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Energy Market and Economic Impacts of the Carbon Limits and Energy for America's Renewal (CLEAR) Act and an Electric-Power Only Cap-and-Trade Program

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Office of Integrated Analysis and Forecasting
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Independent Statistics and Analysis

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In should be emphasized that the projections in this report are not statements of what *will* happen but of what *might* happen, given the assumptions and methodologies used. The Reference case in this report is a business-as-usual trend estimate, reflecting known technology and technological and demographic trends, and current laws and regulations. Thus, it provides a policy-neutral starting point that can be used to analyze policy initiatives. EIA does not propose, advocate, or speculate on future legislative and regulatory changes.

The Office of Integrated Analysis and Forecasting prepared this report. General questions concerning the report can be directed to John J. Conti (john.conti@eia.gov, 202/586-2222), Director of the Office of Integrated Analysis and Forecasting; J. Alan Beamon (joseph.beamon@eia.gov, 202/586-2025), Director of its Coal and Electric Power Division; Michael Schaal (michael.schaal@eia.gov, 202/586-5590), Director of its Oil and Gas Division; Paul Holtberg (paul.holtberg@eia.gov, 202/586-1284), Director of its Demand and Integration Division; and Andy S. Kydes (akydes@eia.gov, 202/586-0883), Senior Technical Advisor to the Office Director. Specific questions about the report can be directed to the following analysts:

Greenhouse Gas Analysis	Dan Skelly (daniel.skelly@eia.gov, 202/586-1722)
Macroeconomic Analysis	Kay Smith (kay.smith@eia.gov, 202/586-1132)
	Russ Tarver (russell.tarver@eia.gov, 202/586-3991)
Buildings	Erin Boedecker (erin.boedecker@eia.gov, 202/586-4791)
	Owen Comstock (owen.comstock@eia.gov, 202/586-4752)
Industrial	Elizabeth Sendich (elizabeth.sendich@eia.gov, 202/5867145)
Transportation	John Maples (john.maples@eia.gov, 202/586-1757)
	Nicholas Chase (nicholas.chase@eia.gov, 202/586-8851)
Electricity	Laura Martin (laura.martin@eia.gov, 202/586-1494)
	Jeffrey Jones (jeffrey.jones@eia.gov, 202/586-2038)
	Michael Leff (michael.leff@eia.gov, 202/586-1297)
Coal	Diane Kearney (diane.kearney@eia.gov, 202/586-2415)
	Michael Mellish (michael.mellish@eia.gov, 202/586-2136)
Renewables	Chris Namovicz (cnamovicz@eia.gov, 202/586-7120)
	Robert Smith (robert.smith@eia.gov, 202/586-9413)
Liquid Fuels	William Brown (William.brown@eia.gov, 202/586-8181)
Natural Gas	Joe Benneche (jbennech@eia.gov, 202/586-6132)
Enhanced Oil Recovery	Dana Van Wagener (dana.vanwagener@eia.gov, 202/586-4725)

For information and questions on other energy information products available from EIA, please contact EIA's National Energy Information Center at:

National Energy Information Center, EI-30
Energy Information Administration
Forrestal Building
Washington, DC 20585

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FAX: 202/586-0727
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Request Summary

This paper responds to a request from Senators Bingaman, Cantwell, Collins, Murkowski and Voinovich to the U.S. Energy Information Administration (EIA) to provide technical assistance to help inform deliberations on energy and climate legislation, including an evaluation of the Carbon Limits and Energy for America's Renewal (CLEAR) Act and several possible variants of that legislation (some of which had quite extensive components), as well as a separate electric power sector only cap and trade (EPOCT) proposal.[1]

The Senators specifically noted the critical nature and time sensitivity of their request, while also recognizing that EIA resources were already engaged in addressing a prior request for analysis of the May 12, 2010 discussion draft of the American Power Act.[2] Under these circumstances, EIA is unable to provide a single response to the full request that is both timely and complete, and has therefore focused this initial report on modeling results for the CLEAR Act and the EPOCT program, the latter of which had been identified as a high priority and for which specifications were provided by staff from the requesting offices. If still timely, EIA will develop and report additional modeling simulations to expand upon this initial report.

This report considers the energy-related provisions in the CLEAR Act and the specified EPOCT program that can be analyzed using the National Energy Modeling System (NEMS). The starting point for the analysis is a Reference case similar to the *Annual Energy Outlook 2010 (AEO2010)* Reference case issued in December 2009. The slight differences in the Reference case for this report reflect modeling changes required to analyze the legislation, such as emissions coverage definitions and minor structural changes to represent the proposals' incentives and programs.[3] The choice of a baseline is one of the most influential assumptions for any analysis of global climate change legislation. EIA recognizes that projections of energy markets over a 25-year period are highly uncertain and subject to many events that cannot be foreseen, such as supply disruptions, policy changes, and technological breakthroughs. In addition to these phenomena, long-term trends in technology development, demographics, economic growth, and energy resources may evolve along a different path than shown in the projections. Generally, differences between cases, which are the focus of this report, are likely to be more robust than the specific projections for any one case. The published *AEO2010*, which includes numerous cases reflecting a variety of alternative futures for the economy, energy markets, and technology, is a resource that can be used to examine the implications of alternative baselines.

Like other EIA analyses of energy and environmental policy proposals, this report focuses on the impacts of those proposals on energy choices made by consumers and producers in all sectors and the implications of those decisions for the economy. This focus is consistent with EIA's statutory mission and expertise. The study does not account for the health or environmental benefits associated with curtailing greenhouse gas (GHG) emissions.

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[1] See Appendix A for a copy of the request.
[2] The analysis was released on July 16, 2010 and is available at http://www.eia.gov/oiaf/servicerpt/kgl/pdf/sroiaf(2010)01.pdf.
[3] In evaluating impacts of the EPOCT program in the High Natural Gas Resource sensitivity case, an alternative reference case with the same resource assumptions is used.

To facilitate the use of this report by readers who are mainly interested in only one or the other of the two proposals addressed in this report, the policy specification, cases, results, and key findings for the CLEAR Act and EPOCT programs are presented in separate sections. The analysis cases discussed for each of the proposals, while not exhaustive, focus on several key areas of uncertainty that impact the analysis results. Detailed results tables can be found at http://www.eia.gov/oiaf/service_rpts.htm.

Analysis of the CLEAR Act

The CLEAR Act focuses on carbon dioxide (CO_2) emissions from fossil fuels combusted or otherwise released into the atmosphere, which are generally regulated at the point where fuels are introduced into domestic commerce.[4] Regulated entities must cover the CO_2 emissions associated with fossil fuel use by surrendering "shares" that are auctioned by the government. While the CLEAR Act does not allow regulated entities to meet their obligations through the use of domestic or international offsets, it does set a maximum share auction price, or safety valve, and will provide enough shares at this price to meet the needs of regulated entities. The number of shares issued each year starts in 2012 at the 2012 emissions level (estimated by EIA at 5,714 million metric tons carbon dioxide equivalent ($MMTCO_2e$) and declines over time at an accelerating rate[5] reaching 5,421 $MMTCO_2e$ in 2020 (9 percent below 2005 level), 4,048 $MMTCO_2e$ in 2030 (32 percent below the 2005 level), 3,174 $MMTCO_2e$ in 2035 (47 percent below 2005 level), and 1,025 $MMTCO_2e$ by 2050 (83 percent below 2005 level). However, the safety valve price, which rises over time, effectively caps the value of shares, and if triggered, allows the aggregate emissions of regulated entities to exceed the number of emissions shares.

Seventy-five percent of auction revenue goes to the Carbon Refund Trust Fund (CRTF), which is distributed to taxpayers lump sum on a per capita basis as a non-taxable energy security dividend. Twenty-five percent of auction revenue plus safety valve payments and penalty payments, go into the Clean Energy Reinvestment Trust (CERT) fund, which is to be used for designated purposes listed in Section 6(c) of the Act, subject to allocation decisions in the annual appropriations process. In this analysis it is assumed that the CERT Fund revenues are used as specified by the requestors. If these funds are not appropriated in that manner the results would differ, particularly with regard to purchases of offsets, investments in research and development and transition assistance.

While the emissions targets in the CLEAR Act decline through the year 2050, the modeling horizon in this report runs only through 2035, the end of the projection horizon in *AEO2010*. Also, while this analysis is as comprehensive as possible given time constraints, it does not address all the provisions of the CLEAR Act. Provisions that are not represented include the adjustment for voluntary carbon reductions and the two-year compliance period for covered entities, although the latter seems unlikely to alter the results.

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[4] Entities that capture and store CO_2 are provided with share credits so that carbon capture and storage is incentivized even though the CLEAR Act generally applies regulation "upstream" of fuel-using facilities.
[5] Relative to the 2012 level, the number of shares reflects a reduction of 5 percent in 2020, 29 percent in 2030, 44 percent in 2035, and 82 percent in 2050.

CLEAR Act Analysis Cases

Several recent EIA analyses of greenhouse gas mitigation policies have included sensitivity cases related to the cost and availability of low- and no-carbon technologies in the electricity sector and the cost and availability of offsets. Such cases are not as germane to analysis of the CLEAR Act, which does not apply offsets towards compliance and uses a safety valve to place a hard cap on share prices that is not sensitive to the availability of low- and no-carbon technology. Instead, as outlined below, the structure of the CLEAR Act suggests several alternative sensitivity cases that can be used to highlight key implementation uncertainties and the effects of key CLEAR Act provisions that differentiate it from other economy-wide proposals that have recently been modeled by EIA. The CLEAR Act analysis cases in this report are as follows:

- The **CLEAR Basic case** represents a scenario where key low-emissions technologies, including nuclear, fossil with Carbon Capture and Storage (CCS), and various renewables, are developed and deployed on a large scale in a timeframe consistent with the emissions reduction requirements of the CLEAR Act without encountering any major obstacles. Because the safety valve provision is triggered in this case, constraining share prices both before and after 2035, regulated entities do not bank allowances for use beyond 2035. Based on input from staff in the requesting offices, the Basic case allocates available CERT funds among the designated uses as follows:
    - 15 percent for GHG mitigation split equally between: (1) domestic offsets excluding agriculture and forestry biosequestration; (2) domestic agricultural and forestry offsets; and (3) international offsets.
    - 25 percent for clean energy research, development, and deployment.
    - 50 percent for transition assistance, of which 60 percent is directed towards energy-intensive trade exposed industries, 20 percent to support buildings efficiency retrofits, 10 percent for early retirement of GHG intensive technologies, and 10 percent for the Weatherization Assistance programs.
    - 10 percent for State block grants for energy efficiency and conservation.

- The **CLEAR No Safety case** is similar to the Basic case but removes the safety valve provision. Without a safety valve, the number of emissions shares available by any given date places an upper level ceiling on the cumulative domestic CO_2 emissions associated with the use of fossil fuels by regulated entities. This case responds to the requestors' interest in understanding at what level the safety valve might have to be set to ensure full compliance with the emissions reduction goals. Without a safety valve, covered entities and investors, who anticipate increasingly stringent caps and rising allowance prices after 2035, are assumed to amass an aggregate allowance bank of approximately 10 billion metric tons (BMT) by 2035 through emission reductions that exceed the level required under the emission caps. This is the same banking level as assumed in EIA's analysis of the American Power Act.

