An Analysis of the Economic Impacts of the 2007 Energy Independence and Security Act*

DOUGLAS S. MEADE

Inforum, University of Maryland, College Park, MD.

In December 2007, the Energy Independence and Security Act (EISA) was passed by Congress. The main goal of the EISA is to reduce U.S. dependence on imported oil. Our study assesses two major provisions of the Act: (1) an upward revision to the Corporate Average Fuel Economy (CAFE) standards and (2) a mandate for a significant increase in production and consumption of renewable fuels – the Renewable Fuels Standard (RFS)[1].

The EISA raises the CAFE standards for cars and light trucks by 40% between now and 2020, from 25 miles per gallon (mpg) to 35 mpg, a 2.9% average annual increase in fuel efficiency. It also sets a target of 36 billion gallons of ethanol by 2022, up from about 6 billion gallons in 2006, an annual average increase of 11.9%.

Our study analyzes the structural and economic changes brought about by the implementation of the EISA. The INFORUM LIFT model of the U.S. economy is extended with additional modules enabling it to analyze ethanol production, as well as to project consumption of motor fuels based on number of vehicles, average mpg, and miles driven. We compare two scenarios: (1) a "business as usual" scenario, that projects the ethanol production and vehicle mileage without the EISA, and (2) an "EISA" case, that incorporates the CAFE standards stipulated in EISA, along with an increase in ethanol production, though not nearly as high as that stipulated by EISA.

This paper reviews how the LIFT model was extended to study ethanol production and CAFE standards, how the model was used to implement these scenarios, and summarizes the results of the simulations. We find small negative macroeconomic impacts of EISA by 2020 and 2030, on the order of 0.6% and 0.9% of real GDP, respectively. Although the EISA is successful at reducing crude oil imports by nearly 14% by 2030, this is not enough to offset the negative effects on output, jobs and real disposable income.

1. Introduction

Background

In comparison with the EU, Japan and other OECD countries, the U.S. has been a laggard in saving energy and reducing greenhouse gas emissions. Energy taxes are relatively low in the U.S. and we also refused to ratify the Kyoto protocol for the reduction of greenhouse gases (GHGs). Nevertheless, concerns about global warming have been growing, and the recent runup in the price of oil has brought questions of energy efficiency and conservation back into the public arena. After the 2006 elections, there was also a change in leadership in the House and

---

* This study was initiated, supported by, and substantially designed by the U.S. Department of Commerce. David Henry of the Economics and Statistics Administration and Kemble Stokes of the International Trade Association were the primary contributors. However, any statements and results presented in this report are solely the responsibility of the author, and do not reflect views held by the Departmen of Commerce.

[1] The various provisions of the EISA 2007 are summarized in Sissine (2007).

Senate. In 2007, the new Congress put energy legislation high on its agenda. In addition, President Bush proposed his "twenty in ten" initiative in the 2007 State of the Union Address. The goal is to reduce gasoline usage by 20 percent in ten years, through increasing the supply of alternative and renewable fuels, and by reforming and modernizing the CAFE standards.

Table 1 reviews some of the more important energy and environmental legislation that has been recently introduced in Congress. With the exception of EISA and the Energy Policy Act of 2005, none of these bills have yet passed, but they have stimulated a lot of controversy and economic analysis. Common wisdom is that some form of greenhouse gas legislation may pass in the next Congress. However, in the current legislative environment, it is difficult even to get these bills out to the floor for debate. It is significant that the bills that have passed don't promise higher energy taxes or energy prices. When Americans are feeling the pain of higher energy prices, it is difficult to get consensus on greenhouse gas legislation that will probably raise energy prices even further.

Major Provisions of EISA 2007

The Energy Independence and Security Act of 2007 (P.L. 110-140, H.R. 6) is an omnibus energy policy law, consisting mainly of provisions to increase energy efficiency and the availability of renewable energy. The major provisions are as follows:

1. Corporate Average Fuel Economy (CAFE). The law sets a target of 35 mpg for the combined fleet of cars and light trucks by model year 2020. The new standards are based on a mathematical function of vehicle attributes, so that the standards cannot be satisfied simply by adjusting the mix of cars and trucks produced. Interim standards will be set, beginning with model year 2011. Manufacturers will be required to come within 92% of the standard for a given model year, and civil penalties will be assessed for non-compliance.
2. Renewable Fuels Standard (RFS). The law sets a modified standard that starts at 9 billion gallons in 2008 and rises to 36 billion gallons by 2022. Of the latter total, 21 billion gallons is required to be obtained from cellulosic ethanol (16 billion gallons) and other advanced biofuels (5 billion gallons), including biodiesel.
3. Energy Efficiency Equipment Standards. This part of the law includes a variety of new standards for lighting and for residential and commercial appliances.
4. Repeal of Oil and Gas Tax Incentives. Two tax subsidies to the oil and gas industries are repealed to offset the estimated costs to implement the CAFE provision.

The main goals of the legislation are to reduce gasoline usage, and therefore reduce dependence on imported oil.

Summary of the Modeling Strategy

The INFORUM *LIFT* model was used to analyze the most important impacts of EISA. In particular, the main assumptions incorporated into the model relate to the Corporate Average Fuel Economy (CAFE) standards and the Renewable Fuel Standard (RFS)[2] provisions of the Act. The

[2] We chose to follow the AEO in assuming that the RFS would not be met by 2022, but that only 22 billion gallons of ethanol would be produced, 20 billion from corn, and 2 billion from cellulosic and other. The motivation for this assumption is discussed in more detail below.

simulations did not incorporate assumptions as to the energy efficient equipment standards, nor of the repeal of the oil and gas tax incentives.

The modeling strategy consisted of developing two scenarios, a "business as usual" (BAU) case, and an EISA case. To develop the EISA case, we started with the published Department of Energy (DOE) Annual Energy Outlook (AEO) baseline from March 2008 (which already includes estimated impacts of EISA 2007) and calibrated *LIFT* to the AEO macroeconomic and energy consumption projections. In other words, the EISA case is consistent with the published AEO. The (BAU) case was developed by removing the EISA provisions from the assumptions, to model the projected path of the U.S. economy in the absence of EISA.

In order to accurately capture the impact of increased production of corn and cellulosic ethanol, as well as the impact of the CAFE standards, several submodules or model extensions were developed for *LIFT*. These submodules included in their outputs calculations of variables that could be used to make assumptions about flows or input-output (IO) coefficients in *LIFT*. For example, the increased use of corn and cellulosic biomass in ethanol production results in a change in the IO coefficient from the *LIFT* Agriculture, forestry and fisheries industry (1) into the Other chemicals (23) industry, which includes ethanol production. Increased fuel efficiency in autos and light trucks was modeled partly by changes in the personal consumption of gasoline, but also in the IO coefficients of fuel used by the business sector.

2. Modeling the EISA

Advantages of LIFT for this Study

The INFORUM *LIFT*[3] model embodies a quantity and price IO model within a full macro model. The forecasts of the model are based on empirically estimated econometric equations for final demand components, employment and value added by industry, and for many of the macro variables. *LIFT* has commodity detail for 97 sectors[4], and value added for 51 sectors comprising the U.S. economy. Many of the macrovariables in the model are determined as aggregates of the corresponding sectoral variables. Nominal GDP components such as labor compensation, corporate profits, proprietors' income and capital consumption allowances are formed as the sum of the values by industry. Real GDP is formed as the sum of detailed final demand variables. The aggregate GDP deflator is simply the ratio of aggregate nominal GDP divided by real GDP. Total employment is the sum of employment by industry plus government employment.

The IO coefficients play a pivotal role in the model, in the determination of both output and prices. They are not constant, but are projected to change over time, based on logistic equations that indicate that all coefficients in a row of the IO table should rise or fall at the same rate. They can be modified by special assumptions, called "fixes", in a given scenario. For example, calibration of LIFT industrial electricity use to the Department of Energy projection is achieved by modifying coefficients of Electric utilities (66) in the industrial sectors (1-58).

The *LIFT* model is particularly suited for studies where one is interested in the interplay of industry behavior and the macroeconomy. For example, in studying the effects of energy price changes, *LIFT* can address the effects of relative price changes on consumption, as well as the impact of energy prices on the aggregate GDP or PCE deflator. Higher oil prices lead to reduced consumption of petroleum products, and thus reduce real oil imports. However, nominal imports are likely to be higher, as oil is relatively price inelastic.

---

[3] See Meade (2001) for a summary of the *LIFT* model.

[4] See Appendix B for a full list of the 97 commodity sectors in *LIFT*.

LIFT is not an energy model, and doesn't include the great degree of detail by energy product and end use that is found in a modeling system such as the DOE National Energy Modeling System (NEMS).[5] However, *LIFT* includes many IO flows, sectoral variables and macro variables that relate to variables in NEMS. The knowledge base from NEMS can be incorporated into *LIFT* through fixes that calibrate *LIFT* variables to those in NEMS. Furthermore, the *LIFT* model incorporates energy flows, interindustry transactions and macro variables into one internally consistent forecast. For this study, several submodules were developed to relate specific details of ethanol production and consumption and of vehicle miles traveled and fuel efficiency to variables already in LIFT.

