel  
meridam  
ray.squit  
mark.ma  
jonathan

protocol?

6. Could rules affect an umbrella?

Message Sent To:

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Adele C. Morris/CEA/EOP  
Robert J. Tuccillo/OMB/EOP  
greenfieva @ ms6820wpoa.us-state.gov @ inet  
meridame @ ms6820wpoa.us-state.gov @ inet  
ray.squitieri @ treas.sprint.com @ inet  
mark.mazur @ hq.doe.gov @ inet  
jonathan.gruber @ treas.sprint.com @ inet

MARIO MERIDA

DEPARTMENT

# FAX

To: Adele Morris - C

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Phone: \_\_\_\_\_

Fax phone: 395-6870

CC: \_\_\_\_\_

REMARKS:  Urgent

Copy of the rev  
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 new "Cover sheet

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② Official  
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③ Consequ  
 off

Regards  
 Mario

MARIO MERIDA

DEPARTMENT OF STATE,

2201 C STREET, NW,

WASHINGTON, DC 20520

# FAX

Date: 3/18

Number of pages including cover sheet: 5

To:

Adele Morris - CEA

Phone:

Fax phone: 395-6870

CC:

From:

EB/ESC/IEP/ECC

Phone: (202) 647-2231

Fax phone: (202) 647-4037

REMARKS:

Urgent

For your review

Reply ASAP

Please comment

Copy of the revised cover sheet for the NZ paper for the next A/S discussion on trading. (I thought today's 4pm mtg. was on trading but have been told otherwise.) As I mentioned, on this new "cover sheet" we have concerns that:

- ① throughout: trading does not make the commitments "annual" - we still do have a 5yr-period!
- ② Official trades vs. Contract trades: we need not mandate who assumes risk: this is an issue for contract negotiation.
- ③ Consequences: Yellow flag presented on official USG proposal, which it is not.

*Regards  
Mario*

## Emissions Trading Attachment

### o Article 17 on Emissions Trading:

#### -- What are the significant features?

- o The penultimate draft said parties had the right to trade "once" rules were adopted; the final provision has a free-standing sentence containing the right to trade.
- o While some countries had sought to put a percentage limit on the amount of a country's target that could be met through trading, the final provision says only that trading must be "supplemental" to domestic action (without giving the Parties the authority to quantify this term).
- o Unlike other provisions, the Article refers to "Annex B" rather than "Annex I" Parties. This would allow developing countries, through an amendment to Annex B, to participate in emissions trading.
- o Unlike other provisions, the body charged with developing the rules is the COP rather than the COP/MOP; this could allow earlier establishment of the rules.

#### -- What is missing that was in earlier drafts?

- o In order to engage in emissions trading, a Party has to be in compliance with its measurement and reporting obligations (now Articles 5 and 7), as well as have in place a national mechanism for the certification and verification of emissions trades.
- o A Party may authorize intermediaries (which would have been understood to include the private sector) to participate in actions leading to the transfer or acquisition of tons. [Note: Even without such an explicit rule, we would interpret the Protocol not to preclude private sector participation.]
- o With respect to any trading in which they engage, Parties were to submit annually to the Secretariat information regarding the quantity, Party of origin or destination, and the relevant budget period.

- Emission levels achieved before the start of the first commitment period (so-called "superheated air") could not be used as the basis for emissions trading; such a provision is arguably no longer necessary in light of Article 3.10 and 3.11, which refers to transfers and acquisitions of "assigned amounts."
- A Party whose emissions were in excess of its allowed amount in any budget period could have acquired, but not transferred, tons.
- When a question was raised regarding a Party's compliance with its reporting/measurement obligations, transfers could continue to be made, but transferred tons could only be used to meet targets after the compliance issue had been resolved.

## THE SIMPLE STEPS OF AN EMISSION TRADE:

Buyer and seller, having met the preconditions (budgets, monitoring, reporting), find themselves with compliance obligations that do not match their emission unit balances.

Willing buyer and seller agree on a price and delivery date.

Buyer checks that originator of the offered allowances (either seller or prior seller) was not on the public FCCC non-compliance list at the time the offered allowances were first sold.

(If first seller is/was on the bad boy list, buyer may still buy, but with notice that allowance acquired will not be accepted for FCCC compliance until the seller's compliance deficiency is cured. Impaired allowances may be cheap and may be a good value, depending what you know about the source and its prospects for compliance.)

Seller determines that its anticipated emissions unit needs permit it to sell.

Buyer pays the seller and seller delivers the allowances in a simultaneous transaction or through an escrow arrangement.

Buyer may be a government in a G to G trade. Buyer may be a private firm buying from a government seller, buyer may be a firm buying from a firm, or buyer may be a government buying from a private firm. In each case the required safeguards and authentications may vary.

As money and allowances change hands, the FCCC records the transfer, debiting the seller's account and crediting the buyer.

These same allowances could trade further before their use in emissions compliance. Interim trades may or may not be officially recorded, but the last ownership change before compliance use should be recorded.