- The **CLEAR Offsets OK case** is similar to the Basic case, except that it allows regulated entities to apply up to 2 BMT per year of domestic and international offsets towards their compliance obligation. This case explores the sensitivity of the analysis results to a relaxation of the prohibition on offset use in the CLEAR Act. For convenience, assumptions

regarding the availability of domestic and international offsets in this case are assumed to be identical to those applied in EIA's recent analysis of the American Power Act and entities bank 10 BMT by 2035.

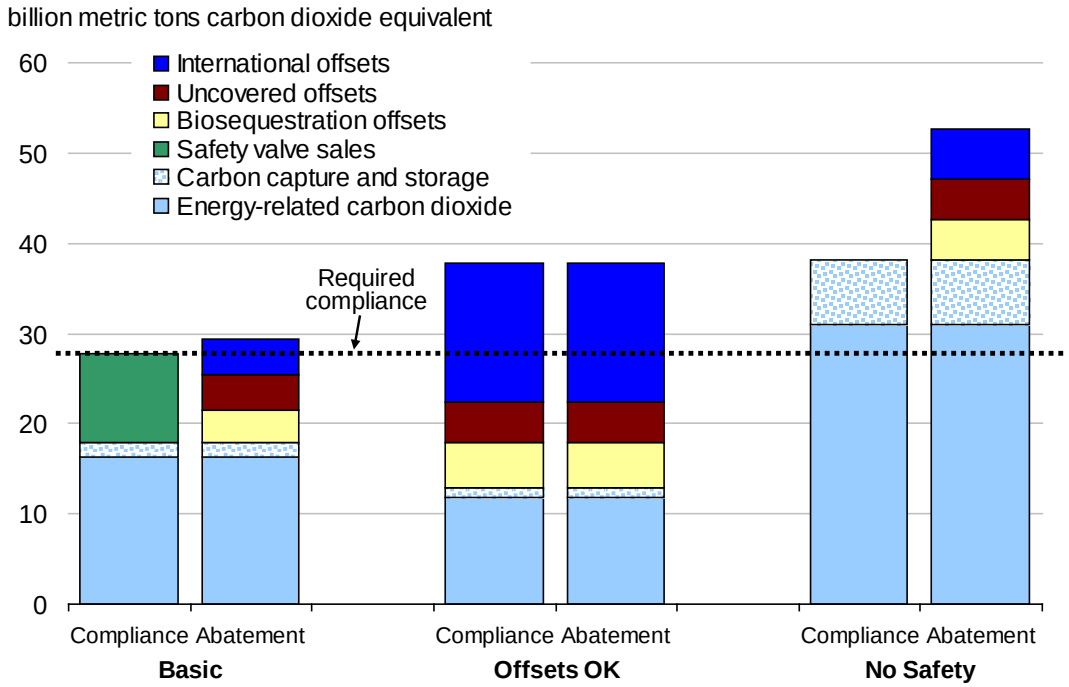
CLEAR Act Analysis Findings

The operation of the safety valve and the prohibition on the use of offsets significantly influences both the level and composition of emission reduction. In the Basic case, the safety valve is triggered from the beginning of the policy in 2012. As a result, although the cumulative number of emissions shares issued through 2035 reflects a reduction in emissions of 28 BMT relative to the Reference case, the actual reduction in emissions of regulated entities through 2035 relative to the Reference case is 18 BMT, as shown by the light blue segments at the bottom of each bar in Figure 1. The discrepancy between the reduction in emissions shares and actual emissions reductions of regulated entities relative to the baseline would likely grow between 2035 and 2050 as the annual issuance of emissions shares declines at an accelerating rate while abatement opportunities that are cost-effective at the safety valve price are likely to remain in limited supply. The use of a portion of the CERT Fund to purchase domestic and international offsets produces additional emissions reductions although they do not count towards compliance. In the Basic case, the additional reductions outside of domestic fossil fuel use between 2012 and 2035 are approximately equal to the roughly 10 BMT gap between targeted and actual reductions by regulated entities (i.e., the safety valve sales). In other words, while the emissions reductions counting towards compliance are only 18 BMT, the total emissions abatement, which includes offset purchases through the CERT Fund, is slightly higher than the 28 BMT reduction in emissions required.

Allowing offsets to count toward compliance yields greater overall emission reductions at lower cost. In the Offsets OK case, covered entities are allowed to utilize offsets for compliance and choose to over comply through 2035 by approximately 10 BMT to accumulate a bank of shares for later use. In the No Safety case, covered entities again choose to over comply through 2035 by approximately 10 BMT. They also purchase offsets with revenue from the CERT Fund although, as in the Basic case, those offsets do not contribute toward compliance with the policy. Relative to the Basic case, share prices in the Offsets OK case are lower and covered domestic emissions from fossil fuels are higher, but the increase in estimated emissions reductions from offsets exceeds the extra emissions from domestic fossil fuel use.

Without the safety valve, both share prices and reductions in domestic fossil fuel use and emissions would be greater. In the No Safety case, covered entities again choose to over comply through 2035 in order to accumulate a bank of approximately 10 BMT for future use. Revenue from the CERT Fund is also used to purchase offsets although, as in the Basic case, these offsets do not contribute toward compliance with the policy.

Figure 1. Components of cumulative compliance and abatement in CLEAR Act cases, 2012-2035

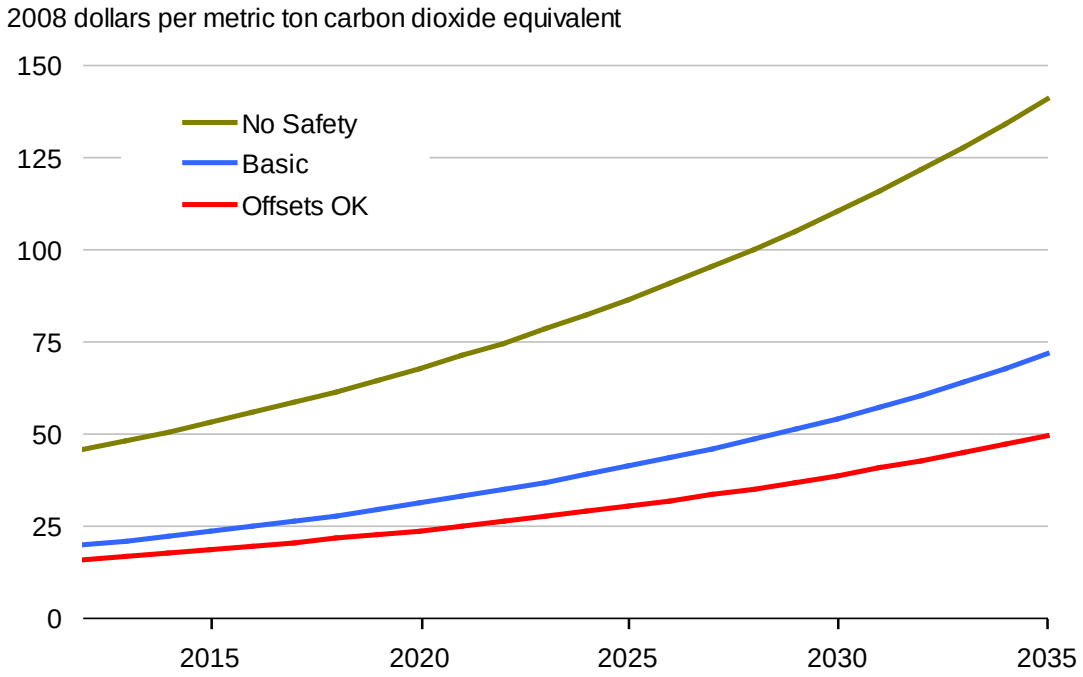


Source: National Energy Modeling System, runs CLR_REFERENCE.D071610A, CLR_BASIC.D071610A CLR_NOSAFETY.D071810A and CLR_OFFSETSOK.D071810A

Note: The required abatement shown here reflects the cumulative emissions reductions over the 2012 to 2035 period from Reference case level needed to meet the emissions cap. The offsets shown in the Basic and No Safety cases represent those purchased with funds from the CERT fund and do not count towards compliance with the policy.

GHG share prices are sensitive to the treatment of offsets and the level of the safety valve. Share prices in the Basic case remain at the safety valve level throughout the projections, reaching $31 per metric ton of CO_2 in 2020 and $72 per metric ton of CO_2 in 2035 (Figure 2 and Table 1). Without the safety valve, share prices increase substantially to meet the emissions reduction targets, reaching $68 per metric ton of CO_2 in 2020 and $141 per metric ton of CO_2 in 2035 in the No Safety case. However, if offsets were allowed to be used for compliance in a similar fashion as they are in the American Power Act, share prices would remain below the safety valve price, reaching $24 per metric ton CO_2 in 2020 and $49 per metric ton CO_2 in 2035 in the Offsets OK case.

Figure 2. Share prices in CLEAR Act cases, 2012-2035



Source: National Energy Modeling System, runs CLR_REFERENCE.D071610A, CLR_BASIC.D071610A CLR_NOSAFETY.D071810A and CLR_OFFSETSOK.D071810A

The vast majority of reductions in emissions occur in the electric power sector. Across the CLEAR Act cases, the electricity sector share of the total reduction in U.S. energy-related CO_2 emissions relative to the Reference case ranges from 78 percent to 86 percent in 2020 and 76 percent to 81 percent in 2035 (Figure 3). Reductions in electricity-sector emissions are primarily achieved by reducing the role of conventional coal-fired generation, which in 2008 provided 48 percent of total U.S. generation, and increasing the use of no- or low-carbon generation technologies (Figures 4 and 5). In addition, a portion of the electricity-related CO_2 emissions reductions results from reduced electricity demand stimulated by consumer responses to higher electricity prices and the CERT Fund expenditures on energy efficiency investments. Relative to the Reference case, electricity consumption is reduced by 3 to 8 percent in 2020 and 4 to 10 percent in 2035.