Calibration of LIFT to the Annual Energy Outlook

The *Annual Energy Outlook* (AEO) is normally published by DOE once a year, in February. The AEO currently has projections out to 2030, and includes tables on the macroeconomic outlook, energy prices, energy consumption, energy production and imports, and energy-related carbon dioxide emissions. Tables are available in Excel format, with values of many NEMS variables from the current year to 2030.[6]

This year, due to the passage of EISA in December 2007, a revised version of the AEO was released in March 2008, incorporating estimates of the effect of EISA, as well as revised macroeconomic growth assumptions. The *LIFT* model was calibrated to this revised AEO for the EISA case. The strategy followed was to get exogenous variables calibrated first, and then to work forward into variables with greater and greater degrees of endogeneity. The details of this calibration are described in Appendix A.

The Ethanol Submodule and Ethanol Assumptions

The ethanol submodule in *LIFT* was developed to explicitly show the accounting for ethanol feedstock (corn or cellulose) use, other input requirements, plant and equipment investment requirements, capacity, production, number of plants, average plant size, and capacity utilization. Some variables calculated in the ethanol model are converted back to constant dollars to guide IO coefficient change in the main *LIFT* model.

Table 2 shows assumptions used in the BAU and EISA cases for corn and cellulosic ethanol production. Annual production of corn ethanol is assumed to reach 15 billion gallons by 2030 in the base, and 20 billion gallons in the EISA case. Cellulosic ethanol production is assumed to reach only 2.1 billion gallons in the base and 12 billion gallons in the EISA case. Capacity for both types of plant is assumed to grow slightly ahead of production, so that capacity utilization ratios are generally between 80 and 95 percent.

The RFS mandates that by 2022 the use of corn ethanol should rise to 15 billion gallons, and that of cellulosic ethanol should rise to 21 billion gallons, for a total of 36 billion gallons of ethanol. Following the AEO, we decided to only assume 22 billion gallons by 2022, of which 2.1 billion gallons is cellulosic ethanol. By 2030 we assume that total production rises to 32 billion gallons, of which 12 is cellulosic ethanol, and 20 is corn ethanol. Although news reports often refer to

---

[5] NEMS is the modeling system used by DOE in the *Annual Energy Outlook*, and for numerous analyses of energy and environmental legislation. Documentation on NEMS can be found on the DOE web site at http://tonto.eia.doe.gov/reports/reports_kindD.asp?type=model%20documentation.

[6] These tables are available at http://www.eia.doe.gov/oiaf/aeo/.

imminent "break-throughs" in the production of cellulosic ethanol, the fact is that there are no commercial-scale cellulosic biofuel plants in the United States, and there are only a few demonstration-scale plants in the U.S. and Canada. Many scientists suggest that commercial realization of cellulosic ethanol is still 5 to 15 years away.[7]

Investment requirements for ethanol are calculated by assuming a certain incremental capacity cost, measured in 2008 dollars of investment per gallon of production capacity. For corn ethanol plants, this cost is fairly well understood, and is currently about $1.50 capital cost for gallon of capacity. In other words, a 50 million gallon plant will have an initial plant cost of $75 million, in today's prices. For this study, we assumed that the incremental capital cost falls further to $1.30 by 2015, and remains flat thereafter. Much less is known about cellulosic ethanol plants. We assume a current incremental capital cost of $7.20 per gallon of capacity. Assuming that economies of scale and learning by doing will bring this cost down, we specify that it falls to $5.60 by 2015, and to $3.00 by 2030.[8] The projected investment expenditure is simply the change in capacity multiplied by the incremental capacity cost. These costs are shown for both corn ethanol and cellulosic ethanol in the line labeled 'Investment'.

Feedstock requirements for ethanol production are calculated in quantities, then converted to constant dollars for the purpose of calculating changes in IO coefficients. For corn ethanol, corn inputs are measured in physical units in billions of bushels (bil bu).

In order to relate corn ethanol production to the context of overall corn production and use, a module for corn supply and disposition was developed that presents results similar to those in the corn table of the USDA Baseline Projections (currently available to 2017)[9]. The USDA baseline was used as our starting point. However, since the ethanol projection in that baseline is slower than either the base or the EISA case, we made some downward adjustments to exports and feed use to keep the non-ethanol Food, seed and industrial (FSI) at about 2.5 bil. bu.

The impact of corn ethanol production on the corn market is very sensitive to assumptions about the productivity growth of corn production, and the number of acres planted and harvested. For this analysis, we assumed productivity growth in both the production of corn, and in the conversion of corn to ethanol. In both simulations, we assume that acreage planted in corn is the same, starting at 88 million acres in 2008, and staying at 92 million acres from 2020 to 2030. This acreage constitutes about 21% of total US cropland, which is assumed to hold steady at 434 million acres. Acres harvested is related to acres planted by regression, using historical USDA data, and reaches 84.6 million acres by 2030. The productivity measure, bushels per acre, starts at 148.4 in 2008, and climbs to 190 by 2030. [10] With these assumptions, corn production reaches 14.2 billion bushels by 2015, and 16.1 billion bushels by 2030. The corn to ethanol conversion rate is assumed to start at 2.91 (gallons per bushel) in 2008, reach 3.0 by 2022, and reach 3.1 by 2030. Combining these assumptions, we find that the ethanol per acre harvested of corn starts at 432.2 gallons in 2008, reaches 500.6 gallons in 2015, and 589 gallons in 2030.

---

[7] See Yacobucci and Capehart (2008) for discussion of constraints to the realization of the goals of the RFS.

[8] The incremental investment costs for corn and cellulosic ethanol plants were taken from the AEO 2007, p.58. Efficiency improvements for the investment costs for cellulosic ethanol plants were determined in consultation with industry experts from the Mitre Corporation.

[9] The USDA Agricultural Baseline can be found at http://www.ers.usda.gov/publications/oce081/.

[10] We used the USDA Baseline yield per acre harvested figures through 2017, and extended these to 2030 linearly.

Table 3 shows some of the results of the ethanol submodule calculations for both cases. For each variable displayed in that table, there are two lines. The first line shows the value in the BAU case, and the second line shows the value in the EISA case. Total corn devoted to ethanol production in the base case reaches 4.8 billion bushels by 2030 in the base case, and 6.5 billion bushels in the EISA case. In percentage terms, this implies that ethanol production constitutes 30.1 percent of total corn production in the base case by 2030, and 40.1 percent in the EISA case. In both the base and the EISA case, corn available for feed and for exports is reduced from the initial USDA-based projection, to make room for ethanol demand. In the EISA case, corn exports fall to 1.1 billion bushels in 2015, but rise eventually to 1.9 billion bushels by 2030.

In this study, we also assume a significant growth of ethanol imports. However, we assume the same import trajectory in both the BAU and the EISA case. Imports reach 2.4 billion gallons by 2014, and 7 billion gallons by 2030, in both cases. Total ethanol supply consists of corn ethanol, cellulosic ethanol and imports. In the base case, supply reaches 17.1 billion gallons by 2015, and 24.1 billion gallons by 2030. In the EISA case, the figures are 20.6 and 39.0, respectively.

Corn requirements for ethanol are converted to constant dollars, using the USDA historical price ($/bu). Cellulosic biomass requirements for ethanol are taken from a National Renewable Energy Laboratory (NREL) paper[11], which provides a figure for corn stover of $0.49 per gallon in 1999 dollars. Although not all cellulosic ethanol may be produced from corn stover, we assume that other biomass costs are comparable. The IO coefficient of Agriculture, forestry and fisheries (1) to Other chemicals (23) (A(1,23)) is modified in both the base and the EISA case to account for these increased purchases of feedstock from the agricultural sector.

The blending of ethanol into gasoline is modeled by assuming an increased flow from Other chemicals (23) into Petroleum refining (24). The IO coefficient A(23,24) is modified by first converting the ethanol supply to constant dollars, then adding it to the existing IO flow, and creating a new coefficient projection.

For a given quantity of gasoline demand, the increased ethanol composition translates into a reduction in crude petroleum requirements. This is calculated by assuming that one gallon of ethanol substitutes for 2/3 gallon of petroleum-derived gasoline, and that one barrel of oil produces 19.5 gallons of gasoline. We then calculate the reduction in barrels of oil required for petroleum refining, convert this quantity to constant dollars, and modify the IO coefficient of Crude petroleum (5) into Petroleum refining (24).

Corn and Agriculture Price Assumptions

Farm prices have increased sharply over the past two years in the U.S. The index of prices received by farmers for all farm products has increased 34 percent from January 2006 to May 2008. The index of prices received for seed grains and hay has increased by 144 percent over that period. High farm prices have contributed to significant retail food price increases, which rose 4.9 percent in 2007, the largest increase in 17 years.[12] Since these price increases have accompanied a surge in ethanol production, many observers have blamed the increase in farm prices on the pressure on the corn market due to ethanol. Others point out that there are several factors behind the high prices, including strong global economic growth, the declining value of the dollar, reduced global supplies due to bad weather conditions, high energy prices that raise production costs, and changes in foreign agricultural policies. Not surprisingly, trade associations

[11] McAloon, et.al. (2000).

[12] Collins (2008).

representing the ethanol producers and the corn growers have argued that the effects of ethanol production on corn and other farm prices are not that significant, and that the other factors listed above are more important.

The debate over the issue is contentious, and rising sentiment against the ethanol mandates may lead to pressure in Congress for a relaxation of the RFS. However, the issue requires careful analysis, and quantifying the effects of ethanol on food prices is difficult. One approach is to view the increase in corn ethanol production as a demand shift for corn, and then estimate the supply elasticity and the resulting price multiplier. Recent testimony by the USDA chief economist suggests that this multiplier is in the range of 2.6 to 3.0.[13] Several studies have analyzed the increase in corn prices from 2006 to 2008, and suggest that the increase in corn ethanol may account from between 28 to 55 percent of the recent corn price increases. Of course, recently the increase in corn used for ethanol has been relatively large as a share of total corn production (4.2% in 2007).