At the end of the agreed compliance period, buyer/owner of the allowance makes tender of allowances for its actual emissions. If the direct owner of the traded allowance is a Party, the allowance from trade may be submitted directly to the FCCC as part of international compliance. If the owner is a firm, it makes a compliance tender to its national government (a Party). The Party then can use that same allowance that it collected in its national compliance process in tender to the FCCC as part of the international compliance process.

As one of the enabling rules for trading, the international compliance process must explicitly state that all valid allowances are equal when tendered for compliance, regardless of their national origin.



pollution emissions by 90 percent. These technological advances have been made possible through the efforts of the Partnership for a New Generation of Vehicles between the Administration and the U.S. auto companies and their suppliers.

Such progress may be replicated in other sectors. VCRs and TVs, even when off, consume about \$1 billion worth of electricity annually. EPA has established a partnership with major manufacturers that has a goal of achieving a 70% reduction in energy use, without sacrificing product quality, usefulness, or increasing costs. This partnership offers promise of substantial improvements in energy efficiency.

#### *Non-Climate Benefits*

A final factor that should be included in any comprehensive assessment of the economic implications of the Kyoto protocol are the benefits of the agreement. The literature has emphasized that any relative price shifts that prove necessary to reduce emissions should produce non-climate benefits in three areas: air pollution unrelated to climate change, traffic congestion, and highway accidents. These benefits are hard to quantify precisely but are potentially significant; our rough estimates suggest that these three benefits could offset 15-25% of any resource cost of the climate change policy. *Suggest deleting unless it*

#### *Synthesis*

*can be verified by specific modeling results as described in other parts of*

A comprehensive evaluation of the economic impact of the Kyoto Protocol must integrate all of the factors described above: reliance on flexible market-based mechanisms domestically; international trading and Joint Implementation among Annex I countries; the Clean Development Mechanism; meaningful developing country participation; the potential cost-mitigating role of including six gases and carbon sinks; the benefits of electricity restructuring; and emissions reductions achieved as a consequence of other proposed Administration climate change initiatives. Assuming that effective mechanisms for international trading, Joint Implementation and the Clean Development Mechanism are established, and assuming also that the U.S. achieves meaningful developing country participation, our overall assessment is that the economic cost to the United States in aggregate and to typical households of attaining the targets and timetables specified in the Kyoto Protocol, will be modest.

This conclusion that the impact will be modest is not entirely dependent upon, but is fully consistent with, formal model results. I have previously emphasized the limitations of relying on any single model in assessing the economic impact of the Kyoto Protocol, and continue to view any such results as just one input into an overall analysis. But it is worth emphasizing that model results reflecting the details of the Kyoto Protocol are consistent with our conclusion. For

*keep*

*The Testimony*



EXECUTIVE OFFICE OF THE PRESIDENT  
OFFICE OF MANAGEMENT AND BUDGET  
WASHINGTON D.C. 20503

TRANSMISSION NUMBER: 202/395-5836  
VERIFICATION NUMBER: 202/395-6827

ENVIRONMENT BRANCH  
ROOM 8026  
NEW EXECUTIVE OFFICE BLDG.

Name

Fax # 56870

To: Joe Aldy  
\_\_\_\_\_  
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From: Bob Tuccillo  
\_\_\_\_\_

Message: Comments on testimony  
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Number of Pages to Follow: 18

Date: 3/2/98

Time: 5:40 pm

LRM ID: EHF395  
Climate Treaty

SUBJECT: Council of Economic Advisers Oversight Testimony on Kyoto

**RESPONSE TO  
LEGISLATIVE REFERRAL  
MEMORANDUM**

If your response to this request for views is short (e.g., concur/no comment), we prefer that you respond by e-mail or by faxing us this response sheet. If the response is short and you prefer to call, please call the branch-wide line shown below (NOT the analyst's line) to leave a message with a legislative assistant.

You may also respond by:

- (1) calling the analyst/attorney's direct line (you will be connected to voice mail if the analyst does not answer); or
- (2) sending us a memo or letter

Please include the LRM number shown above, and the subject shown below.

TO: Robert J. Tuccillo Phone: 395-5809 Fax: 395-5838  
Office of Management and Budget  
Branch-Wide Line (to reach legislative assistant): 395-4586

FROM: 3/2/98 (Date)  
REYNOLD MENI (Name)  
EPA (Agency)  
260-5428 (Telephone)

The following is the response of our agency to your request for views on the above-captioned subject:

- Concur
- No Objection
- No Comment
- See proposed edits on pages \_\_\_\_\_
- Other: see attached

FAX RETURN of \_\_\_\_\_ pages, attached to this response sheet

EPA comments on Janet Yellen's draft testimony  
March 2, 1998

The testimony is generally excellent. Here are several specific comments and proposed changes. Most have these have been reviewed already with Randy Lutter, who found them acceptable. (We were interrupted in discussing the last point, and need to talk again about that one.)