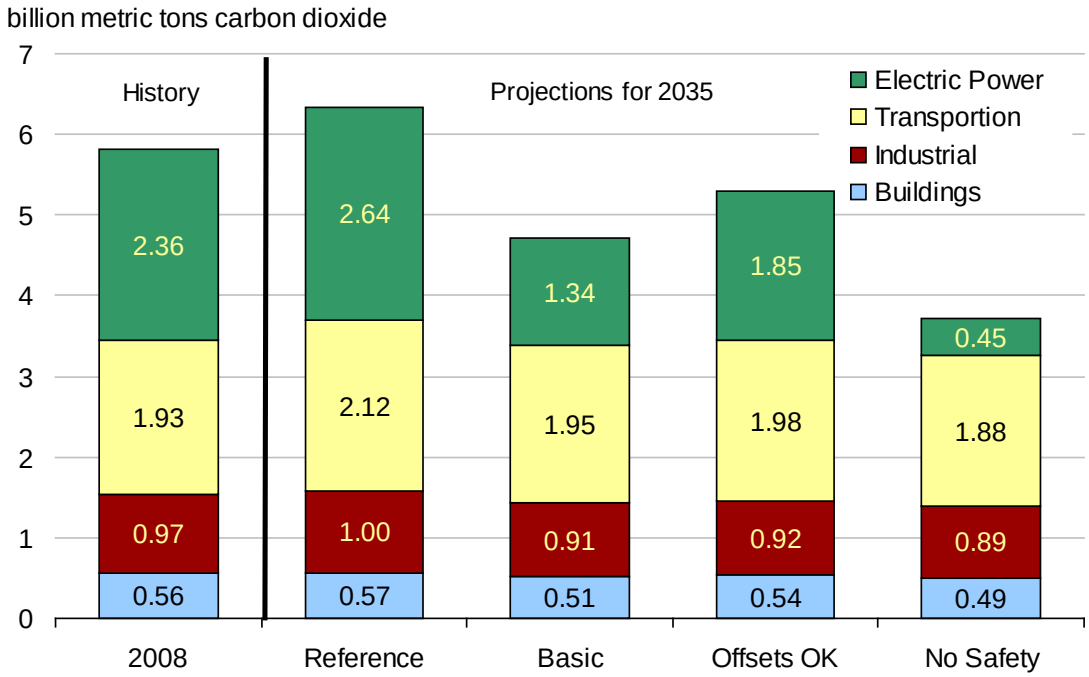
Table 1. CLEAR Act Summary results

	2008	2020				2035			
			CLEAR Act Cases				CLEAR Act Cases		
		Refer-ence	Basic	Offsets OK	No Safety	Refer-ence	Basic	Offsets OK	No Safety
Greenhouse gas emissions (mmt)									
Covered emissions									
Energy-related carbon dioxide	5807	5858	5345	5451	4613	6325	4711	5286	3708
Other covered emissions	0	0	0	0	0	0	0	0	0
Total covered emissions	5807	5858	5345	5451	4613	6325	4711	5286	3708
Noncovered emissions	1328	1591	1443	1399	1397	1562	1333	1327	1340
Total greenhouse gas emissions	7135	7449	6788	6850	6010	7887	6044	6613	5047
Uncovered abatement purchases (mmt)									
Noncovered gases	0	0	147	192	192	0	227	234	218
Biogenic sequestration	0	0	126	183	188	0	233	295	199
International sources	0	0	126	336	256	0	282	1000	199
Total additional abatement	0	0	399	711	636	0	742	1528	616
Total emissions net of induced biosequestration (mmt)	7135	7449	6536	6246	5566	7887	5529	5068	4650
Compliance summary (mmt)									
Allowances (shares) issued or cap	n.a.	5421	5421	5421	5421	3174	3174	3174	3174
Covered emissions, less offset credits	5807	5858	5345	4740	4613	6325	4711	3758	3708
Net allowance bank change	0	0	75	681	807	0	0	-584	-534
Allowance bank balance	0	0	2241	5483	7308	0	0	9974	10299
Safety-valve purchases	0	0	0	0	0	0	1537	0	0
Allowance and related prices (2008 dollars per metric ton CO2 equivalent)									
Emission allowance price	n.a.	n.a.	31.2	23.8	67.8	n.a.	71.6	49.5	141.0
Minimum allowance price	n.a.	n.a.	11.2	11.2	11.2	n.a.	29.5	29.5	29.5
Maximum allowance price (safety-valve)	n.a.	n.a.	31.2	31.2	n.a.	n.a.	71.6	71.6	n.a.
Noncovered gas abatement bid price	n.a.	n.a.	14.4	23.8	23.9	n.a.	36.8	49.5	25.6
Sequestration abatement bid price	n.a.	n.a.	16.8	23.8	24.4	n.a.	35.8	49.5	28.2
International abatement bid price	n.a.	n.a.	16.8	19.0	17.9	n.a.	29.6	35.7	28.1
Delivered energy prices (including net allowance costs) (2008 dollars per unit indicated)									
Motor gasoline, transport (per gallon)	3.27	3.35	3.61	3.55	3.91	3.91	4.32	4.18	4.86
Jet fuel (per gallon)	3.07	2.93	3.21	3.16	3.52	3.58	4.06	3.87	4.70
Diesel (per gallon)	3.79	3.51	3.79	3.74	4.12	4.11	4.60	4.42	5.28
Natural gas (per thousand cubic feet)									
Residential	13.87	12.28	12.98	12.81	14.02	14.85	18.51	16.93	22.66
Electric power	9.34	6.58	8.24	7.87	10.70	8.70	11.87	10.36	15.89
Coal, electric power sector (per million Btu)	2.05	1.98	4.84	4.16	8.14	2.08	8.58	6.61	15.01
Electricity (cents per kilowatthour)	9.83	9.03	10.66	10.39	12.97	10.20	13.05	12.06	14.75
Fuel Market Indicators									
Liquid fuels (million barrels per day)									
Consumption	19.5	20.7	20.5	20.4	20.2	22.2	21.7	21.9	21.1
Production	8.3	10.6	10.9	10.7	11.0	11.9	13.6	13.4	13.7
Net Imports	11.2	9.9	9.5	9.6	9.2	10.2	8.1	8.5	7.4
Natural gas (trillion cubic feet)									
Consumption	23.2	22.5	22.7	22.7	24.0	24.8	23.8	23.4	24.7
Production	20.6	20.0	20.1	20.1	21.2	23.3	22.5	22.2	22.9
Net Imports	3.0	2.6	2.6	2.6	2.7	1.5	1.2	1.1	1.7
Coal consumption (quadrillion Btu)	22.4	23.0	18.5	19.5	11.8	25.1	13.2	17.9	8.7
Electricity generation (billion kilowatthours)									
Petroleum	45	62	59	60	55	64	57	60	46
Natural gas	879	758	821	815	1044	1086	1116	1000	1352
Coal	1995	2089	1689	1772	1027	2300	1179	1646	544
Nuclear power	806	883	887	883	903	903	1194	1088	1345
Renewable/Other	391	737	885	849	1084	908	1330	1250	1386
Total	4116	4529	4342	4379	4112	5261	4876	5044	4674

mmt: million metric tons of carbon dioxide equivalent

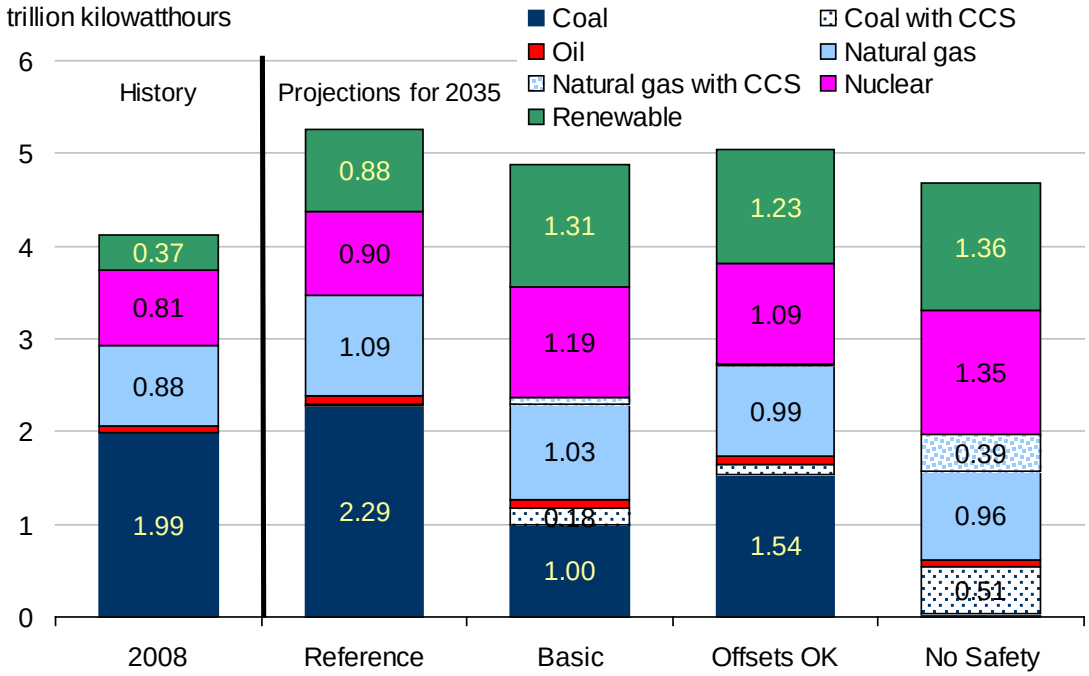
Source: National Energy Modeling System, runs CLR_REFERENCE.D071609A, CLR_BASIC.D071609A, CLR_OFFSETSOK.D071809A, and CLR_NOSAFETY.D071809B.

Figure 3. Energy-related CO_2 emissions by emitting sector in CLEAR Act cases, 2035



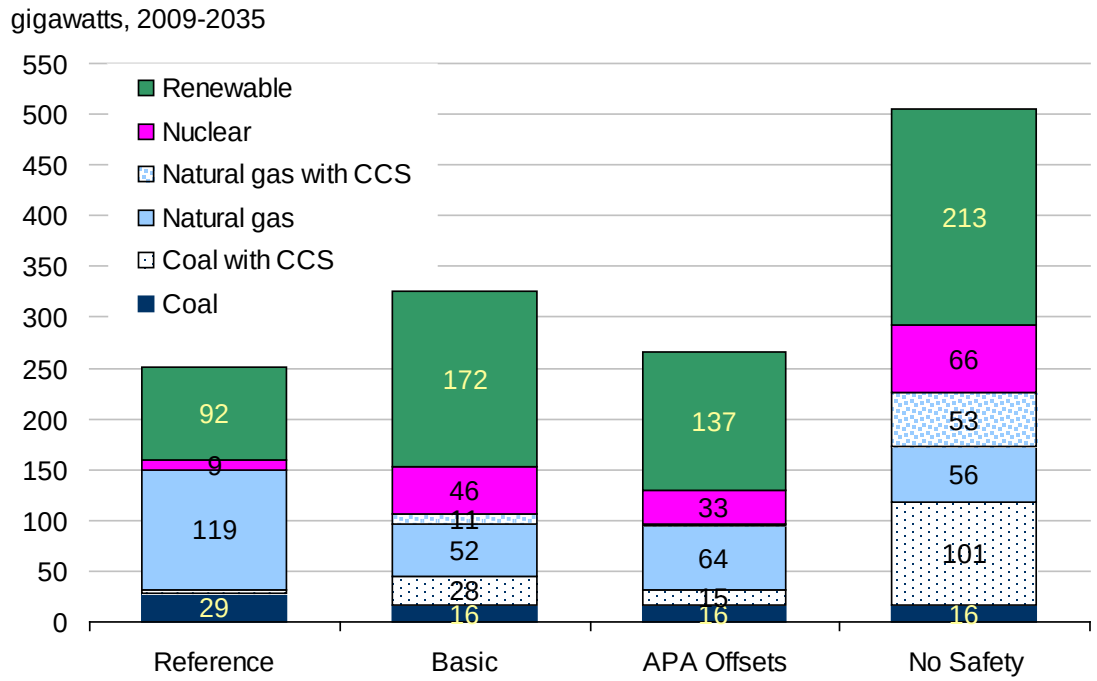
Source: National Energy Modeling System, runs CLR_REFERENCE.D071610A, CLR_BASIC.D071610A CLR_NOSAFETY.D071810A and CLR_OFFSETSOK.D071810A.

Figure 4. Electricity Generation by fuel in CLEAR Act cases, 2035



Source: National Energy Modeling System, runs CLR_REFERENCE.D071610A, CLR_BASIC.D071610A CLR_NOSAFETY.D071810A and CLR_OFFSETSOK.D071810A.