Using a similar technique, we can estimate the effect on the corn price of increased ethanol production in the EISA case versus the BAU case. Table 4 shows corn production for ethanol in the BAU and EISA cases in the first two rows. The next line shows the difference, which is the additional corn needed for ethanol production in the EISA case. Dividing this difference by total corn production we obtain the demand shift due to ethanol production, calculated as a percentage of total production. This is roughly 10 percent in 2020. If we take for a value of the price multiplier the middle of the range of estimates mentioned above (2.8), this implies that the difference in the corn price between the two cases will be about 28 percent in 2020.

The increase in corn prices may have more impact than is indicated by the production of corn alone. For example, soybeans competes for acreage devoted to corn, and also competes as an ingredient for animal feed. Collins (2008) argues that the price effect of ethanol on corn can be expected to cause soybean prices to rise in proportion. Wheat prices are also affected by corn prices to a certain extent, though not as directly. Furthermore, higher corn prices raise the price of growing livestock and poultry.

For the last year for which we have complete data (2006), the share of value of corn and soybeans in the total Agriculture, forestry and fisheries sector was 11.6 percent. We assume that only these two product prices are affected by the increase in ethanol production. The final change in the price change assumed for the full Agriculture, forestry and fisheries sector in *LIFT* is then the product of this share (0.116) and the corn price increase (28% in 2020). The result is a 3.2 percent change in price in EISA with respect to the BAU case in 2020.

The Vehicle Fuel Consumption Submodule and Assumptions

LIFT normally calculates personal consumption of gasoline in constant dollars, using a consumer demand system. In this system, gasoline is one of 92 categories of consumption goods. Business use of gasoline is calculated (also in constant dollars) in the IO model, using coefficients for the petroleum refining row into other industries. For this study, we developed an alternative approach to forecasting gasoline consumption, based on explicit accounting for fleet miles per gallon (mpg) of autos and light trucks.

---

[13] The multiplier is defined as the percentage by which the corn price is expected to increase in response to a one percent increase in demand (in this case, in ethanol production). Joseph Glauber's testimony includes a table on p.11 that purports to show what the corn price would have been in the absence of increased ethanol production. The implied multipliers were calculated from this table. See the References for the title and URL of this testimony.

The data used to develop this module were taken from the Department of Transportation *Transportation Statistics*[14]. Data were used for the following categories of vehicles:

1. Passenger cars
2. Motorcycles
3. Other 2-Axle 4-Tire Vehicles (light trucks)

For each vehicle type, the following characteristics or variables are available:

1. Number registered
2. Vehicle-miles traveled (total)
3. Fuel consumed (total)
4. Average miles traveled per vehicle
5. Average miles traveled per gallon
6. Average fuel consumed per vehicle

The model first calculates projections for the number of vehicles, average miles traveled per vehicle, and average mpg. It then calculates total vehicle miles traveled (VMT), fuel consumed, and fuel consumed per vehicle by identity.

To forecast the number of vehicles, we first construct an estimate of the capital stock of vehicles, by cumulating annual domestic purchases of motor vehicles, and using a stock depreciation rate of 7.5%. [15] We then relate the growth rate of autos and light truck stocks to this stock measure, but modify the growth of each category so that the composition changes from the 52% autos/48% light trucks mix in 2008 to a 65/35 mix in 2030. This reduction in the share of light trucks over time was assumed to be driven by higher energy prices.

The changing of the capital stock is also essential to understanding the average fleet mpg. For both passenger cars and light trucks, we assumed that new vehicles satisfied the CAFE standards, and implicitly tracked the effect of the different mpg of successive vintages by cumulating them into the capital stock, and then taking the average mpg of the existing capital. The mpg calculated in this way lags the actual CAFE standards, but if the CAFE standards stop increasing, the mpg average will catch up to CAFE level [16].

Finally, the average miles traveled per vehicle was first calculated by using a time trend projection. However, this equation gave vehicle-miles traveled projections that grew too fast. [17] The VMT per vehicle projections were modified to grow more slowly, and the projections for number of vehicles were adjusted down to keep the total VMT growing at a rate closer to the AEO.

[14] Table 4-11 *Passenger Car and Motorcycle Fuel Consumption and Travel*, and Table 4-12 *Other 2-Axle 4-Tire Vehicle Fuel Consumption and Travel*.

[15] This depreciation rate implies an average service life of about 13 years in the fleet. If this life is too long, we may be overstating the measure of total auto and light truck capital stock and stock growth.

[16] A minor wrinkle is that cars generally decline in efficiency as they age.

[17] An initial estimate yielded 2.5% annual growth in VMT from 2008 to 2030. The *AEO* figure in Table A-7 grows by 1.7% from 2006 to 2030, so we adjusted the miler per vehicle projections downward.

The assumptions and results of the model calculations are shown in Tables 5 and 6. The number of passenger cars grows from 140.7 million in 2008 to 217.6 million in 2030 in the base, and to 219.0 million in the EISA. The number of light trucks grows more slowly, from 100.3 million in 2008 to 116.6 (116.8 in EISA) million in 2030. In the base case, the average passenger car mpg grows from 22.5 in 2008 to 23.6 in 2030. In the EISA case, mpg for passenger cars grows to 30.2 by 2030. Light trucks mpg grows from 18.6 to 22.5 in the base, and to 30.8 in the EISA case. Total light-duty fleet mpg grows from 20.9 to 23.3 in the base, and to 30.0 in the EISA case by 2030. The average rate of growth of mpg is 0.5% in the base, and 1.7% in the EISA case.

Total fuel consumption grows from 138.8 billion gallons [18] in 2008 to 180.3 billion in 2030. In the EISA case, fuel consumption dips, but then rises again, to end at 139.0 billion gallons in the EISA case. From the ethanol assumptions (see below), total ethanol supply rises from 9.4 billion gallons in 2008 to 24.1 billion in 2030 in the base, and to 39 billion gallons in the EISA case. The quantity of petroleum based gasoline displaced is about two thirds of this.

Assumptions for fuel consumption in the main LIFT model were derived by first converting gallons of fuel to constant dollars. The difference in total constant dollar consumption in the base and EISA cases was then apportioned between personal consumption use and intermediate use, by reducing all uses by the same percentage. Intermediate use was adjusted by modifying IO coefficients.

Other Assumptions

Two other model variables were modified to capture essential changes in the Motor vehicle industry. These variables are:

1. Input requirements for motor vehicles, and the resulting producer price index of motor vehicles.
2. Equipment investment in the motor vehicle industry.

We assumed that the average factor price of motor vehicles would be about 6 % higher in the EISA case relative to the base by 2015, and assumed this differential would climb to 17% by 2030.[19] The LIFT model calculates prices by adding up unit input costs plus value added. The profits and other capital income equations play the role of the price equations in many other models, responding to demand pressures, changing unit costs, and labor productivity changes in a system of econometrically estimated equations. The prices can be fixed. In this case, the price identity is forced to be satisfied by adjusting the capital income equations (if prices rise, there is more profit). However, since the assumed price changes were thought to arise from changes in technology, we specified that several motor vehicle input components would rise more quickly over time. These industry components (with their industry numbers) are listed below:

1. Plastic products (27)
2. Engines and turbines (35)
3. Electrical industrial apparatus (43)

---

[18] The proper measure is gasoline equivalent gallons (GEG), where the measured quantity of ethanol is reduced by multiplying by its energy coefficient (ethanol has about 2/3 the energy of gasoline). However, the DOT data may measure physical gallons consumed, blended or not.

[19] These cost increases, and the IO coefficient changes necessary to bring them about, were drawn from a National Research Council study (2002).

4. Electronic components (48)
5. Motor vehicle parts (50)
6. Other instruments (57)
7. Professional services (77)

These IO coefficient increases in turn stimulate output and employment in the providing industries.

The additional equipment investment in the EISA case was achieved by calculating the implied increase from the base, and incorporating it as an add factor.

Summary of LIFT Variables Affected by Assumptions for CAFE and Ethanol

In regard to both the CAFE and the ethanol provisions of EISA, the development of the submodules served two goals:

1. Extend the capabilities of LIFT to model quantities and detailed variables related to CAFE or ethanol.
2. Provide assumptions for LIFT model variables to affect the model forecast.

The following table summarizes the variables that are changed either by direct assumption, or through calculations from the submodules.