P.15: In the paragraph on restructuring, change the fourth sentence to read: "In addition, stronger incentives for improved generation efficiency, in conjunction with provisions to conserve energy and promote use and development of renewable energy sources appropriate market based provisions, will could achieve modest reductions in emissions."

ok  
• The change from "will" to "could" is needed to reflect the uncertainty regarding the emissions consequences of retail legislation -- NEC and CEQ project a small (1-3%) decline (relative to approximately 40% baseline growth 1990-2010), and also acknowledge substantial uncertainty and that actual emissions could increase.

• The phrase "appropriate market based provisions" was used in the October 22 fact sheet on restructuring to accompany the President's climate speech in order to bridge the gap between the DOE and EPA views on whether the renewables portfolio, etc. was sufficient to address emissions, or whether market based emissions provisions are needed as well.

sh  
P. 17: In the first paragraph on sinks, change the second to last sentence to read: "Very preliminary estimates ... indicate that carbon sinks could comprise up to nearly 10% ..." We have not reached a definitive policy decision on interpretation of the Protocol's sinks language and are not yet in a position to imply a "nearly 10%" bonus from sinks. The addition qualifies the point.

sh  
P.18: There is a typo in the first full para: "25 percentage points" should read "0.25 percentage points," or "one quarter of one percent". More important, the current formulation does not track the interagency agreement reached last week on language going something like this:

"For example, results based on SGM and other model simulations with different assumed rates of AEEI suggest that permit prices could be reduced by as much as 40 percent for each quarter percent by which the AEEI can be successfully increased."

may  
In addition, we suggest switching the order of the first and second full paragraphs on that page, and moving the first sentence of the last paragraph forward, as follows:

no  
"Our justification for incorporating ... In this instance, we prudently and have made conservatively assumptions as to the rate of new that there will be substantial delays between investments ...

"There are reasons, however, for faith in the ability of American ingenuity to offer solutions to the challenge of climate change. The President's FY 1999 budget ... For example, published results based on SGM model simulations with different assumed rates of AEEI suggest that an increase in the AEEI of 25 percentage points could lead to

~~declines in the permit price of approximately 40 percent. For example, results based on SGM and other model simulations with different assumed rates of AEEI suggest that permit prices could be reduced by as much as 40 percent for each quarter percent by which the AEEI can be successfully increased.~~

~~"There are many other reasons for faith in the ability of American ingenuity to offer solutions to the challenge of climate change. Moreover, at the recent automobile show ...~~

P.19: In the first full para:

*no*  
"Such progress ~~may be~~ is being replicated in other sectors. To give but one recent example, VCRs and TVs ..."

*oh*  
P.20: Last para: Please try to find another term besides "fraught with uncertainty." "Fraught" is generally a perjorative. How about: "As highlighted earlier, there are substantial, but unavoidable uncertainties surrounding estimates like these."

You may want to include here some words emphasizing once again that there really is no responsible alternative to acting under uncertainty, given the long-term nature of this problem, and the fact that greater certainty cannot be had in time to be useful.

To discuss these comments, please call David Doniger, 280-2865.

FEB-27-1998 16:15 TO:61 - JUSTICE

FROM:FITTER, R.

P. 2/74

LRM ID: EHF385  
Climate Treaty

SUBJECT: Council of Economic Advisors Oversight Testimony on Kyoto

**RESPONSE TO  
LEGISLATIVE REFERRAL  
MEMORANDUM**

If your response to this request for views is short (e.g., concur/no comment), we prefer that you respond by e-mail or by faxing us this response sheet. If the response is short and you prefer to call, please call the branch-wide line shown below (NOT the analyst's line) to leave a message with a legislative assistant.

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(1) calling the analyst/attorney's direct line (you will be connected to voice mail if the analyst does not answer); or

(2) sending us a memo or letter

Please include the LRM number shown above, and the subject shown below.

TO: Robert J. Tunello Phone: 395-5800 Fax: 395-5830  
Office of Management and Budget  
Branch-Wide Line (to reach legislative assistant): 395-4506

**URGENT**

FROM: 3/2/98 (Date)  
Velma Taylor (Name)  
DJS (Agency)  
514-7279 (Telephone)

The following is the response of our agency to your request for views on the above-captioned subject:

Concur

No Objection

No Comment

See proposed edits on pages 7 and 9.

Other: \_\_\_\_\_

FAX RETURN of \_\_\_\_\_ pages, attached to this response sheet

FEB-27-1998 16:15 TO:61 - JUSTICE

FROM: FITTER, E.

P. 9/24

Page 7

energy prices, which we will shortly address. In general it is difficult to undergo a structural change in the economy without having the effect of expanding some sectors and contracting others. But to provide some perspective on this issue, consider the following facts. First, on average, energy constitutes only 2.2 percent of total costs to U.S. industry. Second, energy prices already vary significantly across countries. According to the 1997 Statistical Abstract, for example, in 1996 premium gasoline cost \$1.28 per gallon in the United States -- but only 8 cents per gallon in Venezuela. Similarly, gas prices were \$3.71 per gallon in Switzerland and \$4.41 per gallon in France. Electricity prices also vary significantly: in the U.S. they were 5 cents per kilowatt hour, a fraction of prices in Switzerland of 13 cents per kilowatt hour. Yet U.S. industry is not moving en masse to Venezuela, nor is Swiss industry moving to the United States. Third, roughly two-thirds of all emissions are not in manufacturing at all, but in transportation and buildings. We therefore believe we need developing country participation because the problem is global and cost-effective solutions are essential, than to avoid adverse effects on competitiveness.