Figure 5. Electricity generating capacity additions and retrofits in CLEAR Act cases, 2009 to 2035



Source: National Energy Modeling System, runs CLR_REFERENCE.D071610A, CLR_BASIC.D071610A CLR_NOSAFETY.D071810A and CLR_OFFSETSOK.D071810A.

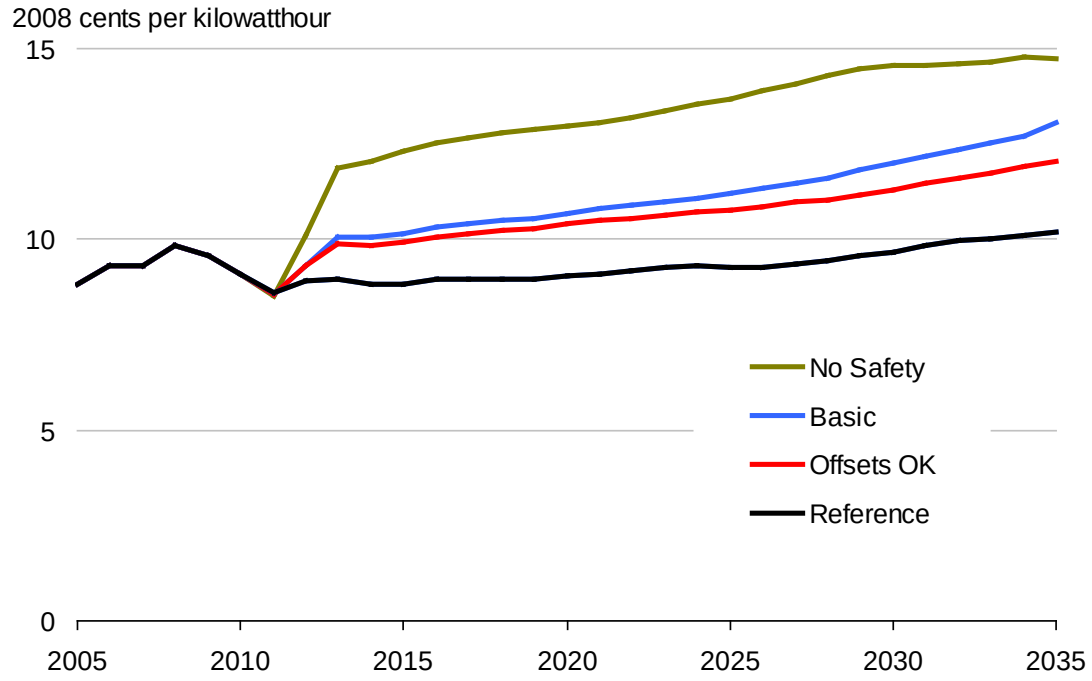
Emissions reductions from changes in direct fossil fuel use in residential and commercial buildings and in the industrial and transportation sectors are small relative to those in the electric power sector. The overall changes in the use of fossil fuels other than coal are relatively modest**.** Across the CLEAR Act cases, the total reduction in U.S. energy-related CO_2 emissions relative to the Reference case resulting from changes in direct fossil fuel use outside of electricity ranges from 15 percent to 22 percent in 2020 and 16 percent and 24 percent in 2035. The industrial, transportation, and buildings sectors experience smaller overall changes in delivered fossil fuel prices than the electricity generation sector (see below) and also have relatively low availability of alternatives in many applications. For example, motor gasoline prices in the Basic case are 26 cents per gallon (8 percent) higher than in the Reference case in 2020 and 41 cents per gallon (11 percent) higher in 2035 (in 2008 dollars).

The CLEAR Act reduces liquid fuel consumption, increases domestic oil production, increases biofuel use, and reduces oil imports. The higher fuel prices in the CLEAR Act cases lead consumers to reduce their consumption of liquid fuels while suppliers increase their production of biofuels which are treated as having zero net GHG emissions. Across the CLEAR Act cases, total liquid fuel consumption in 2035 is between 0.3 and 1.1 million barrels per day (bpd) below the Reference case level. At the same time, consumption of ethanol and other biofuels is between 1.4 and 1.7 million bpd above the Reference case level.

The CLEAR Act increases energy prices. The average U.S. electricity price in the Basic case is 10.7 cents per kilowatthour in 2020, 18 percent above the Reference case level (Figure 6), with

estimated prices across the full range of sensitivity cases ranging from 10.4 to 13.0 cents per kilowatthour (15 to 44 percent above the Reference case). By 2035, the electricity price in the Basic case is 13.1 cents per kilowatthour, 28 percent above the Reference case level, with a band of 12.1 cents to 14.7 cents (18 to 45 percent above the Reference case level) across the sensitivity cases.

Figure 6. Electricity prices in CLEAR Act cases, 2005-2035



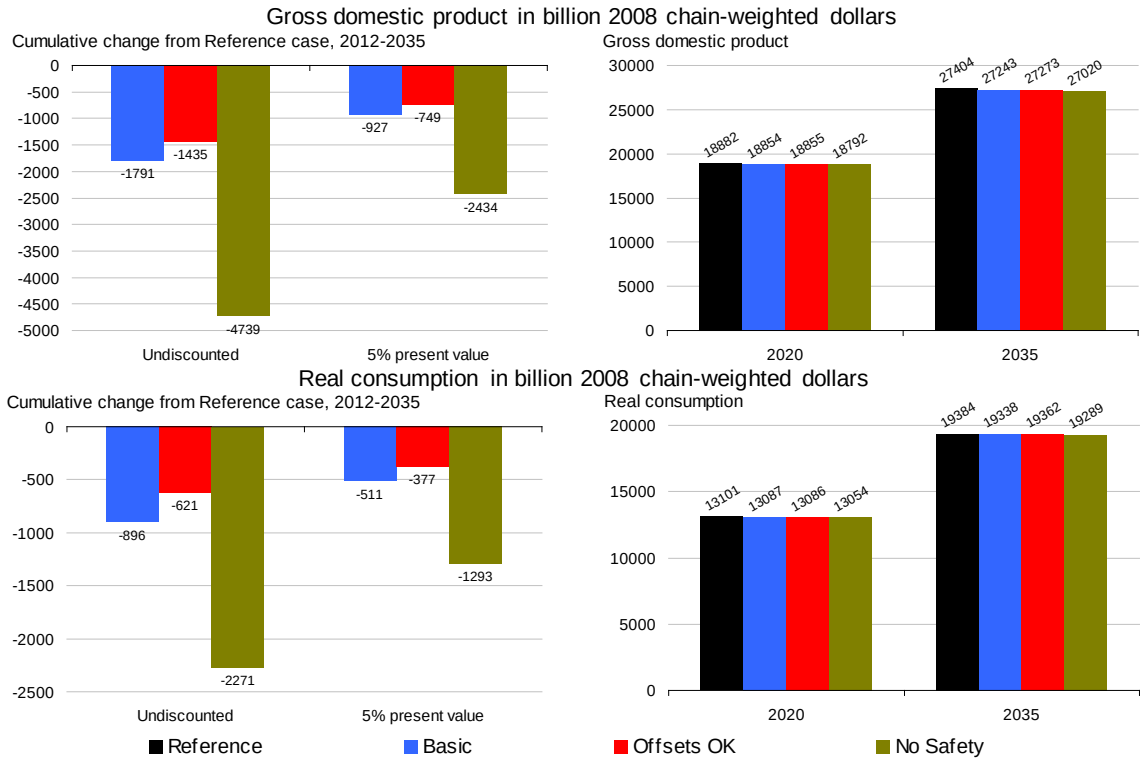
Source: National Energy Modeling System, runs CLR_REFERENCE.D071610A, CLR_BASIC.D071610A CLR_NOSAFETY.D071810A and CLR_OFFSETSOK.D071810A.

The CLEAR Act increases the cost of using energy, which reduces real economic output, purchasing power, and aggregate demand for goods and services. The result is that real GDP generally falls relative to the Reference case, but those impacts are significantly ameliorated by the recycling of purchasing power to consumers through the CRTF. In the Reference case, GDP rises 92 percent, from $14.3 trillion in 2008 to $27.4 trillion in 2035. Total present value[6] GDP losses over the 2012-2035 time period are $927 billion (-0.3 percent) in the Basic case, with a range from $749 billion (-0.3 percent) to $2.4 trillion (-0.9 percent) across the CLEAR Act cases (Figure 7 and Table 2).

Similarly, the cumulative discounted losses for personal consumption are $511 billion (-0.3 percent) in the Basic case and range from $290 billion (-0.1 percent) to $1.3 trillion (-0.7 percent) across the CLEAR Act cases. In all cases, real consumption starts to return to Reference case levels over the last few years of the projection, as the amount of share revenue devoted to the CRTF grows.

[6] Present value figures represent discounting at a real rate of 5 percent.

Figure 7. Macroeconomic impacts of CLEAR Act cases relative to the Reference case



Source: National Energy Modeling System, runs CLR_REFERENCE.D071610A, CLR_BASIC.D071610A CLR_NOSAFETY.D071810A and CLR_OFFSETSOK.D071810A.
Note: All changes shown are relative to the updated Reference case.
Note: All changes shown are relative to the updated Reference case except for the High Natural Gas Resource case which is compared to a reference case with similar natural gas resource assumptions.
Source: National Energy Modeling System runs, CLR_REFERENCE.D071410A, CLR_BASIC.D071610A, CLR_OFFSETSOK.D071810A, and CLR_NOSAFETY.D071810B. .

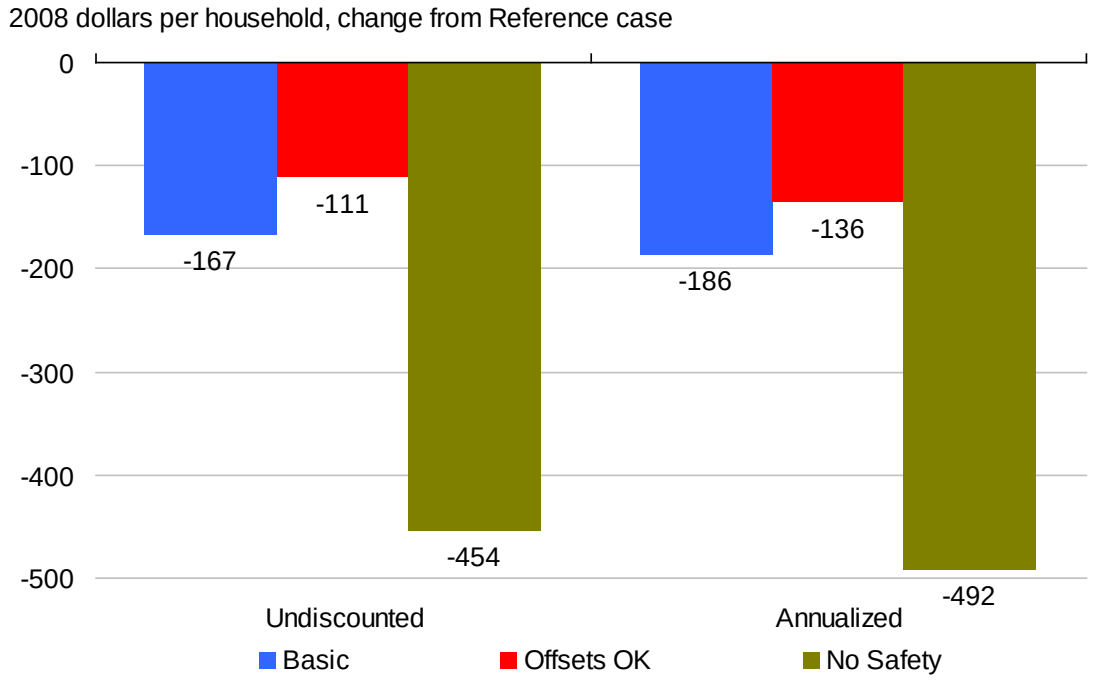
Table 2. Macroeconomic impacts of CLEAR Act cases relative to the Reference case
(billion 2008 dollars, except where noted)