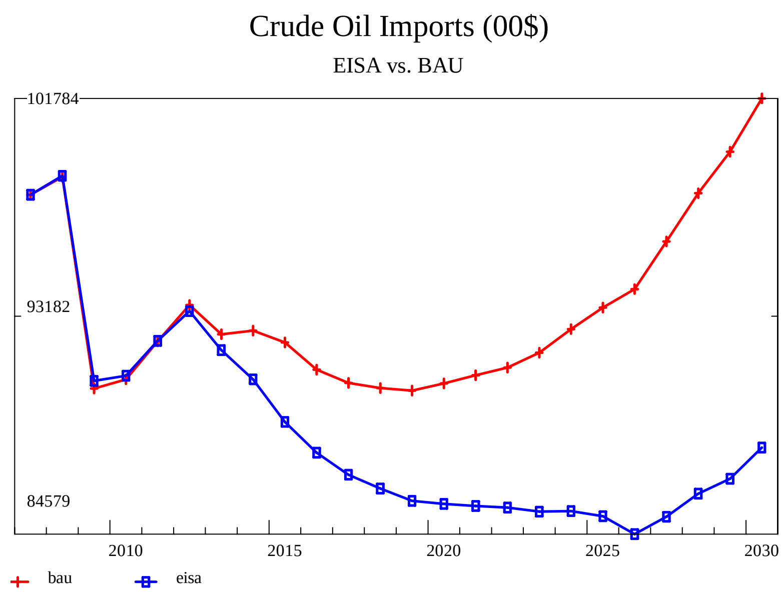
Model Variable	**Description of Calculation or Assumption**
Price of motor vehicles (pdm49)	Input coefficients of several industries raised, to cause an increase in cost
Price of Agriculture, forestry and fisheries	Raised exogenously, based on calculations described above.
Equipment investment of motor vehicles (eqi34)	Increased directly, for the EISA case, to model investment cost of new fuel-saving technologies.
Equipment investment of Chemicals (eqi12)	Increase to reflect investment in new ethanol capacity.
Personal consumption of gasoline (pce65)	Reduced to reflect reduced consumption due to CAFÉ standards.
IO Coefficient from Agriculture to Chemicals: A(1,23)	Raised to reflect increased use of corn and biomass for ethanol production.
IO Coefficient from Chemicals to Petroleum refining: A(23,24)	Raised to reflect the increased ethanol content of gasoline.
IO Coefficient from Crude oil to Petroleum refining: A(5,24)	Reduced to reflect the lower crude oil content of gasoline.
IO Coefficients of various industries to Motor vehicles	Raised to model the increased cost of motor vehicles.

3. Simulation Results

Macroeconomic Effects

Table 7 shows summary macroeconomic results. GDP is lower in the EISA case, for all years shown, though not by much. In constant 2000$, real GDP is lower in the EISA case by $180 billion (0.9%) by 2030. Of this difference, $122 billion is comprised of a lower level of personal consumption expenditures, equipment investment is $23 billion lower, and residential and nonresidential structures investment combined is about $9 billion lower. Exports are lower by $66 billion.

The GDP price deflator is higher in the EISA case (by about 1.5% by 2030), and real disposable income is lower, by $116 billion (0.8%). The nominal trade deficit improves by $55 billion in 2030. Oil imports in constant 2000$ are $13.8 billion lower by 2030, a reduction of about 14%. The full time path of the oil import reduction is shown in the graph below.



Most of the reduction in personal consumption and in exports in the EISA case relative to the BAU can be explained by the higher price level, which is due in large part to higher agricultural and motor vehicles prices. Nominal income is increased, but not as much as the increase in the price level, so that real disposable income is generally lower. The personal consumption category with the largest reduction is of course gasoline and oil. Exports are reduced because of the increase in domestic prices relative to foreign prices.

Industry Output and Employment

Table 8 shows selected industry employment and output results (constant 2000$), where significant changes occurred between and EISA and BAU scenarios. They are summarized in the list below:

- Agriculture, forestry and fisheries (1) – Due to additional requirements of corn and biomass for ethanol production, intermediate flows to chemicals are driving the increase in output for this industry. (nearly $5 billion additional output by 2030). Employment increases by 25.6 thousand jobs by 2030.
- Crude petroleum (5) – Output of this industry is reduced, due to reduced crude petroleum requirements for gasoline production. Note that the import share for petroleum was kept the same in both scenarios, so that the reduction in crude petroleum demand is split between imports and domestic production. However, the employment differences for this industry were not significant, and are not shown in the table.
- Other chemicals (23) – This is the industry which includes ethanol production. Output increases by almost $12 billion by 2030. Employment increases by nearly 13 thousand jobs.
- Petroleum refining (24) – Output in this industry falls by $8.9 billion by 2030. This is due to reduced personal consumption and intermediate consumption of gasoline. The employment figures for the petroleum and fuel oil industries are combined, and the total loss in jobs in this combined industry reaches 1.7 thousand by 2030.
- Fuel oil (25) – This includes diesel, and is part of Personal consumption category 65 (Gasoline and oil). It is also affected by the assumed reduction in spending on this category. Output declines by 3.6 billion by 2030.
- Miscellaneous plastic products (27) – This increases by $16 billion by 2030, due to the increased plastics content assumed for Motor vehicles. Employment increases by 25.5 thousand jobs by 2030.
- Electrical industrial apparatus (43) – Output increases by $1.0 billion, and employment by 1.8 thousand, by 2030. This is also a result of the assumed increased content in Motor vehicles.
- Electronic components (48) – This industry output increases by $6.6 billion and jobs by 3.6 thousand by 2030, for the same reason.
- Motor vehicles (49) – Output falls by $15.6 billion, in response to the increase in price. Jobs fall by 17.8 thousand by 2030.
- Other instruments (57) – Output increases (+$2.7 billion) and jobs increase (+4.2 thousand), due to increased content in Motor vehicles.
- Pipelines (63) – Output and jobs decline slightly from the base, due to reduced requirements for transporting crude oil and refined petroleum products.

4. Conclusions and Further Analysis

Summary of Results

This paper describes the application of the Inforum *LIFT* model to the analysis of various provisions of the EISA 2007 out to 2030. The BAU ("business as usual") scenario attempts to project the path of the economy in the absence of the EISA, and the EISA case assumes that most of the provisions of the EISA take effect, except that the RFS provisions of the act were assumed not to be reached. However, in the EISA case we do assume significant levels in the production in both corn (20 billion gallons) and cellulosic ethanol (12 billion gallons) by 2030, an increase of about 15 billion gallons from the BAU scenario. The CAFE standards specifed in EISA were assumed to be maintained, which call for an increase in CAFE for new passenger cars to 35 mpg by 2020, and 30.8 mpg for light trucks. However, due to the relatively small penetration of new vehicles into the existing stock in any given year the average fleet mpg of passenger cars only reaches 26.7 mpg by 2020 and 30.2 mpg by 2030. The figures for light trucks are 25.2 mpg by 2020 and 29.3 mpg by 2030.

Our findings indicate that aggregate GDP and real income will be slightly reduced in the EISA case, due primarily to differences in personal consumption expenditures and exports. Some of the most important assumptions affecting these aggregate results are:

1. An increase in the price index of motor vehicles, in order to produce more fuel-efficient cars.
2. An increase in agricultural prices, due to increased ethanol production.
3. Declines in fuel consumption of automobiles.

Unlike some other studies which found positive macroeconomic impacts of increased ethanol production[20], we did not assume a fall in the world oil price due to reduced U.S. demand for crude petroleum, nor did we assume that ethanol would be cheaper to produce than gasoline, thus bringing down the price of gasoline/ethanol blend. We also assume that the decline in domestic use of crude petroleum is shared proportionally between domestic production of crude oil and imports, which results in a more negative GDP impact than if we had assumed that the decline came solely from imports.

Industries that are positively affected include Agriculture, Other Chemicals and several industries that were assumed to increase their sales to Motor vehicles to achieve increases in fuel efficiency. Industries that were negatively affected include Crude petroleum, Petroleum refining, Fuel oil, Motor vehicles and Pipelines.

We would like to emphasize that the percentage declines in GDP are quite small (0.6% by 2020 and 0.9% by 2030). Non-market considerations, such as the reduction of carbon emissions and the reduced dependence on imported crude oil may outweigh the decline in GDP in policymakers' considerations.

[20] In particular, Dixon, Osborne and Rimmer (2007), and Osborne (2007).

Appendix A. Calibration of *LIFT* to the *Annual Energy Outlook*

As described in the text, the *LIFT* model was calibrated to this revised AEO for the EISA case. Part of this calibration was at the macroeconomic level, and part included detailed calibration of energy coefficients. At the macroeconomic level, the calibration included the following variables:

1. *Population and labor force* – Population projections are made by detailed age group in *LIFT*. However, total population and labor force can be controlled to a specified level.
2. *Real government spending* – Government spending in *LIFT* is composed of many detailed categories, for federal defense, federal nondefense, state and local (S&L) education, S&L health, and S&L other. These can all be fixed in real terms. The model calculates the nominal values, using government spending price deflators.
3. *Total real exports* – Instead of using the INFORUM Bilateral Trade Model (BTM), exports are left endogenous. Add factors are applied to bring the total in line with AEO. This method allows exports to respond to relative prices.
4. *Crude oil price, natural gas price and coal price* – The AEO presents these prices in real terms, i.e., divided by the GDP deflator. Once the path of the GDP deflator has settled down, these price assumptions can be more finely tuned.
5. *Total real personal consumption* – This total can be specified exogenously. However, this removes much of the model's behavioral response. Instead, we guide the consumption total with add factors on the personal savings rate.
6. *Real investment* – The AEO total for real investment consists of detailed categories of equipment investment, residential construction and nonresidential construction in *LIFT*.
7. *Total real imports* – Individual import equations for each commodity relate imports to domestic demand and relative foreign to domestic prices. Aggregate fixes can be applied, but one must be careful not to make imports of any commodity greater than domestic demand, or this will result in negative output.
8. *Crude oil imports* – Crude oil imports are targeted by fixing the import share.
9. *Labor productivity growth* – Aggregate labor productivity growth in LIFT is a weighted average of productivity growth by industry. Industry variables must be adjusted to adjust the total. The aggregate growth is also affected by industry mix, so that a simulation with higher exports will have faster productivity growth than a simulation with low exports, since productivity growth in the tradeable sectors tends to be faster.
10. *Employment and unemployment* – Since employment and productivity are integrally related, it is useful to hit the productivity targets first, and then make minor modifications to employment. The aggregate unemployment rate can also be calibrated by altering the multiple job adjustment, which relates industry employment to household employment.
11. *Real disposable income* – This can be adjusted most effectively by adjusting the personal tax rate. However, the growth rate of the components of personal income are also important.
12. *GDP price level* – The aggregate price level is a result of a myriad of factors, including individual price fixes, labor compensation, corporate profits, proprietors' income, and capital consumption allowances. These value added categories can be adjusted through the use of aggregate fixes.