*oh*  
Flexibility and Market Mechanisms

*industries which by their nature would not locate to other countries.*

A global solution is thus critical to the global problem of climate change. Globalizing the solution is not, however, enough by itself. We must also ensure that our efforts to reduce global greenhouse gas emissions reductions in the most efficient manner possible. The nature of the climate change problem suggests three basic methods to lower costs of achieving given levels of environmental protection. They can be characterized in terms of three categories of flexibility: (1) "when" flexibility; (2) "what" flexibility; and (3) "where" flexibility, which may be the most important of all. Such methods have long been championed by economists interested in increasing the efficiency of protection. Indeed, 2,600 economists from academia, industry, and government alike urged such approaches in a letter they signed last year advocating action on climate change:

"Economic studies have found that there are many potential policies to reduce greenhouse gas emissions for which the total benefits outweigh the total costs...The most efficient approach to slowing climate change is through market-based policies."

#### 1. "When flexibility" (timing)

First is "when flexibility" or timing. Since climate change is a long-term problem, the exact timing of emissions reductions is, within some range, not of primary importance. Thus the freedom to delay or accelerate reductions within an agreed upon time frame -- while ensuring credibility of emissions reductions -- lowers costs.

As a result of U.S. leadership, the Kyoto Protocol incorporates this



LRM ID: EHF385  
Climate Treaty

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Please include the LRM number shown above, and the subject shown below.

TO: Robert J. Tuccillo Phone: 395-5809 Fax: 395-5838  
Office of Management and Budget  
Branch-Wide Line (to reach legislative assistant): 385-4586

FROM: 3/2/98 (Date)  
Vanessa Harrison (Name)  
State (Agency)  
647-4463 (Telephone)

The following is the response of our agency to your request for views on the above-captioned subject:

- Concur
- No Objection
- No Comment
- See proposed edits on pages \_\_\_\_\_
- Other: \_\_\_\_\_

FAX RETURN of 3 pages, attached to this response sheet



## United States Department of State

*Bureau of Oceans and International  
Environmental and Scientific Affairs*

Washington, D.C. 20520

March 2, 1998

TO:

FROM:

SUBJECT: LRM EHF 385 -- Comments on Draft CEA Climate testimony

Overall, the draft testimony provides a useful summary of our economic understanding of the costs of the climate agreement. It also appropriately provides caveats on what we do and do not know. However, the testimony as drafted overemphasizes the issue of developing countries and the umbrella -- and in neither case fully reflects current policy on these items. While additional comments are provided to correct errors in the draft, these two items are of the greatest importance and must be fixed prior to submitting the testimony. Thus, comments on pages 16, 17, 19 and 20 are critical.

### Specific Comments

NO. Page 2. Top paragraph: It is not just "commerce" that will be affected, but also quality of life, and in some cases life itself -- e.g., deaths from spread of disease, and from damage to human infrastructure are not only commercial issues. In addition, the end of the paragraph suggests that the only issue is lack of incentives for unilateral action -- while omitting the fact that unilateral action is inadequate for solving the problem. Propose a rewrite to the last sentence to read: "The fundamental logic of the Kyoto Protocol is that without such an international agreement, we cannot solve the global problem: individual nations cannot individually reduce emissions sufficiently to constrain global concentrations, and absent a global accord, will not have the incentives to address this threat."

modified Page 2. Climatic impact. Should add a short sentence after the second sentence to read: "Few modellers expect that we will be able to constrain global concentrations to only twice pre-industrial levels -- and therefore, increases in both temperature and sea level are likely to exceed amounts suggested here." wray

ok Page 3. Economic and Monetary damages; second paragraph. Need a cite/affiliation for Cline

ok Page 4, first full paragraph, last sentence. The possibility of non-linear events is not know; to say they are small presumes knowledge. Delete words: "small and unknown" from sentence.

NO Page 5. Need for Global Action, first paragraph. Second sentence, add words "can or" before "has an incentive..." Also, at the beginning of the fourth sentence, insert new text to read: "Few other countries are likely to act unless the US acts, and conversely, even if ..."

*no*  
 Page 5, third paragraph of section. Rewrite first sentence to read: "Both to address the lack of progress among many industrialized countries toward meeting the Rio objective and to set a post-2000 goal for action to mitigate climate change (neither of which were included in the original Convention text), the United States and 160 other nations agreed in negotiations held in Kyoto, Japan last December to take additional steps to reduce emissions of greenhouse gases."  
*oh* In addition, it would be appropriate to either spell out all gases, or provide formulas for all gases; current text mixes both.