	Basic	Offsets Allowed	No Safety
Cumulative Real Impacts 2012-2035 (present value using 5-percent discount rate)			
GDP			
Change	-927	-749	-2,434
Percent Change	-0.3%	-0.3%	-0.9%
Consumption			
Change	-511	-377	-1,293
Percent Change	-0.3%	-0.2%	-0.7%
Industrial Shipments (excludes services) 2000 Dollars			
Change	-1997	-1,536	-3,931
Percent Change	-2.1%	-1.6%	-3.6%
Nominal Revenue Collected 2013-2035[a]	6,437	4,200	12,255
2020 Impacts (not discounted)			
GDP			
Change	-29	-27	-90
Percent Change	-0.2%	-0.1%	-0.5%
Consumption			
Change	-14	-15	-47
Percent Change	-0.1%	-0.1%	-0.4%
Industrial Shipments (excludes services) 2000 Dollars			
Change	-90	-71	-199
Percent Change	-1.4%	-1.1%	-3.0%
Nominal Revenue Collected[a]	195	148	426
2035 Impacts (not discounted)			
GDP			
Change	-161	-131	-384
Percent Change	-0.6%	-0.5%	-1.4%
Consumption			
Change	-46	-21	-95
Percent Change	-0.2%	-0.1%	-0.5%
Industrial Shipments (excludes services) 2000 Dollars			
Change	-342	-255	-582
Percent Change	-4.4%	-3.3%	-7.5%
Nominal Revenue Collected[a]	507	254	754

[a] Includes revenues from allowance auctions and revenues generated by the resale of allowances distributed to non-emitters. These values are not discounted.
Note: All changes shown are relative to the updated Reference case except for the High Natural Gas Resource case which is compared to a reference case with similar natural gas resource assumptions .
Source: National Energy Modeling System runs, CLR_REFERENCE.D071410A, CLR_BASIC.D071610A, CLR_OFFSETSOK.D071810A, and CLR_NOSAFETY.D071810B.

Consumption impacts can also be expressed on a per household basis. The annualized value of household consumption losses from 2012 to 2035 is $186 (2008 dollars) in the Basic case, with a range of $75 to $492 across the CLEAR Act cases (Figure 8). [7]

Figure 8. Household Consumption Impacts through 2035 in the Clear Act cases



Source: National Energy Modeling System, runs CLR_REFERENCE.D071610A, CLR_BASIC.D071610A, CLR_NOSAFETY.D071810A and CLR_OFFSETSOK.D071810A.

Employment impacts are fairly small. Overall employment stays within 0.1 to 0.2 percent of the Reference case level in most years across the CLEAR Act cases.

Challenges beyond 2035. As previously noted, the modeling horizon for this analysis ends in 2035. Unless substantial progress is made in identifying low- and no-carbon technologies outside of electricity generation, the emissions targets established under the CLEAR Act for the 2035-2050 period are likely to be very challenging, as opportunities for further reductions in power sector emissions are exhausted and reductions in other sectors are thought to be more expensive.

[7] The values are calculated as per household annuity payments over the 2012-2035 period equivalent to the present value using a 5 percent real discount rate.

Analysis of an Electric Power Only Cap-and-Trade Program

The specifications for the electric power only cap-and-trade (EPOCT) program evaluated in this report are based on guidance provided by Congressional staff from the requestors' offices. Relative to the 2005 CO_2 emissions level from power generation (estimated by EIA at 2,397 MMT), the cap reflects a reduction of 17 percent in 2020 rising to 42 percent in 2030 and thereafter. Initially, 50 percent of allowances are allocated to electric distribution companies and 50 percent are auctioned. Starting in 2014, the allocation to local distribution companies (LDCs) is phased out over a 10-year period, with 100 percent of allowances being auctioned beginning in 2023. The formula for distributing allocated allowances to LDCs reflects a 75 percent weight on emissions from electricity supply and a 25 percent weight on sales during the base period.

The revenue collected from allowance auctions is split between technology research and development, purchase of agricultural offsets and rebates to consumers. The share of total allowance related revenue going to technology research and development is constant at 10 percent per year while the share going towards the purchase of agricultural offsets is 5 percent. The share rebated to consumers grows from 35 percent in 2013 to 85 percent in 2023 and beyond, as allocations to LDCs are phased out.

The EPOCT includes upper and lower level ranges on allowance prices (a price collar), with a lower-level (floor) price starting at $10 and rising at a 3 percent real rate per year, and an upper-level (ceiling) price starting at $25 and rising at a 5 percent real rate per year. Up to 250 MMT of domestic offsets can be applied towards compliance, but international offsets cannot be used.

EPOCT Analysis Cases

To address key areas of uncertainty, EIA prepared several alternative EPOCT sensitivity cases. Important areas of uncertainty include the cost and performance of key low carbon dioxide emitting generating technologies like nuclear, CCS, and selected renewable technologies, the size of the natural gas resource base, as well as the share of allowances to be allocated to LDCs, power sector companies, or taxpayers. The specific EPOCT cases prepared include:

- The **EPOCT Basic** case represents an environment where key low carbon dioxide emitting generating technologies, including nuclear, fossil with CCS, and various renewables, are developed and deployed on a large scale in a timeframe consistent with the emissions reduction requirements of the EPOCT, without encountering any major obstacles. Because the emissions cap does not decline further after 2030, covered entities are not assumed to maintain a bank of allowances after 2035 for later use.

- The **EPOCT High Natural Gas Resource case** is similar to the Basic case, except that it assumes a larger resource for shale gas based on the High Shale Gas Resource sensitivity case in the *AEO2010.* The unexploited portion of each shale gas play is assumed to be able to support twice as many new wells as in the Reference case, increasing the unproved shale gas resource base from 347 trillion cubic feet in the Reference case to 652 trillion cubic feet. This case is not directly comparable to the Reference case shown in the report because of the alternative natural gas resource base assumed. Instead, an alternative High Natural Gas

Resource Reference case that incorporates the same natural gas resource assumptions as in this EPOCT case is used for comparison and is available on the EIA web site along with the detailed results from all the cases discussed.

- The **EPOCT High Cost** case is similar to the Basic case, except that the overnight capital costs of nuclear, fossil with CCS (including CCS retrofit), and dedicated biomass generating technologies are assumed to be 50 percent higher than in the Reference case. As with the High Natural Gas Resource case, this case should be compared cautiously to the Reference case because of the alternative assumptions about generating technology costs. However, because the affected technologies play a fairly small role in the Reference case, comparisons should only be slightly affected.

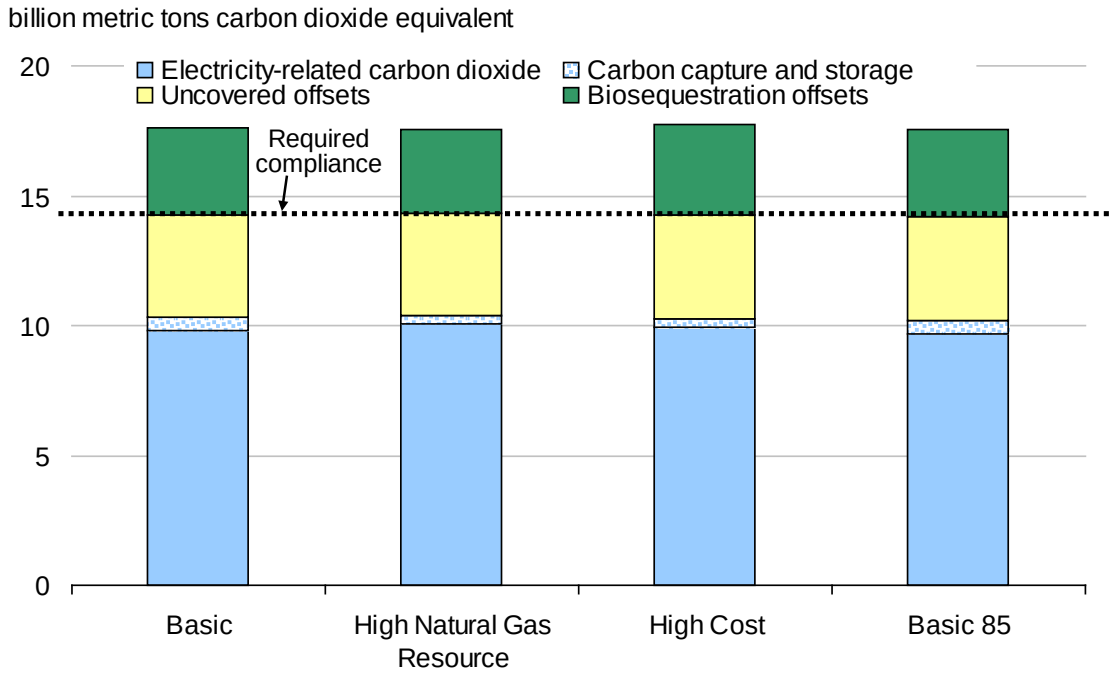
- The **EPOCT Basic85 case** is similar to the Basic case, except that it assumes that 85 percent of allowances are allocated to LDCs (and 15 percent are auctioned) beginning in the 2013 program year. As in the Basic case, the allocation is phased out over a 10-year period, with 100 percent of the allowances being auctioned in 2023 and subsequent years. This case is intended to illustrate the effect of a larger initial LDC allowance allocation on consumer electricity prices.

EPOCT Analysis Findings

Reductions in electricity-related CO_2 emissions are the major compliance option in the EPOCT cases. Over the 2013 to 2035 period, reductions in electricity-related CO_2 emissions account for between 68 percent and 70 percent of total compliance, with the remainder coming mainly from uncovered offsets (Figure 9). While additional emissions reductions result from biosequestration offsets purchased with funds from the allowance auctions, these offsets do not count towards compliance with the emissions cap. In all cases the total compliance – the sum of electricity-related CO_2, carbon capture and storage, and uncovered offsets – exactly equals the level of abatement required to comply with the policy. Covered entities are not expected to accumulate a bank of allowances for use post-2035 because the emissions cap does not decline after 2030.