Calibration of energy consumption aggregates was achieved partly through the adjustment of IO coefficients, and partly through the adjustment of personal and government consumption of energy. Some individual IO flows are shown explicitly in the AEO tables, such as the consumption of coal for electricity generation. Total electricity consumption (residential, commercial, industrial) is calibrated first, given the macroeconomic, consumer and industry forecast. Then the coal to electricity coefficient A(3,66) is adjusted to bring coal use by electric utilities into agreement with the AEO.[21]

Transportation energy consumption was calibrated by adjusting energy input coefficients in the transportation sectors of *LIFT* (59-64). Industrial energy consumption was calibrated in a similar way, adjusting energy coefficients in the industrial sectors (1-58). Commercial energy consumption includes consumption by trade, services (69-87) and government. Residential energy consumption was calibrated by adjusting personal consumption of energy categories.

A carbon emission calculation submodule was also constructed that relates emissions to energy use. The growth of carbon emissions by major sector was scrutinized as an extra check on the success of the energy flow calibrations. Calibration of the model involving the production of ethanol and the effect of CAFE standards on consumption of motor fuels is discussed in text.

[21] This coal to electricity IO coefficient is largely a function of the mix of generation methods (coal, natural gas, oil, hydro, nuclear, wind, solar, etc.) used. The AEO shows the coal coefficient declining until 2018, as more natural gas capacity comes online, but then rising again as natural gas is expected to increase in cost.

Appendix B. 97 **LIFT** *Commodity Sectors*

1 Agriculture, forestry, and fisheries
2 Metal mining
3 Coal mining
4 Natural gas extraction
5 Crude petroleum
6 Non-metallic mining
7 New construction
8 Maintenance & repair construction
9 Meat products
10 Dairy products
11 Canned & frozen foods
12 Bakery and grain mill products
13 Alcoholic beverages
14 Other food products
15 Tobacco products
16 Textiles and knitting
17 Apparel
18 Paper
19 Printing & publishing
20 Agricultural fertilizers and chemicals
21 Plastics & synthetics
22 Drugs
23 Other chemicals
24 Petroleum refining
25 Fuel oil
26 Rubber products
27 Plastic products
28 Shoes & leather
29 Lumber
30 Furniture
31 Stone, clay & glass
32 Primary ferrous metals
33 Primary nonferrous metals
34 Metal products
35 Engines and turbines
36 Agriculture, construction, mining & oilfield equipment
37 Metalworking machinery
38 Special industry machinery
39 General and miscellaneous industrial machinery
40 Computers
41 Office equipment
42 Service industry machinery
43 Electrical industrial apparatus & distribution equipment
44 Household appliances
45 Electric lighting and wiring equipment and misc. electrical supplies
46 TV's, VCR's, radios & phonographs
47 Communication equipment
48 Electronic components
49 Motor vehicles
50 Motor vehicle parts
51 Aerospace
52 Ships & boats
53 Other transportation equipment
54 Search & navigation equipment
55 Medical instruments & supplies
56 Opthalmic goods
57 Other instruments
58 Miscellaneous manufacturing
59 Railroads
60 Trucking, highway passenger transit
61 Water transport
62 Air transport
63 Pipeline
64 Transportation services
65 Communications services
66 Electric utilities
67 Gas utilities
68 Water and sanitary services
69 Wholesale trade
70 Retail trade
71 Restaurants and bars
72 Finance & insurance
73 Real estate and royalties
74 Owner-occupied housing
75 Hotels
76 Personal and repair services, exc. auto
77 Professional services
78 Computer & data processing
79 Advertising
80 Other business services
81 Automobile services
82 Movies and amusements
83 Private hospitals
84 Physicians
85 Other medical services & dentists
86 Nursing homes
87 Education, social services, membership organizations
88 Federal & state and local government enterprises
89 Non-competitive imports
90 Miscellaneous tiny flows
91 Scrap and used goods
92 Rest of the world industry
93 Government industry
94 Domestic servants

95 INFORUM statistical discrepancy
96 NIPA statistical discrepancy
97 Chain weighting residual

Glossary and Conversions

AEO	Annual Energy Outlook
BAU	Business as Usual
CAFE	Corporate Average Fuel Economy
DOE	Department of Energy
EISA	Energy Independence and Security Act
INFORUM	Interindustry Forecasting at the University of Maryland
LIFT	Long-term Interindustry Forecasting Tool
mpg	Miles per gallon
NEMS	National Energy Modeling System
NREL	National Renewable Energy Laboratory
PCE	Personal Consumption Expenditures
RFS	Renewable Fuels Standard
USDA	U.S. Department of Agriculture
VMT	Vehicle miles traveled

Conversions

Acre	1 Acre = .4047 hectare
Barrel	1 Barrel = 42 U.S. gallons
Bushel	.0352 cubic meters, or 35.24 liters
Gallon	1 U.S. Gallon = 3.785 liters
Mile	1 U.S. Mile = 1.609 kilometers

References

Baker, Allen and Steven Zahniser, "Ethanol Reshapes the Corn Market", *Amber Waves*, 4(2), April 2006, ERS/USDA, http://www.ers.usda.gov/AmberWaves/April06/pdf/EthanolFeatureApril06.pdf .

Collins, Keith, "The Role of Biofuels and Other Factors in Increasing Farm and Food Prices," June 19, 2008 at http://www.foodbeforefuel.org/files/Role%20of%20Biofuels%206-19-08.pdf.

DiPardo, Joseph, "Outlook for Biomass Ethanol Production and Demand", EIA, http://tonto.eia.doe.gov/ftproot/features/biomass.pdf .

Dixon, Peter, Stefan Osborne and Maureen Rimmer, "The Economy-wide Effects in the United States of Replacing Crude Petroleum with Biomass," January 2007, at https://www.gtap.agecon.purdue.edu/resources/download/3358.pdf.

Eathington, Liesl and David Swenson, "Dude, Where's My Corn? Constraints on the Location of Ethanol Production in the Corn Belt," Department of Economics, Iowa State University, March 2007.

Food and Agricultural Policy Research Institute, "U.S. Baseline Briefing Book, Projections for Agricultural and Biofuel Markets," University of Missouri-Columbia, FAPRI-MU Report #03-08, March, 2008 at http://www.fapri.missouri.edu/outreach/publications/2008/FAPRI_MU_Report_03_08.pdf .

Glauber, Joseph, "Statement before the Committee on Energy and Natural Resources, United States Senate", June 12 2008 at http://www.usda.gov/oce/newsroom/archives/testimony/2008/GlauberSenate061208.pdf .

Hahn, Robert and Croline Cecot, "The Benefits and Costs of Ethanol," Working Paper 07-17, AEI-Brookings Joint Center for Regulatory Studies, November 2007.

Koplow, Doug, *Biofuels at What Cost? Government Support for Ethanol and Biodiesel in the United States: 2007 Update*, report prepared for the Blobal Studies Initiative of the International Institute for Sustainable Development, Geneva, Switzerland, October 2007.

McAloon, Andrew, Frank Taylor and Winnie Lee, "Determining the Cost of Producing Ethanol from Corn Starch and Lignocellulosic Feedstocks," National Renewable Energy Laboratory NREL/TP-580-28893, at http://www.nrel.gov/docs/fy01osti/28893.pdf.

McPhail, Lihong Lu, and Babcock, Bruce A., "Short-run Price and Welfare Impacts of Federal Ethanol Policies," Center for Agricultural and Rural Development, Iowa State University, Working Paper 08-WP 468, June 2008, at http://www.card.iastate.edu/publications/DBS/PDFFiles/08wp468.pdf.

Meade, Douglas, "The LIFT Model", Inforum Working Paper, June 2001, at http://www.inforum.umd.edu/papers/wp/wp/2001/wp01002.pdf.

Osborne, Stefan, "Energy in 2020: Assessing the Economic Effects of Commercialization of Cellulosic Ethanol," Manufacturing and Services Competitiveness Report, U.S. Department of Commerce, International Trade Administration, November 2007, at http://www.ita.doc.gov/media/Publications/pdf/cellulosic2007.pdf.

Peters, David, J., “Understanding Ethanol Plant Economics: Will Boom Turn Bust?”, University of Nebraska, Institute of Agriculture and Natural Resources, RD-2007-08-1, August 2007, at http://agecon.unl.edu/peters/pubs/rd-2007-08-1.pdf.

Schnepf, Randy, “High Agricultural Commodity Prices: What Are the Issues?’, Congressional Research Service, CRS Report for Congress RL34474, May 8, 2008, at http://www.fremarcoop.com/images/E0016301/CRS_CommodityPrices.pdf.

Schoonover, Heather and Mark Muller, “Staying Home: How Ethanol Will Change U.S. Corn Exports”, December 2006, Institute for Agriculture and Trade Policy, http://www.agobservatory.org/library.cfm?refid=96658 .