Page 6, 2nd full paragraph. Add text to end of second sentence to read: "... under a continuation of business as usual -- although even then, developing country per capita emissions will remain only about one quarter of our own." *reject*

Page 7, Flexibility and Market Mechanisms. Add a new second sentence to first paragraph of this section: "Here too, we must take the lead -- both as the world's largest emitter, and as a key player in and developer of the concept of greenhouse gas emissions markets." *reject*

*oh* Page 8, first bullet: delete phrase: "such as those from prematurely scrapping coal fired electricity plants" -- we do not want to send the signal that we intend to permanently exempt these plants from any obligation. *reject*

Page 8, propose a fifth bullet: "Fifth, joint implementation credits are not time limited by the agreement -- Parties may arrange for project credits and banking as soon as the agreement enters into force." *reject*

*oh* Page 8, 2. What flexibility. Referring to carbon dioxide as a pollutant is inappropriate. Strike this word in the third sentence and replace with "...one gas can be used..."

*oh* Page 9, Where flexibility. First bullet. Rewrite first sentence to read: "First, it provides the opportunity for countries that take on binding targets to trade rights to emit greenhouse gases with each other." Add new final sentence to end of bullet: "While currently only developed countries have emissions caps, this mechanism also offers an incentive for developing countries to take on emissions targets."

*oh* Page 9, second bullet. Delete word: "industrial" in second sentence.

*no* Page 10, top two paragraphs are repetitive. Also, in second paragraph, may wish to note the initial fine imposed by EPA was over \$1000/ton not the \$250 stated.

*no* Page 12, Assessing the Kyoto Protocol, first para of section. Rewrite last two sentences to read: "...in an efficient manner and we are successful in securing an effective international trading regime and an operable clean development mechanism in future negotiations. This small net premium, even...."

*no* Page 15, Estimate costs section, top paragraph. Delete first half of second sentence, begin sentence with "Costs could be reduced substantially...." It is unnecessary to highlight developing countries so much. Also, in this section, it is unclear why so much is underlined -- underlines should be deleted.

no Page 16. Delete entire section on umbrella - we do not have a policy on this issue yet, and this prematurely exposes us to obtaining a specific set of commitments - which may never happen. J

no Page 16, Estimate reduction in costs section. Second paragraph of section Rewrite first sentence to read: "...that will likely accrue from the limited role to which developing countries have already agreed:.....". Also, rewrite second sentence to read: "The CDM might shave costs by roughly another 20 to 25 percent from the reduce costs that result from trading among Annex I countries. Additional developing country action could be expected to yield additional cost reductions." ? no

no Page 16, last paragraph on page. Strike this entire paragraph including that on top of page 17. It implies a specific obligation to which we expect developing countries to agree - and we have not set this policy yet. J

Page 17. First full para. Rewrite second sentence to end as follows: "... emissions trading, and ultimately, meaningful participation by key developing countries." Delete remainder of paragraph. J

Page 17, Accounting for Carbon sinks. Rewrite second to sixth sentences as follows: "...role of carbon sinks in which carbon absorbing activities can be used to offset emissions. The Kyoto protocol specifies that removals of CO2 by sinks count toward meeting the target, and counts the net emissions effects..." no

Page 19, Synthesis. Second sentence, delete words: "an assuming also that the US achieves meaningful developing country participation," - the costs savings are not only predicated on this - and it assumes a very specific level of commitment from developing countries that may not be achievable.

Page 20. Last paragraph on page. Delete clause in second sentence: "the developing country participation that we are insisting upon as a condition for our ratifying the Kyoto protocol but which is not yet part of the protocol and on" -- it prejudices the outcome of internal deliberations on developing countries. J

Drafted: OES/EGC - Jonathan Pershing  
3/1/98

Cleared: OES/E - RPomerance (subs)

LRM ID: EHF385  
Climate Treaty

SUBJECT: Council of Economic Advisors Oversight Testimony on Kyoto

**RESPONSE TO  
LEGISLATIVE REFERRAL  
MEMORANDUM**

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- (2) sending us a memo or letter

Please include the LRM number shown above, and the subject shown below.

**TO:** Robert J. Tuccillo Phone: 306-6008 Fax: 306-5898  
Office of Management and Budget  
Branch-Wide Line (to reach legislative assistant): 306-4580

**FROM:** 3/2/98 (Date)  
Tom Pulliam (Name)  
DOE (Agency)  
586-3397 (Telephone)

The following is the response of our agency to your request for views on the above-captioned subject:

- Concur
- No Objection
- No Comment
- See proposed edits on pages 3, 10, 11, 12, 14, 16, 19
- Other: \_\_\_\_\_
- FAX RETURN of \_\_\_\_\_ pages, attached to this response sheet

growing conditions from changing weather patterns, threats to human health from increased range and incidence of diseases, changes in availability of freshwater supplies, and damage to ecosystems and biodiversity.

### *Economic and Monetary Damages*

The derivation of quantitative or monetary estimates of the damages from such a change in the climate is extremely difficult given the capacity of today's models. Estimates of the economic damages from climate change fall into the following broad areas: agriculture, sea-level rise, air conditioning and heating, water supply, human life and health, air pollution, and other costs (hurricanes, relocation costs, human amenity, construction, leisure activities, urban infrastructure, and ecological damages such as forest loss and species loss). Although the quantification of these effects is quite demanding, researchers have developed estimates that prompt substantial concern. The IPCC reports that a doubling of carbon dioxide levels would lead to about 6,000 to 10,000 additional deaths per year from higher summer temperatures, even after netting out the effects of warmer winters and assuming acclimatization. Other researchers have predicted sea level increases of about 20 inches by 2100, with substantially greater increases in subsequent years.