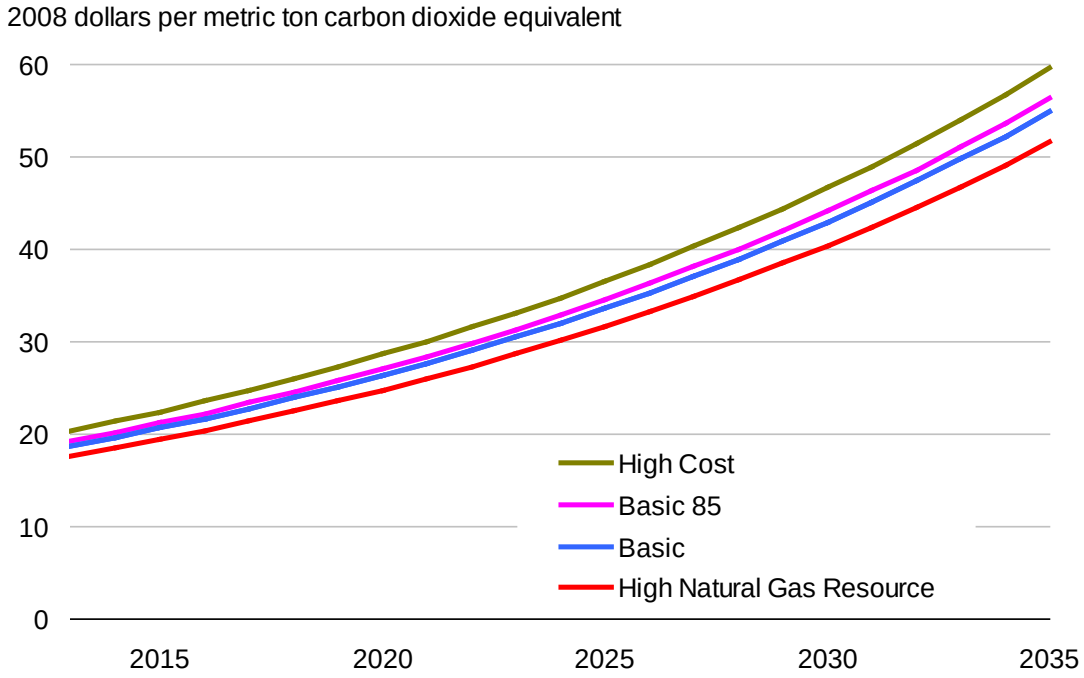
Allowance prices in the EPOCT cases are moderated by the ability to use offsets and the fact that the emission cap does not decline further after 2030. Across the EPOCT cases, allowances prices in 2020 range from $25 to $29 per ton, while the range rises and expands to $52 to $59 per ton in 2035 (Figure 10 and Table 3).

Figure 9. Components of cumulative compliance and additional abatement in EPOCT cases, 2013-2035



Source: National Energy Modeling System, runs PWR_REFERENCE.D071910A, PWR_BASIC.D071610A PWR_HISHALE.D071610A and PWR_HICOST.D071610A and PWR_BASIC85.D071710A.
Note: The required abatement shown here reflects the cumulative emissions reductions over the 2013 to 2035 period from the Reference case level needed to meet the emissions cap. The biosequestration offsets shown are purchased with a portion of the revenue from allowance auctions, although they do not count towards compliance with the cap and trade program.

Figure 10. Allowance prices in the EPOCT cases, 2013-2035



Source: National Energy Modeling System, runs PWR_REFERENCE.D071910A, PWR_BASIC.D071610A PWR_HISHALE.D071610A and PWR_HICOST.D071610A and PWR_BASIC85.D071710A.

Table 3. EPOCT summary results

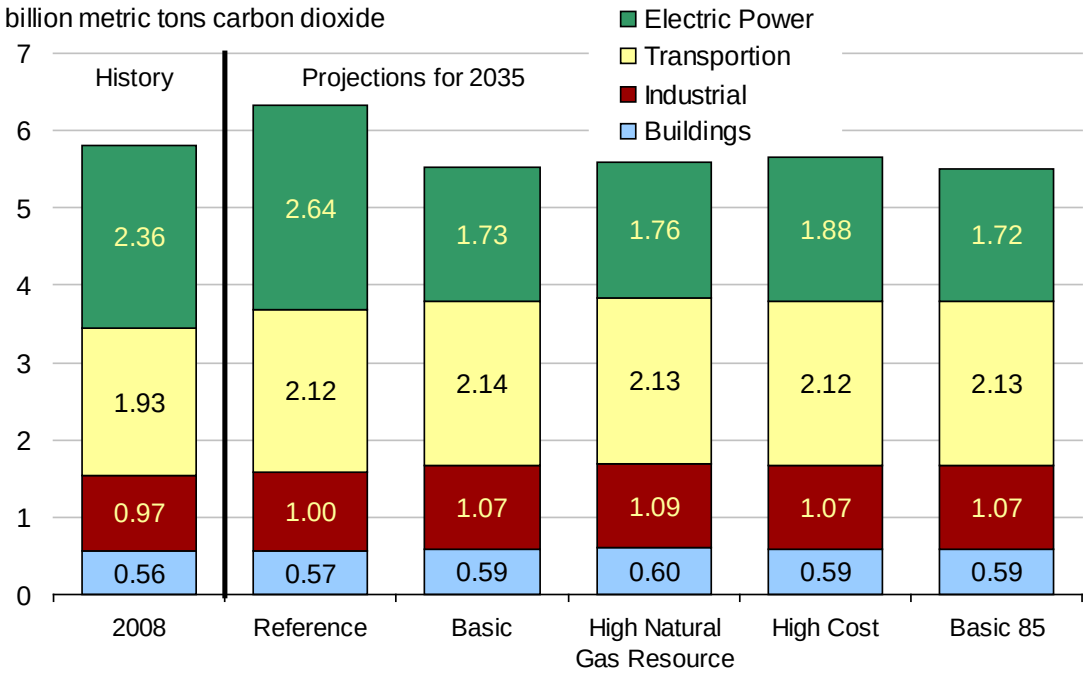
	2008	2020					2035				
			EPOCT cases					EPOCT cases			
		Refer-ence	Basic	High natural gas resource	High cost	Basic85	Refer-ence	Basic	High natural gas resource	High cost	Basic85
Greenhouse gas emissions (mmt)											
Covered emissions											
Energy-related carbon dioxide	2359	2350	2028	2003	1992	2034	2641	1728	1756	1880	1716
Other covered emissions	0	0	0	0	0	0	0	0	0	0	0
Total covered emissions	2359	2350	2028	2003	1992	2034	2641	1728	1756	1880	1716
Noncovered emissions	4772	5095	4926	4949	4927	4926	5242	5153	5181	5134	5143
Total greenhouse gas emissions	7131	7445	6955	6952	6919	6960	7883	6882	6936	7014	6860
Offset and incentive reductions (mmt)											
Noncovered gases (offsets)	0	0	175	173	178	176	0	200	200	200	200
Biogenic sequestration (incentive)	0	0	143	138	149	145	0	173	169	178	174
Total additional abatement	0	0	318	312	327	321	0	372	368	378	374
Total emissions net of induced biosequestration (mmt)	7131	7445	6812	6814	6770	6815	7883	6709	6768	6835	6685
Compliance summary (mmt)											
Allowances issued or cap	n.a.	2028	2028	2028	2028	2028	1417	1417	1417	1417	1417
Covered emissions, less offset credits	2359	2350	1853	1830	1814	1858	2641	1529	1556	1680	1517
Net allowance bank change	0	0	175	198	214	170	0	-112	-139	-263	-100
Allowance bank balance	0	0	2217	2344	2440	2125	0	6	99	-8	-104
Safety-valve purchases	0	0	0	0	0	0	0	0	0	0	0
Allowance and offset prices (2008 dollars per metric ton CO2 equivalent)											
Emission allowance price	n.a.	n.a.	26.4	24.8	28.6	27.1	n.a.	54.8	51.6	59.5	56.3
Minimum allowance price	n.a.	n.a.	11.4	11.4	11.4	11.4	n.a.	17.8	17.8	17.8	17.8
Maximum allowance price (safety-valve)	n.a.	n.a.	32.7	32.7	32.7	32.7	n.a.	67.9	67.9	67.9	67.9
Domestic offset price	n.a.	n.a.	26.4	24.8	28.6	27.1	n.a.	54.8	51.6	59.5	56.3
Biosequestration incentive bid price	n.a.	n.a.	18.8	18.2	19.5	19.0	n.a.	22.5	21.6	23.7	22.9
Delivered energy prices (including net allowance costs) (2008 dollars per unit indicated)											
Motor gasoline, transport (per gallon)	3.27	3.35	3.35	3.34	3.35	3.35	3.91	3.85	3.84	3.89	3.86
Jet fuel (per gallon)	3.07	2.93	2.93	2.92	2.93	2.93	3.58	3.48	3.47	3.52	3.48
Diesel (per gallon)	3.79	3.51	3.51	3.51	3.51	3.51	4.11	3.98	3.96	4.02	3.98
Natural gas (per thousand cubic feet)											
Residential	13.87	12.28	12.08	11.23	11.92	11.90	14.85	14.23	13.11	14.68	14.23
Electric power	9.34	6.58	8.11	7.30	8.15	8.03	8.70	10.77	9.70	11.64	10.86
Coal, electric power sector (per million Btu)	2.05	1.98	4.38	4.21	4.59	4.45	2.08	7.10	6.76	7.56	7.23
Electricity (cents per kilowatthour)	9.83	9.03	10.37	10.09	10.48	10.21	10.20	12.39	11.95	12.80	12.40
Fuel Market Indicators											
Liquid fuels (million barrels per day)											
Consumption	19.5	20.7	20.6	20.6	20.6	20.6	22.2	22.1	22.0	22.0	22.0
Production	8.3	10.6	10.7	10.7	10.6	10.7	11.9	12.5	13.0	12.2	12.5
Net Imports	11.2	9.9	9.8	9.8	9.8	9.8	10.2	9.5	9.0	9.7	9.4
Natural gas (trillion cubic feet)											
Consumption	23.2	22.5	22.9	24.4	23.2	23.2	24.8	23.7	26.2	24.7	23.7
Production	20.6	20.0	20.2	22.1	20.7	20.6	23.3	22.4	25.5	23.2	22.4
Net Imports	3.0	2.6	2.7	2.2	2.5	2.5	1.5	1.2	0.6	1.4	1.2
Coal consumption (quadrillion Btu)	22.4	23.0	19.6	18.7	19.1	19.5	25.1	18.2	17.0	18.3	18.1
Electricity generation (billion kilowatthours)											
Petroleum	45	62	60	60	60	60	64	60	59	60	59
Natural gas	879	758	817	962	851	839	1086	937	1232	1102	934
Coal	1995	2089	1775	1699	1728	1769	2300	1641	1532	1647	1628
Nuclear power	806	883	886	883	883	887	903	1120	1091	904	1129
Renewable/Other	391	737	861	833	862	865	908	1280	1172	1274	1288
Total	4116	4529	4400	4436	4384	4420	5261	5038	5087	4987	5040

mmt: million metric tons of carbon dioxide equivalent

Source: National Energy Modeling System, runs PWR_REFERENCE.D071909A, PWR_BASIC.D071609A, PWR_HISHALE.D071609A, PWR_HICOST.D071609A, and PWR_BASIC85.D071709A.

The cap on power sector emissions leads to significant reductions in CO_2 emissions from the sector, but there is an increase in CO_2 emissions in other sectors. In the Reference case, electricity sector CO_2 emissions increase from 2.36 BMT in 2008 to 2.64 BMT in 2035 (Figure 11). The cap and trade program leads to a decrease in emissions in the electricity sector, with 2035 CO_2 emissions ranging from 2.12 BMT to 2.14 in the EPOCT cases. However, there is a slight increase in energy-related CO_2 emissions in other sectors of the economy that are not covered by the cap and trade program, particularly in the industrial sector. In the industrial sector energy related CO_2 emissions in 2035 range from 1.07 to 1.09 BMT, a 7 to 9 percent increase above the 1.00 BMT level in the Reference case.[8] This occurs because more industrial facilities choose to generate electricity with fossil fuels for their own use, rather than pay for higher priced power from the electricity sector. This change reflects a leakage in emissions from covered to uncovered sectors that can occur as the sectoral scope of a cap-and-trade program is narrowed.