Shapouri, Hosein and Andrew McAloon, “The 2001 Net Energy Balance of Corn-Ethanol”, ERS Report, http://www.usda.gov/oce/reports/energy/net_energy_balance.pdf .

Shapouri, Hosein and Paul Gallagher, “USDA’s 2002 Ethanol Cost of Production Survey”, USDA, July 2005, http://www.ncga.com/ethanol/pdfs/031506USDACostOfProduction.pdf .

Sissine, Fred, Coordinator, “Energy Independence and Security Act of 2007: A Summary of Major Provisions,” Congressional Research Service, CRS Report for Congress RL34294, December 2007, at http://energy.senate.gov/public/_files/RL342941.pdf.

Swenson, David, “Input-Outrageous: The Economic Impacts of Modern Biofuels Production,” Department of Economics, Iowa State University, June 2006, at http://www.nercrd.psu.edu/Biofuels/Swenson.pdf.

Tokgoz, Simla, et al., “Emerging Biofuels: Outlook of Effects on U.S. Grain, Oilseed and Livestock Markets”, Center for Agricultural and Rural Development, Iowa State University, July, 2007, at http://www.card.iastate.edu/publications/DBS/PDFFiles/07sr101.pdf.

Transportation Research Board, National Research Council, *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards*, National Academy Press, Washington, D.C., 2002.

Westcott, Paul, Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust?”, ERS Report FSD-07D-01, May 2007.

U.S. Department of Agriculture, *USDA Agricultural Projections to 2017*, Office of the Chief Economist, February 2008, at http://www.ers.usda.gov/publications/oce081/ .

U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2008*, June 2008, Washington, D.C. at http://www.eia.doe.gov/oiaf/aeo/.

Yacobucci, Brent D. and Tom Capehart, “Selected Issues Related to an Expansion of the Renewable Fuel Standard (RFS),” Congressional Research Service, CRS Report for Congress RL34265, March, 2008, at http://assets.opencrs.com/rpts/RL34265_20071203.pdf.

Tables

Table 1. Sample of Environment / Energy Bills Introduced into Congress: 2005 to 2008

Introduced			Provisions	Passed	Public Law
April 18, 2005	H.R.1640	Energy Policy Act of 2005	Sets forth an energy research and development program covering: (1) energy efficiency; (2) renewable energy; (3) oil and gas; (4) coal; (5) Indian energy; (6) nuclear matters and security; (7) vehicles and motor fuels, including ethanol; (8) hydrogen; (9) electricity; (10) energy tax incentives; (11) hydropower and geothermal energy; and (12) climate change technology.	August 8, 2005	109-58
January 12, 2007	H.R.6	Energy Independence and Security Act of 2007	Reduce oil dependence through 1) CAFE standards; 2) Renewable Fuel Standard (RFS); 3) Appliance and Lighting Efficiency Standards	December 19, 2007	110-140
January 12, 2007	S.280	Climate Stewardship and Innovation Act of 2007	Aims to reduce GHG emissions with a market-driven system of tradeable allownaces, and support the deployment of climate change related technologies		
July 11, 2007	S.1766	Low Carbon Economy Act of 2007 ("Bingaman-Specter")	Places a cap on GHG emissions, establishes market for emission allowances, and does not allow for foreign credits or international offsets.		
October 18, 2007	S.2191	Climate Security Act of 2008 ("Warner-Lieberman")	Aims to reduce greenhouse gas emissions through a system of traded allowances.	Scheduled for debate	

Table 2. Assumptions and Calculations for Ethanol Production

Line No.		2008	2010	2015	2020	2025	2030
1	**Corn Ethanol Production (billions of gallons)**						
2	Without the EISA	8.6	12.0	14.5	14.8	15.0	15.0
3	With the EISA	8.6	12.0	18.0	19.3	20.0	20.0
4	Ethanol Production Resulting from EISA	0.0	0.0	3.5	4.5	5.0	5.0
5							
6	**Cellulosic Ethanol Production (billions of gallons)**						
7	Without the EISA	0.0	0.0	0.2	1.2	2.1	2.1
8	With the EISA	0.0	0.0	0.2	1.2	5.5	12.0
9	Ethanol Production Resulting from EISA	0.0	0.0	0.0	0.0	3.4	9.9
10							
11	**Total Ethanol Production (billions of gallons)**						
12	Without the EISA	8.6	12.0	14.7	16.0	17.1	17.1
13	With the EISA	8.6	12.0	18.2	20.5	25.5	32.0
14	Ethanol Production Resulting from EISA	0.0	0.0	3.5	4.5	8.4	14.9
15							
16	**Corn Ethanol Production Capacity (without EISA)**						
17	Number (115 in existence plus 79 under construction)	140	175	200	200	202	202
18	Average Production Per Plant (millions of gallons)	70	72	81	87	90	90
19	Annual Production Capacity (billions of gallons)	9.8	12.6	16.2	17.4	18.2	18.2
20	Capacity Utilization Rate without EISA (%)	87.8%	95.2%	89.5%	85.1%	82.5%	82.5%
21	Incremental Capital Cost (2007$ per gallon of capacity)	1.45	1.35	1.33	1.30	1.30	1.30
22	Investment (Millions of 2007$)	6244.6	1674.0	530.0	520.0	0.0	0.0
23	**Corn Ethanol Production Capacity (with EISA)**						
24	Number (115 in existence plus 79 under construction)	140	194	230	254	262	267
25	Average Production Per Plant (millions of gallons)	70	72	81	87	90	90
26	Annual Production Capacity (billions of gallons)	9.8	14.0	18.6	22.1	23.6	24.0
27	Capacity Utilization Rate with EISA (%)	87.8%	85.9%	96.6%	87.3%	84.8%	83.2%
28	Incremental Capital Cost (2007$ per gallon of capacity)	1.45	1.35	1.33	1.30	1.30	1.30
29	Investment (Millions of 2007$)	6244.6	3041.6	1656.2	881.4	0.0	117.0
30	**Corn Ethanol Production Capacity (As a Result of EISA)**						
31	Change in the number of plants	0	19	30	54	60	65
32	Change in Annual Production Capacity (billions of gallons)	0.0	1.4	2.4	4.7	5.4	5.9
33							
34	**Cellulosic Ethanol Production Capacity (without EISA)**						
35	Number (None in existence)	0	0	3	17	31	28
36	Average Production Per Plant (millions of gallons)	0	0	75	87	90	99
37	Annual Production Capacity (billions of gallons)	0.0	0.0	0.2	1.5	2.8	2.8
38	Capacity Utilization Rate without EISA (%)	0.0%	0.0%	88.9%	83.8%	75.3%	75.8%
39	Incremental Capital Cost (2007$ per gallon of capacity)	7.2	6.5	5.6	4.7	3.0	3.0
40	Investment (Millions of 2007$)	0.0	0.0	590.6	2180.2	0.0	0.0
41	**Cellulosic Ethanol Production Capacity (with EISA)**						
42	Number (None in existence)	0	0	3	17	65	130
43	Average Production Per Plant (millions of gallons)	0	0	75	87	90	99
44	Annual Production Capacity (billions of gallons)	0	0	0.2	1.5	5.9	12.9
45	Capacity Utilization Rate with EISA (%)	0.0%	0.0%	88.9%	81.1%	94.0%	93.2%
46	Incremental Capital Cost (2007$ per gallon of capacity)	7.2	6.5	5.6	4.7	3.0	3.0
47	Investment (Millions of 2007$)	0.0	0.0	590.6	2180.2	5928.7	2235.0
48	**Cellulosic Ethanol Production Capacity (As a Result of EISA)**						
49	Change in the Number of Plants	0	0	0	0	34	102
50	Change in Annual Production Capacity (billions of gallons)	0.0	0.0	0.0	0.0	3.1	10.1
51							
52	**Corn Market Assumptions**						
53	Acres planted (millions)	88.0	93.0	91.5	92.0	92.0	92.0
54	Acres harvested	80.5	85.6	84.1	84.6	84.6	84.6
55	Yield/Harvested Acre (bushels)	148.4	159.3	169.3	179.3	184.7	190.0
56	Corn Production (bil bu)	11.9	13.6	14.2	15.2	15.6	16.1
57	Ethanol Conversion Rate (gal/bu)	2.91	2.93	2.96	2.99	3.04	3.10
58	Corn Ethanol Yield (gal/acre)	432.2	465.9	500.6	535.7	560.9	589.0
59							
60	**Ethanol Imports (billions of gallons) (w & wo EISA)**	0.800	0.899	2.400	3.200	5.000	7.000