Despite the difficulties, respected researchers have developed estimates of the monetary damages expected from an average worldwide temperature increase. For example, Cline estimated that a temperature change of 4.5 degrees Fahrenheit would impose annual damages of more than \$70 billion per year on the U.S. economy in today's terms. These damages include \$22 billion in lost agricultural production, \$13 billion in additional electricity costs, and \$8 billion in new costs to maintain the existing supply of fresh water. (Cline's original estimates are quoted in 1990 dollars. The figures given above translated those numbers into 1997 dollars using the annual GDP price index.) William Nordhaus of Yale University has likewise computed estimates of the dollar loss attributable to a doubling of greenhouse gas concentrations. Although he uses methods that differ from Cline's in several respects, he finds that the Cline estimate is in the center of three estimates for the U.S., and that the high estimate is only 30 percent greater than the low estimate. It must be noted, however, that the similarity among aggregate estimates masks the true uncertainty associated with forecasts of the damages from given increases in global warming — the estimates are all fundamentally based on extrapolations from current and past experience, and may not fully incorporate effects that will unfortunately become apparent only with future experience.

One key difficulty in interpreting and monetizing these estimates of damages is uncertainty over the extent that they should be discounted because they occur in the distant future. Since the benefits of stemming future climate

NO New scientific information noted in various scientific journals in 1997 indicates that temperature increases from a doubling of CO<sub>2</sub> may be below the low end of the 1995 IPCC range, e.g. below 1.5 degrees C. If this is so, the health effects and the economic impacts are likely to be overstated.

Details of how these provisions will operate will be discussed in future negotiations such as the one in Buenos Aires later this year. Nonetheless, effective international trading of emission credits, joint implementation, and the Clean Development Mechanism can lead to substantial reductions in costs relative to alternative policies that do not exploit the power of market incentives. To illustrate briefly the ability of U.S. industry to perform beyond expectations when given appropriate economic incentives, consider further EPA's highly acclaimed sulfur dioxide (SO<sub>2</sub>) program, which relies, among other things, on a system of tradeable permits to reduce emissions of SO<sub>2</sub> from electric utilities. The SO<sub>2</sub> program has been successful in several ways: a large number of utilities participate, SO<sub>2</sub> emissions and ambient concentrations have fallen and the costs of reducing emissions are considerably lower than originally forecast.

As has been frequently noted, the average cost of SO<sub>2</sub> emissions reductions has recently been significantly lower than was originally forecast, in part due to the role of incentives in fostering innovation. Emission permit prices, currently at approximately \$100 per ton of SO<sub>2</sub>, are well below earlier estimates of around \$250 to \$350 per ton.

Trading programs may not always bring cost savings as large as those achieved by the SO<sub>2</sub> program; trading programs will not always be accompanied by the discovery of much cheaper control strategies. However, the SO<sub>2</sub> experience demonstrates clearly how programs like international permit trading, joint implementation, and the Clean Development Mechanism will lead firms to find cheaper ways of reducing emissions that can lead to unexpectedly low costs.

#### IV. Difficulties of Economic Analysis of the Kyoto Protocol

Now that we have a Protocol -- even if it is not yet fully complete nor ready for the President's submission to the Senate -- it is possible to examine it in somewhat more detail from an economic perspective. But, once again the inherent limitations of any such estimates deserve emphasis. Such limitations should not be surprising to you: economists have a difficult enough time projecting the behavior of the economy over the next quarter or year, let alone over the next two decades. The scale of the forecasting exercise is therefore daunting, and any specific results should be treated with substantial caution.

The difficulties associated with economic analysis of climate change fall into three broad categories. First are the uncertainties that still remain over the terms of the ultimate treaty, necessitating assumptions on which the analysis is predicated. Second are the inherent limitations of available models to analyze even short-term costs and benefits. And finally is a topic discussed earlier: the impossibility of putting a single monetary number on the long-term benefits of climate change mitigation, although there will clearly be economic benefits of

It also should be noted that a worldwide program of greenhouse gas emissions trading is substantially more complex than the trading of one pollutant in one country. Furthermore, monitoring and verification are important elements to be addressed before successful adoption of this program.

emission reductions.

### *Uncertainties in the International Effort to Combat Climate Change*

The Kyoto Protocol was an historic accomplishment, delineating the broad terms of the international effort to address climate change. But although we know a lot more than we did before Kyoto about how that international system will work, and that informs our analysis, there is still much that we do not know.

First, some provisions raise complex implementation issues. At issue here is the treatment of so-called sinks -- activities that affect the rate at which carbon is removed from the atmosphere and "sequestered," e.g., by the planting of trees.