Figure 11. Energy-related CO_2 emissions by emitting sector in EPOCT cases, 2035



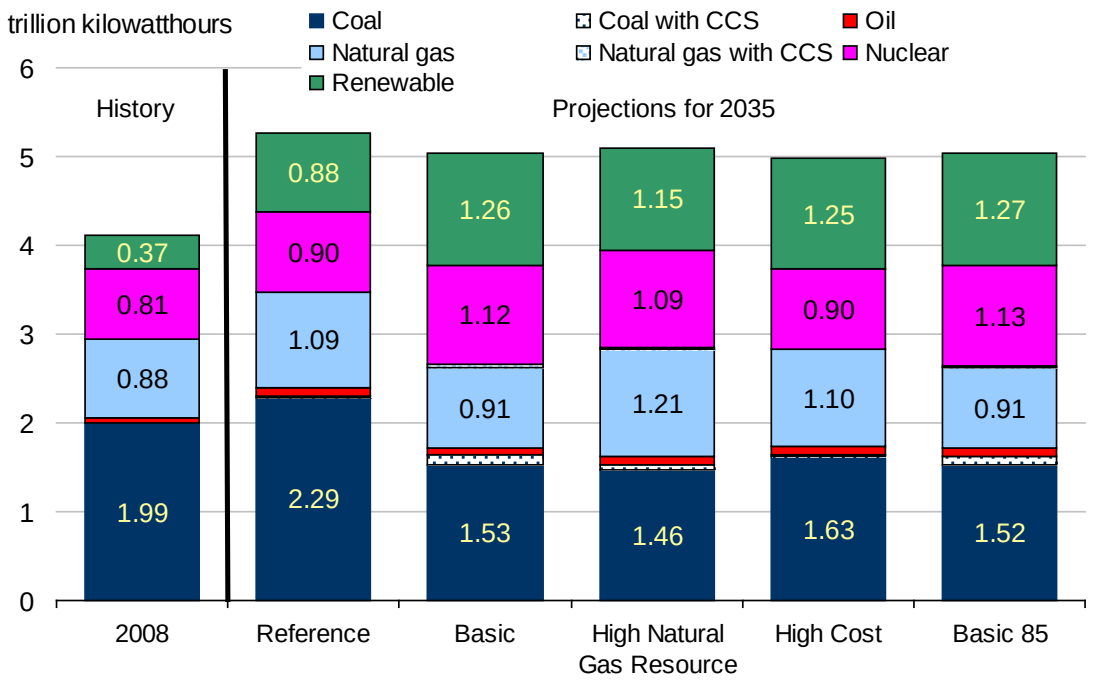
Source: National Energy Modeling System, runs PWR_REFERENCE.D071910A, PWR_BASIC.D071610A PWR_HISHALE.D071610A and PWR_HICOST.D071610A and PWR_BASIC85.D071710A.

To reduce emissions, the power sector will reduce its generation from coal while increasing renewable, nuclear, and in some cases, natural gas generation. Across the EPOCT case coal-fired generation in 2035 is 30 percent to 38 percent below the Reference case level (Figure 12). Conversely, renewable generation is between 30 percent and 43 percent higher. The situation for

[8] The increase in emissions outside of the electricity sector shown here may overstate the potential leakage because some cogeneration facilities will be large enough to be covered by the program, but they were not treated as covered in this analysis.

nuclear varies depending on the costs assumed for new nuclear power plants. If nuclear costs are as much as 50 percent higher than Reference case levels, nuclear power could see little growth beyond that seen in the Reference case. For natural gas, assumptions about the costs of other low-CO_2 emitting technologies and the projected natural gas resource base and price will determine how large a role it might play in reducing power sector CO_2 emissions.

Figure 12. Electricity generation by fuel in EPOCT cases, 2035

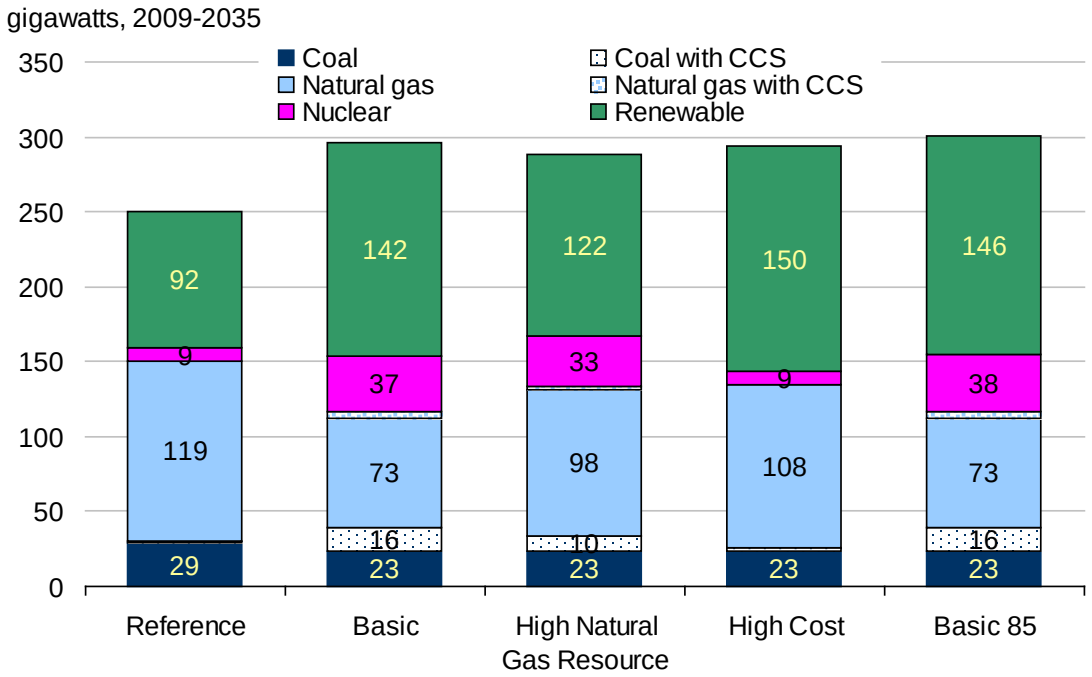


Source: National Energy Modeling System, runs PWR_REFERENCE.D071910A, PWR_BASIC.D071610A PWR_HISHALE.D071610A and PWR_HICOST.D071610A and PWR_BASIC85.D071710A.

Increased renewable and nuclear capacity additions dominate most of the EPOCT cases. While 92 gigawatts of new renewable capacity are built in the Reference case between 2009 and 2035, the amount added increases to between 122 gigawatts and 150 gigawatts in the EPOCT cases (Figure 13). Except for the High Cost case, there are larger nuclear capacity additions in the EPOCT cases, while natural gas capacity additions are sensitive to the size of the natural gas resource base and the costs of other low-CO_2 emitting technologies.

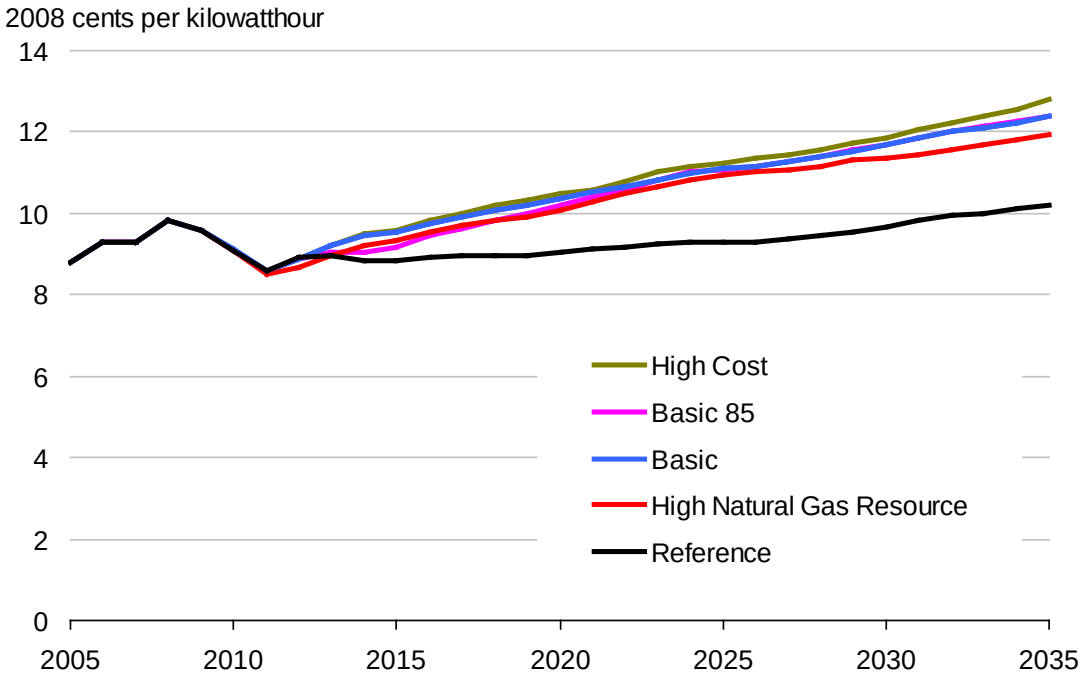
Electricity prices are higher in all of the EPOCT cases. In 2020, electricity prices range from 10.1 cents per kilowatthour to 10.5 cents per kilowatthour, 12 to 16 percent above the 9.0 cent per kilowatthour price in the Reference case (Figure 14). By 2035, electricity prices range from 12.0 cents per kilowatthour to 12.8 cents per kilowatthour, 17 to 25 percent above the 10.2 cents per kilowatthour price in the Reference case. During the first 10 years after the program starts, electricity prices in the Basic85 case are lower than in the Basic case, because electricity LDCs receive a larger number of allowances, enabling them to pass on greater benefits to their customers. However, this difference is eliminated by 2023.

Figure 13. Electricity generating capacity additions and retrofits in EPOCT cases, 2009 to 2035



Source: National Energy Modeling System, runs PWR_REFERENCE.D071910A, PWR_BASIC.D071610A PWR_HISHALE.D071610A and PWR_HICOST.D071610A and PWR_BASIC85.D071710A.