Table 3. Ethanol and Corn Model Results

	2008	2010	2015	2020	2025	2030	08-30	08-20	20-30
Total Ethanol Production	8.6	12.0	14.7	16.0	17.1	17.1	3.2	5.3	0.6
	8.6	12.0	18.2	20.5	25.5	32.0	6.2	7.5	4.6
Ethanol Imports	0.8	0.9	2.4	3.2	5.0	7.0	10.4	12.2	8.1
	0.8	0.9	2.4	3.2	5.0	7.0	10.4	12.2	8.1
Ethanol Supply	9.4	12.9	17.1	19.2	22.1	24.1	4.4	6.2	2.3
	9.4	12.9	20.6	23.7	30.5	39.0	6.7	8.0	5.1
Ethanol subsidy rate ($/gal)	0.51	0.51	0.51	0.51	0.51	0.51	0.0	0.0	0.0
	0.51	0.51	0.51	0.51	0.51	0.51	0.0	0.0	0.0
Total Subsidy Paid (mil$)	4386	6120	7497	8180	8721	8721	3.2	5.3	0.6
	4386	6120	9279	10455	13005	16320	6.2	7.5	4.6
Corn Supply & Disposition (bil bu)									
Beginning Stocks	1.90	0.55	0.76	0.88	1.81	1.72	-0.5	-6.2	6.9
	1.90	0.55	0.75	0.87	1.83	1.32	-1.6	-6.2	4.2
Production	11.86	13.64	14.24	15.17	15.62	16.08	1.4	2.1	0.6
	11.86	13.64	14.24	15.17	15.62	16.08	1.4	2.1	0.6
Imports	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0
	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0
Supply	11.87	13.65	14.26	15.19	15.64	16.09	1.4	2.1	0.6
	11.87	13.65	14.26	15.19	15.64	16.09	1.4	2.1	0.6
Feed and Residual	5.45	5.12	5.11	5.49	5.76	6.49	0.8	0.1	1.7
	5.45	5.12	4.52	4.73	4.97	5.77	0.3	-1.2	2.0
Food, Seed & Industrial	5.50	6.60	7.41	7.45	7.44	7.34	1.3	2.6	-0.2
	5.50	6.60	8.59	8.96	9.08	8.95	2.2	4.2	0.0
Ethanol	2.95	4.10	4.90	4.95	4.94	4.84	2.3	4.4	-0.2
	2.95	4.10	6.09	6.46	6.58	6.45	3.6	6.7	0.0
Non-Ethanol FS&I	2.55	2.50	2.50	2.50	2.50	2.50	-0.1	-0.2	0.0
	2.55	2.50	2.50	2.50	2.50	2.50	-0.1	-0.2	0.0
Domestic Use	10.95	11.73	12.52	12.95	13.19	13.83	1.1	1.4	0.7
	10.95	11.73	13.11	13.69	14.05	14.72	1.4	1.9	0.7
Exports	2.15	1.72	1.74	2.08	2.26	2.65	0.9	-0.3	2.4
	2.15	1.72	1.14	1.33	1.45	1.87	-0.6	-3.9	3.5
Total Use	13.10	13.45	14.25	15.03	15.46	16.48	1.0	1.2	0.9
	13.10	13.45	14.25	15.02	15.50	16.60	1.1	1.1	1.0
Ending Stocks	0.67	0.75	0.76	1.03	1.99	1.33	3.2	3.7	2.6
	0.67	0.75	0.76	1.04	1.97	0.82	0.9	3.8	-2.4
Share of Corn for Ethanol (percent)	24.9	30.0	34.4	32.6	31.6	30.1	0.9	2.3	-0.8
	24.9	30.0	42.7	42.5	42.1	40.1	2.2	4.6	-0.6

Table 4. Calculated Effect of Ethanol Production Increase on Corn and Agriculture Prices

		2012	2015	2020	2025	2030
Corn Production for Ethanol (bil bu)	BAU	4.5	4.9	5.0	4.9	4.8
	EISA	4.5	6.1	6.5	6.6	6.5
	Difference	0.0	1.2	1.5	1.6	1.6
Total Corn Production (bil bu)		13.6	14.2	15.2	15.6	16.1
Ethanol Demand Shift (percent of total)		0.0%	8.3%	9.9%	10.5%	10.0%
Assumed percentage increase in corn price per one percentage point increase in corn use for ethanol	**0.42**					
Percentage increase in corn price		0.0%	3.5%	4.2%	4.4%	4.2%
Share of corn and soybeans in total Agriculture, forestry and fisheries (2006)	**0.116**					
Estimated percent increase in Agriculture, forestry and fisheries price		0	0.40%	0.48%	0.51%	0.49%

Table 5. Assumptions and Calculation of Improved Energy Efficiency in the Auto and Light Truck Fleet as a Result of CAFE Provisions

Line No.		**2008**	**2010**	**2015**	**2020**	**2025**	**2030**
1	Increase in the price of autos/lt. trucks (index)	1.01	1.04	1.06	1.08	1.11	1.15
2	Increase in annual growth in auto ind. equip. investment to						
3	incorporate new technologies (percentage point)	0.00	0.80	0.80	0.80	0.80	0.80
4							
5	**CAFÉ Mix of Fleet (Pre-EISA:Post-EISA)**						
6	Pre EISA fleet (existing technologies) (x00 percent)	1.00	0.90	0.65	0.40	0.15	0.10
7	Post EISA fleet (new technologies) (x00 percent)	0.00	0.10	0.35	0.60	0.85	0.90
8							
9	**Fleet Mix (Autos:Light Trucks)**						
10	Autos (x00 percent)	0.58	0.59	0.62	0.64	0.65	0.65
11	Light Trucks (x00 percent)	0.42	0.41	0.38	0.36	0.35	0.35
12							
13	**Fleet Mix (100 unit example)**						
14	Autos						
15	Old Café	58.00	53.10	40.30	25.60	9.75	6.60
16	New Café	0.00	5.90	21.70	38.40	55.25	59.40
17	Light Trucks						
18	Old Café	42.00	36.90	24.70	14.40	5.25	3.40
19	New Café	0.00	4.10	13.30	21.60	29.75	30.60
20							
21	**CAFÉ Increase**						
22	Autos (mpg avg.)	25.00	26.82	31.36	35.00	35.00	35.00
23	Light Trucks (mpg avg.)	22.00	23.60	27.60	30.80	30.80	30.80

Table 6. Results of Vehicles Submodule

	2008	2010	2015	2020	2025	2030	08-30	08-20	20-30
Automobile Industry									
Factory price index	1.25	1.31	1.47	1.62	1.77	1.92	2.0	2.2	1.7
	1.25	1.32	1.54	1.76	2.00	2.26	2.7	2.9	2.5
Investment (billions of 2007$)	10.8	14.0	16.6	18.6	22.0	28.4	4.5	4.7	4.3
	10.8	14.1	17.0	20.3	24.6	33.0	5.2	5.4	5.0
Fleet Characteristics									
Passenger Cars									
Number of Vehicles	140.7	146.0	163.9	181.5	198.7	218.1	2.0	2.1	1.9
	140.7	146.0	163.4	181.1	198.6	218.6	2.0	2.1	1.9
Avg. Miles/Vehicle	12.7	12.9	13.1	13.2	13.4	13.5	0.3	0.3	0.2
	12.6	12.8	12.9	12.9	13.1	13.2	0.2	0.2	0.2
Vehicle Miles Traveled	1784.1	1877.3	2144.9	2400.0	2653.0	2941.5	2.3	2.5	2.1
	1779.3	1861.9	2102.7	2342.7	2591.9	2891.7	2.2	2.3	2.1
Miles Per Gallon	22.5	22.6	22.8	23.1	23.3	23.6	0.2	0.2	0.2
	22.5	22.7	24.3	26.7	28.7	30.2	1.4	1.4	1.2
CAFE Standard for Cars	25.0	25.0	25.0	25.0	25.0	25.0	0.0	0.0	0.0
	25.0	26.8	31.4	35.0	35.0	35.0	1.5	2.8	0.0
Fuel Consumption (GEG)	79.4	83.2	94.1	104.1	113.7	124.6	2.1	2.3	1.8
	79.2	81.9	86.7	87.8	90.3	95.8	0.9	0.9	0.9
Light Trucks									
Number of Vehicles	100.3	101.5	106.7	110.8	113.6	116.9	0.7	0.8	0.5
	100.3	101.4	106.3	110.4	113.2	116.5	0.7	0.8	0.5
Avg. Miles/Vehicle	11.0	11.0	10.9	10.8	10.8	10.7	-0.1	-0.1	-0.1
	11.0	11.0	10.9	10.8	10.8	10.7	-0.1	-0.1	-0.1
Vehicle Miles Traveled	1101.1	1111.5	1163.0	1201.2	1225.8	1254.6	0.6	0.7	0.4
	1101.1	1111.1	1159.0	1197.0	1221.7	1251.3	0.6	0.7	0.4
Miles Per Gallon	18.6	19.3	20.5	21.4	22.0	22.5	0.9	1.2	0.5
	18.6	19.5	22.1	25.2	27.6	29.3	2.1	2.6	1.5
CAFE Standard for Light Trucks	22.0	22.0	22.0	22.0	22.0	22.0	0.0	0.0	0.0
	22.0	23.6	27.6	30.8	30.8	30.8	1.5	2.8	0.0
Fuel Consumption (GEG)	59.2	57.7	56.6	56.1	55.6	55.8	-0.3	-0.4	-0.1
	59.2	57.1	52.5	47.5	44.2	42.7	-1.5	-1.8	-1.1
Light-duty Vehicles, Total									
Number of Vehicles	247.9	254.7	278.6	301.1	321.9	345.4	1.5	1.6	1.4
	247.9	254.6	277.7	300.3	321.4	345.6	1.5	1.6	1.4
Avg. Miles/Vehicle	11.7	11.8	11.9	12.0	12.1	12.2	0.2	0.2	0.2
	11.7	11.7	11.8	11.8	11.9	12.0	0.1	0.1	0.2
Vehicle Miles Traveled	2898.0	3002.1	3322.8	3617.6	3896.7	4215.6	1.7	1.9	1.5
	2893.2	2986.3	3276.4	3556.1	3831.5	4162.5	1.7	1.7	1.6
Miles Per Gallon	20.9	21.3	22.0	22.5	23.0	23.3	0.5	0.6	0.3
	20.9	21.4	23.5	26.2	28.4	30.0	1.7	1.9	1.4
Fuel Consumption (GEG)	138.8	141.1	151.0	160.5	169.6	180.7	1.2	1.2	1.2
	138.6	139.3	139.4	135.6	134.8	138.7	0.0	-0.2	0.2
Gasoline Summary (mil gal)									
Total Fuel for Light Duty Vehicles	138.8	141.1	151.0	160.5	169.6	180.7	1.2	1.2	1.2
	138.6	139.3	139.4	135.6	134.8	138.7	0.0	-0.2	0.2
Ethanol Supply	9.4	12.9	17.1	19.2	22.1	24.1	4.4	6.2	2.3
	9.4	12.9	20.6	23.7	30.5	39.0	6.7	8.0	5.1
Gasoline Replaced by Ethanol	6.2	8.5	11.3	12.7	14.5	15.9	4.4	6.2	2.3
	6.2	8.5	13.6	15.6	20.1	25.7	6.7	8.0	5.1
Petroleum Based Gasoline	132.6	132.6	139.7	147.8	155.1	164.8	1.0	0.9	1.1
	132.4	130.8	125.8	120.0	114.7	113.1	-0.7	-0.8	-0.6
Gasoline Consumption (bil 2007$)	372.4	378.7	405.1	430.6	455.3	484.9	1.2	1.2	1.2
	372.0	373.8	374.1	363.9	361.7	372.5	0.0	-0.2	0.2
Gasoline Consumption (cu$)	412.6	360.4	340.3	377.9	400.4	442.0	0.3	-0.7	1.6
	412.0	355.7	314.2	319.2	318.0	339.4	-0.9	-2.1	0.6