*clear development mechanisms*  
Second, the details of a number of items -- primarily concerning international trading and developing countries -- are the subject of further discussions including future negotiations in Buenos Aires next fall, because they had not been definitively settled by the end of the last all-night session of the Kyoto talks.

Finally, and most importantly, we have not yet negotiated international agreements to limit emissions beyond the 2012 window. The emission cuts agreed upon at Kyoto are only a first step on a long journey. The first step that we propose to take over the next 15 years is critical. But the reason it is critical is *not* that, by itself, it will solve the climate change problem -- emissions during any given decade are small compared to the cumulative concentrations in the atmosphere. Rather, the first step is critical because we can not take the second and third steps until we have taken the first. At the same time, any analysis is complicated by the lack of knowledge over what the subsequent steps will be.

### *Inherent Limitations of Models*

In addition to these uncertainties about the details of the international effort to address climate change, are the inherent limitations of the models used to evaluate that effort. Even within a given model, answers depend critically on the precise nature of the question asked. For example, the costs of emissions reductions depend critically on the extent of global participation and international trading that a treaty is assumed to feature. But in addition to the dependence of the results from a given model on the precise assumptions, different models can give different answers even when all the assumptions are specified to be the same -- a concrete illustration of the range of uncertainty to which we must assign the predictions of any one individual model.

One area in which the uncertainty is particularly large is the pace of technological progress -- especially the diffusion of existing energy-efficient

technologies, but also the development of new technologies -- and the extent to which the pace will accelerate in response to government programs. Models and experts on climate change policy tend to have a wider range of disagreement on the scope for speeding the diffusion of existing energy-efficient technologies than on any other single issue.

Furthermore, each model has strengths and weaknesses; each has questions to which it is better or worse suited to answer. Some, for example, model the energy sector in detail. Some allow for the fact that a coal-fired power plant cannot costlessly be converted to one that runs on natural gas. Some show the effects of hypothetical tax cuts made possible by the new revenues earned through the auction of emissions permits. Some are capable of showing recessions and booms. Others include a long-term "carbon cycle" model that can keep track of the accumulation of greenhouse gas concentrations in the atmosphere and their climatological effects. Some break down the rest of the world into regions and so can model international trade. No one model does everything, and therefore we must not rely blindly on the results of any one model or set of models. Professional judgement and economic intuition, along with diplomatic assessments, are also crucial.

#### *Benefits of Averting Climate Change*

As discussed above, it is evident that the benefits of averting climate change are potentially immense. But we have chosen not to try to quantify them in monetary terms, in light of the difficulties we have enumerated. These include the uncertainty of these benefits, their timing and therefore the extreme sensitivity of the results to the chosen discount rate, and the dependence of benefits on emissions paths after the 2008 to 2012 budget period specified in Kyoto.

#### **V. Assessing the Kyoto Protocol**

In order to evaluate the likely net economic impact of the Kyoto Protocol, *excluding the benefits of mitigating climate change itself*, we have drawn upon a variety of tools to assess the various possible costs and non-climate benefits of the Administration's emissions reduction policy. To give away the punch line, our conclusion is as follows: the net costs of our policies to reduce emissions are likely to be small, assuming those reductions are undertaken in an efficient manner and we are successful in securing meaningful developing country participation as well as effective international trading and clean development mechanisms in future negotiations. That potential small net premium, even excluding the benefits of mitigating climate change, in effect, purchases a partial insurance policy against a serious environmental threat.

Because the results from any model must be treated with caution, the

*assumptions that will require much effort to realize.*

no

I said in Congressional testimony last July that we can do this smart or we can do this dumb. I was referring to the point that the costs of cutting emissions can be much reduced if flexible, market-based mechanisms are used. Our economic analysis highlighted the importance of such flexible, market-based mechanisms -- which are therefore reflected, at the President's insistence, in the Kyoto Protocol and our ongoing diplomatic strategy.

*John*  
*clean development mechanisms*

Within the Kyoto Protocol, this means an insistence on international trading, joint implementation, and, ultimately, on meaningful developing country participation. Domestically, this means that we implement any emissions reductions through a market-based system of *tradeable* emissions permits, which ensures that we achieve reductions wherever they are least expensive. But this also means taking serious and responsible steps in the short run to prepare us to meet our obligations in the longer term.

The first such step is the inclusion in this year's budget of an aggressive, \$5.3 billion program of tax cuts and R&D investments -- \$1.3 billion more than the \$5 billion package the President promised in his October 22 speech on this issue. The goal is both to stimulate the development of new energy-saving and carbon-saving technologies and to encourage the dissemination of those that exist already. The proposed package contains \$3.6 billion over the next 5 years in tax cuts for energy efficient purchases and renewable energy, including tax credits of \$3,000 to \$4,000 for consumers who purchase highly fuel efficient vehicles, a 15 percent credit (up to \$2,000) for purchases of rooftop solar equipment, a 20 percent credit (subject to a cap) for purchasing energy-efficient building equipment, a credit up to \$2,000 for purchasing energy-efficient new homes, an extension of the wind and biomass tax credit, and a 10 percent investment credit for the purchase of combined heat and power systems. The package also contains \$2.7 billion over the next 5 years in additional research and development investments -- covering the four major carbon-emitting sectors of the economy (buildings, industry, transportation, and electricity), plus carbon removal and sequestration, Federal facilities, and cross-cutting analyses and research. One example of the R&D effort is the Partnership for a New Generation of Vehicles (PNGV). PNGV is a government-industry effort to develop attractive, affordable cars that meet all applicable safety and environmental standards and get up to three times the fuel efficiency of today's cars. In FY99, the combined proposal for PNGV is \$277 million, up from \$227 million appropriated in FY98. Similar government-industry efforts are proposed to develop more efficient diesel engines for both light trucks and heavy trucks.