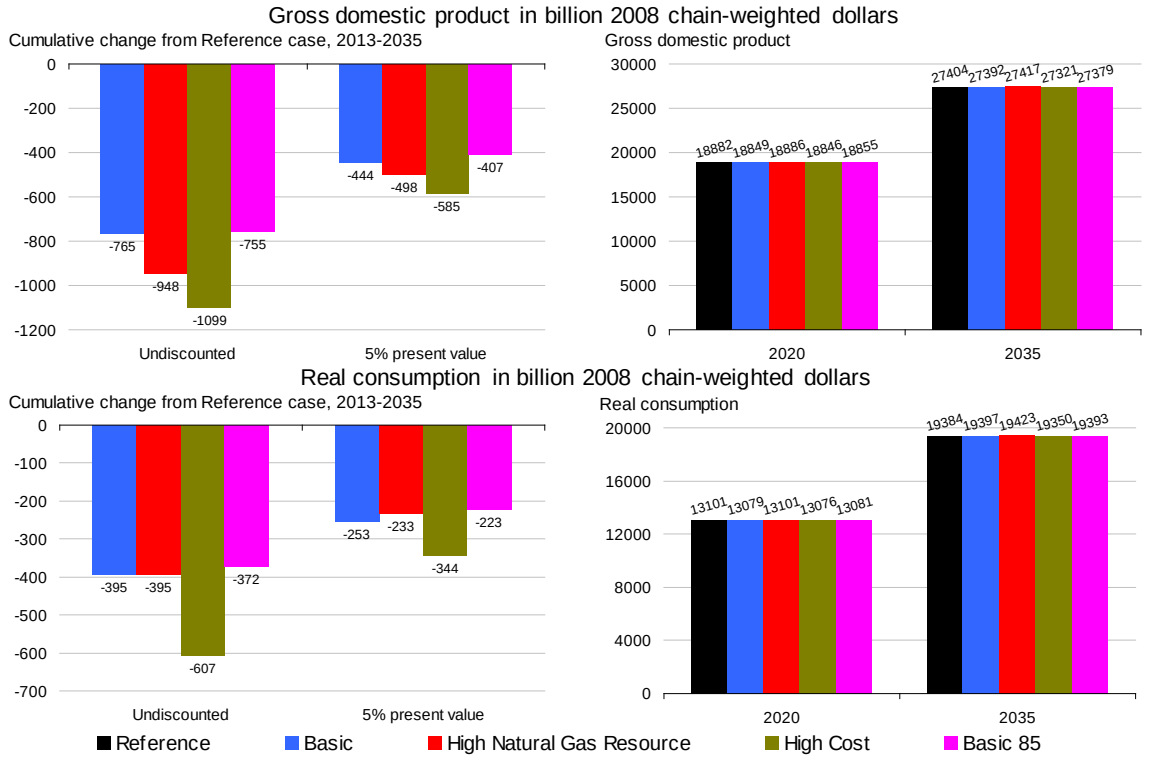
Figure 14. Electricity prices in EPOCT cases, 2005 to 2035



Source: National Energy Modeling System, runs PWR_REFERENCE.D071910A, PWR_BASIC.D071610A PWR_HISHALE.D071610A and PWR_HICOST.D071610A and PWR_BASIC85.D071710A.

The EPOCT program increases the cost of using electricity, which reduces real economic output, reduces purchasing power, and lowers aggregate demand for goods and services. The result is that real GDP generally falls relative to the Reference case, but those impacts are partially ameliorated over the first 10 years of the program by the allocation of allowances to electricity LDCs and in the later years by the recycling of purchasing power to consumers through allowance auction revenues. In the Reference case GDP rises 92 percent, from $14.3 trillion in 2008 to $27.4 trillion in 2035. Total present value[9] GDP losses over the 2013-2035 time period are $444 billion (-0.2 percent) in the Basic case, with a range from $143 billion (-0.1 percent) to $585 billion (-0.2 percent) across the EPOCT cases (Figure 15 and Table 4).

Figure 15. Macroeconomic impacts of EPOCT cases relative to the Reference case



Source: National Energy Modeling System, runs PWR_REFERENCE.D071910A, PWR_BASIC.D071610A PWR_HISHALE.D071610A and PWR_HICOST.D071610A and PWR_BASIC85.D071710A.
Note: All changes shown are relative to the updated Reference case except for the High Natural Gas Resource case.

[9] Present value figures represent discounting at a real rate of 5 percent.

Table 4. Macroeconomic impacts of EPOCT cases relative to the Reference case

(billion 2008 dollars, except where noted)

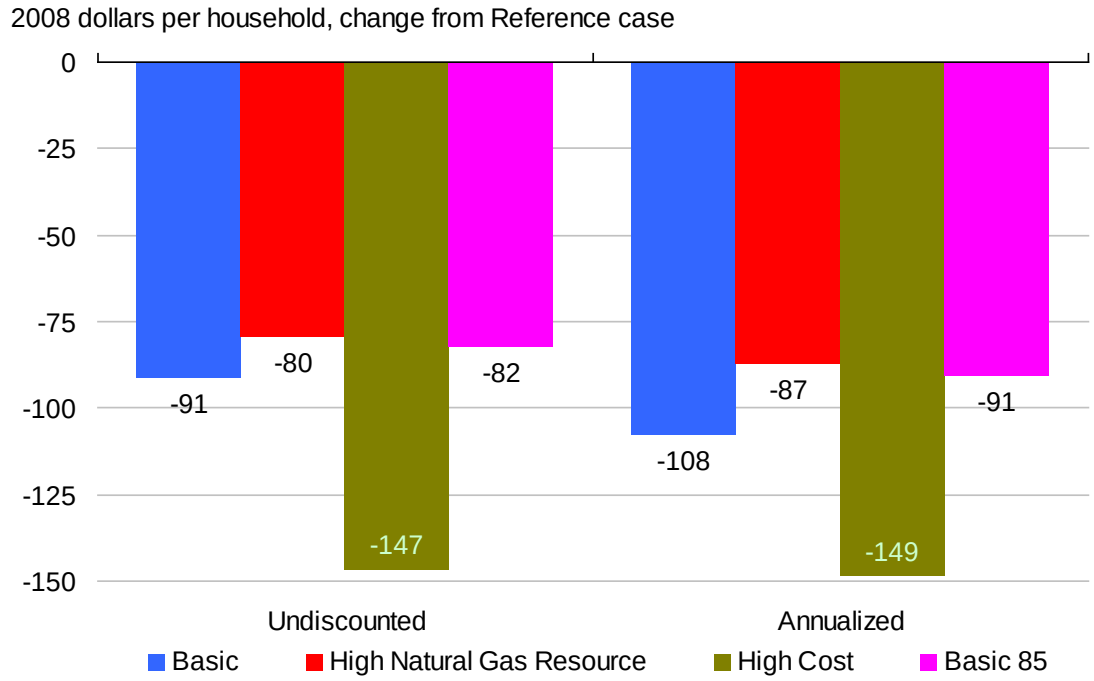
	Basic	High Cost	High Natural Gas Resource	Basic85
Cumulative Real Impacts 2013-2035 (present value using 5-percent discount rate)				
GDP				
Change	-444	-585	-143	-407
Percent Change	-0.2%	-0.2%	-0.1%	-0.1%
Consumption				
Change	-253	-344	-51	-223
Percent Change	-0.1%	-0.2%	-0.0%	-0.1%
Industrial Shipments (excludes services) 2000 Dollars				
Change	-568	-651	-274	-414
Percent Change	-0.6%	-0.7%	-0.3%	-0.4%
Nominal Revenue Collected 2013-2035[a]	1,606	1,824	1,583	1,605
2020 Impacts (not discounted)				
GDP				
Change	-33	-37	4	-28
Percent Change	-0.2%	-0.2%	0.0%	-0.1%
Consumption				
Change	-22	-25	0	-20
Percent Change	-0.2%	-0.2%	0.0%	-0.2%
Industrial Shipments (excludes services) 2000 Dollars				
Change	-38	-39	-4	-32
Percent Change	-0.6%	-0.6%	-0.1%	-0.5%
Nominal Revenue Collected[a]	58	61	52	50
2035 Impacts (not discounted)				
GDP				
Change	-12	-83	13	-25
Percent Change	-0.0%	-0.3%	0.0%	-0.1%
Consumption				
Change	14	-34	39	9
Percent Change	0.1%	-0.2%	0.2%	0.0%
Industrial Shipments (excludes services) 2000 Dollars				
Change	-49	-84	-31	-56
Percent Change	-0.6%	-1.1%	-0.4%	-0.7%
Nominal Revenue Collected[a]	134	143	124	134

Note: All changes shown are relative to the updated Reference case except for the High Natural Gas Resource case which is compared to a reference case with similar natural gas resource assumptions.
Source: National Energy Modeling System runs, PWR_REFERENCE.D071910A, PWR_BASIC.D071610A, PWR_BASIC85.D071710A, PWR_HISHALE.D071610A, PWR_HICOST.D071610A, and PWR_REFSHALE.D072010A.

Consumption impacts can also be expressed on a per household basis. The annualized value of household consumption losses from 2013 to 2035 is $108 (2008 dollars) in the Basic case, with a range of $87 to $149 across the EPOCT cases (Figure 16). [10]

[10] The values are calculated as per household annuity payments over the 2013-2035 period equivalent to the present value using a 5 percent real discount rate.

Figure 16. Household consumption impacts through 2035 in the EPOCT Cases



Source: National Energy Modeling System runs, PWR_REFERENCE.D071910A, PWR_BASIC.D071610A, PWR_BASIC85.D071710A, PWR_HISHALE.D071610A, PWR_HICOST.D071610A, and PWR_REFSHALE.D072010A.

Appendix A: Analysis Request Letter

United States Senate
WASHINGTON, DC 20510

June 3, 2010

Dr. Richard Newell
Administrator
Energy Information Administration
1000 Independence Ave., SW
Washington, DC 20585

Dear Administrator Newell:

As you are probably aware, the Senate continues to debate energy and climate legislation this Congress. Because of the profound impact that any such legislation may have on our nation's energy supply and economy, we request technical assistance from the Energy Information Administration (EIA) to help inform the Senate's deliberations. We are particularly interested in determining the most efficient and effective policies for reducing greenhouse gas emissions, protecting consumers from associated energy price increases, minimizing both regional disparities and carbon leakage, increasing the diversity and resiliency of our nation's energy mix, and reducing our use of foreign sources of energy.

We believe that in addition to your current analyses of the discussion draft released on May 12, 2010, the Senate would benefit from your evaluation of the Carbon Limits and Energy for America's Renewal (CLEAR) Act (S.2877) as well. We therefore request that EIA similarly analyze the impacts of this measure.

As part of the analysis, we also request that EIA determine the different outcomes from the following modifications to the CLEAR Act:

1. modifying the dividend allocations to minimize any disparate regional impacts due to historically differential levels of fossil fuel consumption;
2. adjusting price collar starting points and growth rates to further reduce both greenhouse gas emissions and adverse economic impacts;
3. revising the transitional assistance levels to further protect energy-intensive, trade-exposed industries and to minimize carbon leakage;
4. providing carbon credits for manufacturers that invest in product or technology innovation, including efficiency, to incentivize additional greenhouse gas emission reductions;
5. providing carbon credits for project developers that invest in additional greenhouse gas mitigation from uncapped sectors, particularly from the agricultural and forestry sectors;
6. incorporating clean energy and energy efficiency standards that ensure the diversification of our nation's energy mix (such as those found in S.1462 and the Committee amendments recently adopted to that bill);
7. increasing fuel economy and biofuel use standards;

8. altering the point of regulation to maximize administrative efficiencies and reduce compliance costs; and
9. including any other important measure or mechanism that EIA's technical experts believe are critical to facilitate the goals described above.

Due to the critical nature and time sensitivity of this information for the legislative process, we strongly urge the EIA to make this request a top priority.

Sincerely,

Jeff Bingaman
United States Senator

Lisa Murkowski
United States Senator

Maria Cantwell
United States Senator

Susan Collins
United States Senator

George Voinovich
United States Senator