Table 7. Macroeconomic Summary

	2008	2010	2015	2020	2025	2030	08-30	08-20	20-30
REAL GDP by FINAL DEMAND CATEGORY (Billions of chained 2000 dollars)									
Gross Domestic Product	11650	12361	14320	15936	17906	20439	2.6	2.6	2.5
	-14	-45	-155	-97	-129	-180	0.0	0.0	0.0
Personal Consumption Expenditures	8392	8860	10285	11403	12716	14080	2.4	2.6	2.1
	-12	-41	-148	-97	-109	-122	0.0	-0.1	0.0
Gross Private Fixed Investment	1716	1929	2351	2598	3018	3665	3.5	3.5	3.5
	-2	-7	-35	0	-15	-23	0.0	0.0	-0.1
Nonresidential Structures	288	365	387	388	419	502	2.6	2.5	2.6
	0	-2	-5	1	-2	-3	0.0	0.0	-0.1
Equipment Investment	1025	1128	1315	1511	1836	2296	3.7	3.3	4.3
	-1	-5	-17	-3	-13	-19	0.0	0.0	-0.1
Residential Investment	413	430	640	715	818	961	3.9	4.7	3.0
	0	0	-13	0	-4	-6	0.0	0.0	-0.1
Real Net Exports	-498	-469	-369	-128	129	764			
	0	3	26	-3	-16	-58			
Exports	1518	1764	2467	3408	4539	6050	6.5	7.0	5.9
	0	0	-2	-16	-33	-66	-0.1	0.0	-0.1
Imports	2017	2233	2836	3536	4410	5286	4.5	4.8	4.1
	0	-3	-28	-13	-17	-8	0.0	0.0	0.0
Government	2078	2103	2181	2283	2397	2504	0.9	0.8	0.9
	0	-1	0	-2	0	-1	0.0	0.0	0.0
Gross Domestic Product, bil cu$	14252	15672	19915	24304	30298	38004	4.6	4.5	4.6
	-18	-57	-214	-13	71	230	0.0	0.0	0.1
GDP Deflator	122.3	126.8	139.1	152.5	169.2	185.9	1.9	1.9	2.0
	0.0	0.0	0.0	0.9	1.6	2.8	0.1	0.0	0.1
Unemployment Rate	5.8	5.9	3.6	4.5	5.5	5.9	0.0	-2.1	2.6
	0.1	0.3	0.9	0.3	0.3	0.3	0.1	0.4	-0.1
Real Disp Income, bil 00$	8765	9220	10800	11977	13324	14922	2.4	2.6	2.2
	-13	-44	-162	-100	-107	-116	0.0	-0.1	0.0
Trade Balance	-833	-824	-902	-943	-1060	-748	-0.5	1.0	-2.3
	-1	3	41	30	48	55	-0.3	-0.3	-0.4
Oil Imports	98.7	90.7	92.1	90.5	93.5	101.8	0.1	-0.7	1.2
	0.0	0.1	-3.0	-4.7	-8.2	-13.8	-0.7	-0.4	-0.9

Table 8. Output and Employment for Selected Industries

	2008	2010	2015	2020	2025	2030	08-30	08-20	20-30
Output (billions of constant 2000$)									
1 Agriculture, forestry and fisheries	397.6	416.3	464.1	495.0	516.7	562.4	1.6	1.8	1.3
	-0.2	-0.5	-0.2	0.2	1.9	4.8	0.0	0.0	0.1
5 Crude petroleum	81.4	89.3	85.9	88.6	81.6	68.7	-0.8	0.7	-2.5
	0.0	0.1	-2.4	-3.9	-5.9	-7.3	-0.5	-0.4	-0.7
23 Other chemicals	246.3	263.4	309.0	332.0	348.1	392.4	2.1	2.5	1.7
	-0.1	-0.3	2.9	4.2	7.2	11.8	0.1	0.1	0.2
24 Petroleum refining	259.8	259.3	266.1	270.8	274.1	278.5	0.3	0.3	0.3
	0.1	0.5	-2.3	-5.7	-7.8	-8.9	-0.1	-0.2	-0.1
25 Fuel oil	74.9	75.2	79.0	82.0	86.6	91.7	0.9	0.8	1.1
	0.0	-0.2	-1.2	-2.2	-3.0	-3.6	-0.2	-0.2	-0.1
27 Plastic products	153.3	163.5	193.0	215.1	241.0	288.6	2.9	2.9	3.0
	-0.1	0.2	2.5	6.7	10.6	16.0	0.3	0.3	0.2
43 Electrical industrial apparatus	33.2	34.5	37.5	38.9	40.2	47.4	1.6	1.3	2.0
	0.0	0.1	0.5	0.9	0.8	1.0	0.1	0.2	0.0
48 Electronic components	221.7	241.8	296.7	343.4	387.0	468.9	3.5	3.7	3.2
	-0.1	0.0	1.0	3.4	4.7	6.6	0.1	0.1	0.0
49 Motor vehicles	292.6	314.7	366.6	397.1	435.4	499.0	2.5	2.6	2.3
	-0.4	-1.8	-6.3	-6.2	-10.6	-15.6	-0.1	-0.1	-0.2
57 Other instruments	86.2	96.5	120.5	146.7	177.8	229.6	4.6	4.5	4.6
	-0.1	0.1	0.4	1.4	2.4	2.7	0.1	0.1	0.0
63 Pipelines	8.0	8.1	8.7	9.5	10.3	11.5	1.6	1.4	1.9
	0.0	0.0	-0.1	-0.3	-0.4	-0.4	-0.2	-0.2	-0.1
Employment (thousands)									
1 Agriculture, forestry, and fisheries	3824.5	3832.3	3752.1	3485.4	3194.0	3000.6	-1.1	-0.8	-1.5
	-1.2	-4.8	-3.0	1.2	10.0	25.6	0.0	0.0	0.1
23 Other chemicals	441.9	460.6	488.4	467.8	436.7	428.6	-0.1	0.5	-0.9
	-0.1	-0.4	3.0	5.9	8.0	12.8	0.1	0.1	0.2
24 Petroleum refining & fuel oil	106.6	97.8	84.1	70.3	59.0	49.6	-3.4	-3.4	-3.4
	0.0	0.1	-0.7	-1.5	-1.7	-1.7	-0.1	-0.2	-0.1
27 Plastic products	629.2	608.3	576.7	522.0	480.6	468.6	-1.3	-1.5	-1.1
	-0.2	0.0	6.6	15.6	20.4	25.5	0.2	0.2	0.2
43 Electrical industrial apparatus	156.0	146.9	124.4	104.0	88.4	85.1	-2.7	-3.3	-2.0
	0.0	0.1	1.5	2.5	1.8	1.8	0.1	0.2	0.0
48 Electronic components	535.6	397.9	262.4	213.1	204.2	233.9	-3.7	-7.4	0.9
	-0.3	-0.1	1.3	3.4	3.3	3.6	0.1	0.1	0.0
49 Motor vehicles	474.0	493.2	544.4	549.3	555.7	580.0	0.9	1.2	0.5
	-0.4	-2.2	-9.2	-8.1	-13.4	-17.8	-0.1	-0.1	-0.2
57 Other instruments	255.6	277.4	300.7	308.4	312.3	329.4	1.2	1.6	0.7
	-0.1	0.1	0.7	3.0	3.8	4.2	0.1	0.1	0.0
63 Pipelines	9.6	9.1	8.5	8.1	7.8	7.7	-1.0	-1.4	-0.6
	0.0	0.0	-0.1	-0.2	-0.3	-0.3	-0.2	-0.2	-0.1
Total Employment	148166.4	151245.5	160114.8	162126.2	165845.5	171798.5	0.7	0.8	0.6
	-127.1	-432.7	-1466.5	-465.7	-517.1	-493.7	0.0	0.0	0.0