A second responsible step entails industry-by-industry consultations to prepare emission reduction plans in key industrial sectors. The Administration will work in partnership with industry to identify ways in which the Federal government

*Estimated reduction in costs from umbrella trading*

One possibility that emerged in Kyoto, which none of us foresaw, was the idea developed there by the U.S. delegation, that the United States might undertake trading with a subset of Annex I countries, dubbed the "umbrella". Countries that have expressed interest in the umbrella include the United States, Australia, Canada, Japan, New Zealand and Russia, with strong indications of interest from some others. This subset of Annex I countries shares a common interest in promoting market-based mechanisms, most specifically, fully flexible rules for international trading of emissions permits.

It is too early to state the precise form the umbrella will take. But we can envision a number of potential benefits. The umbrella could, for example greatly reduce costs to the U.S. Results that we have derived from various BGM simulations of efficient international trading suggest that, relative to the situation in which there is no trading at all, the umbrella can reduce costs by an estimated 60-75 percent, depending on whether the former Warsaw Pact countries fall within the umbrella. The Kyoto Protocol classifies these countries outside of the EU bubble for the first budget period 2008-2012.

*Estimated reduction in costs from developing country participation*

The next consideration is participation by developing countries. The President has said that he will not submit the treaty for ratification without meaningful participation by key developing countries. Such participation would further reduce the costs involved.

The substantial potential gains from meaningful developing country participation are highlighted by the significant benefits that will likely accrue even from the limited role that the developing countries have already agreed to: the Clean Development Mechanism (CDM), ~~modeled after the U.S. joint implementation concept.~~ The CDM cannot realistically be expected to yield all the gains of binding targets for developing countries, but it might shave costs by roughly another 20 to 25 percent from the reduced costs that result from trading among Annex I countries. leaf  
no

~~Another possibility is that we persuade some of the key developing countries that are the largest emitters to commit to targets, and allow us to buy emission reductions from these paths.~~ Simulations with the BGM model suggest that full participation by non Annex I countries could cut roughly 55 percent off the reduced costs that result from Annex I trading. The actual cost reduction would depend on the extent of developing country participation that is ultimately obtained, as well as the effectiveness of international trading arrangements. The more developing countries that take on modest binding targets and trade in international Keep  
no

pollution emissions by 90 percent. These technological advances have been made possible through the efforts of the Partnership for a New Generation of Vehicles between the Administration and the U.S. auto companies and their suppliers.

Such progress may be replicated in other sectors. VCRs and TVs, even when off, consume about \$1 billion worth of electricity annually. EPA has established a partnership with major manufacturers that has a goal of achieving a 70% reduction in energy use, without sacrificing product quality, usefulness, or increasing costs. This partnership offers promise of substantial improvements in energy efficiency.

### *Non-Climate Benefits*

A final factor that should be included in any comprehensive assessment of the economic implications of the Kyoto protocol are the benefits of the agreement. The literature has emphasized that any relative price shifts that prove necessary to reduce emissions should produce non-climate benefits in three areas: air pollution unrelated to climate change, traffic congestion, and highway accidents. These benefits are hard to quantify precisely but are potentially significant; our rough estimates suggest that these three benefits could offset 15-25% of any resources cost of the climate change policy. *Suggest deleting unless it*

### *Synthesis*

A comprehensive evaluation of the economic impact of the Kyoto Protocol must integrate all of the factors described above: reliance on flexible market-based mechanisms domestically; international trading and Joint Implementation among Annex I countries; the Clean Development Mechanism; meaningful developing country participation; the potential cost-mitigating role of including six gases and carbon sinks; the benefits of electricity restructuring; and emissions reductions achieved as a consequence of other proposed Administration climate change initiatives. Assuming that effective mechanisms for international trading, Joint Implementation and the Clean Development Mechanism are established, and assuming also that the U.S. achieves meaningful developing country participation, our overall assessment is that the economic cost to the United States in aggregate and to typical households of attaining the targets and timetables specified in the Kyoto Protocol, will be modest.

This conclusion that the impact will be modest is not entirely dependent upon, but is fully consistent with, formal model results. I have previously emphasized the limitations of relying on any single model in assessing the economic impact of the Kyoto Protocol, and continue to view any such results as just one input into an overall analysis. But it is worth emphasizing that model results reflecting the details of the Kyoto Protocol are consistent with our conclusion. For

*keep*

*can be verified by specific modeling results as described in other parts of*

*The Testimony*