TESTIMONY OF PAUL N. CICIO
PRESIDENT
INDUSTRIAL ENERGY CONSUMERS OF AMERICA

SENATE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

SUBCOMMITTEE ON PRIVATE SECTOR AND CONSUMER SOLUTIONS TO GLOBAL WARMING AND WILDLIFE PROTECTION

OCTOBER 24, 2007

"A HEARING TO EXAMINE AMERICA'S CLIMATE SECURITY ACT OF 2007"

Chairman Lieberman, Ranking Member Warner and Committee Members, we are grateful for the opportunity to testify before you on this important and timely topic.

As you know, one of the greatest environmental legislative accomplishments was the enactment of the Clean Air Act of 1990 which took ten years and passed overwhelmingly with bipartisan support. While its complexity is well noted, it pales in complexity to comprehensive climate change legislation and its implication to our country's economic health and future. Much is at stake and we encourage you to take the time to do it right. Doing so will yield the greatest possible greenhouse gas (GHG) reductions based on a coherent strategy.

We are not on opposite sides of the debate. We are in this together. IECA member companies support action by Congress to increase energy efficiency and lower greenhouse gas emissions (GHG) to reduce the threat of climate change. We also support mandatory reporting. IECA is concerned about the availability of low GHG emitting energy supply and the availability of technology that will be needed given the legislation's time table.

IECA's starting point for dealing with climate legislation appears to be very different than that of the proposed legislation. We already see high and rising energy costs that are impacting our competitiveness and jobs. Homeowners and farmers are suffering from high heating, cooling and transportation costs. And, while the cost of this legislation is not transparent, home owners, farmers and manufacturers will pay for the CO2 auctions and the higher costs of natural gas, heating oil, electricity and gasoline. Consumers will pay for all of the hidden transaction costs as well because the proposed legislation allows non-regulated entities to buy, sell, hold or retire carbon allowances. As we have already seen in a number of commodity markets, adding financial or other participants to a market historically made up of suppliers and users will add volatility and add a price premium when that commodity is in short supply. Higher energy costs and compliance costs are inflationary which will reduce disposable income.

All consumers are already reeling from high energy prices. Consumers paid $76 billion more in 2006 for natural gas and $65 billion more for electricity as compared to 2000. The below price comparison was featured in a Saturday, October 20, 2007 Washington

Post article which illustrates how much more consumers are paying for energy since last October.

Energy Product	% Change
Crude oil, WTI	+56%
Diesel	+39%
Fuel Oil, NY	+41%
Gasoline, Reg NY	+47%
Propane, NTET, MB	+61%
Natural Gas	-

Without EIA economic modeling that uses realistic supply, demand and price assumptions, it is impossible to tell how this legislation will impact energy costs or the economy. In that regard, it is essential that Congress review an article that is attached to our testimony entitled "Betting on Bad Numbers". The article was written by two Penn State professors who prove that the EIA modeling is systematically flawed. It is critical this be corrected as soon as possible.

Five Key Points

1. The only way for the U.S. and the world to reduce absolute GHG emissions is to increase the supply of affordable and reliable low carbon intensive energy. The world is growing at a rate of 70 million people per year which will increase demand for energy. It is critical that this energy be less carbon intensive. This legislation does not increase low carbon energy supply. (Ongoing conservation and energy efficiency will continue to play an important role.)

2. No one disagrees that natural gas will play a vital role in the U.S. as the "bridge fuel". At best, our supply situation is fragile. In our opinion, this legislation would accelerate demand for natural gas that does not exist.

3. Nothing in this legislation will prevent the power generation industry from fuel switching from coal to natural gas which will increase the price of natural gas and electricity from all consumers. Cap and trade policy increases the potential for this to occur as it did in Europe with the EU ETS (Emissions Trading Scheme).

4. There are at least three major mandatory options to control GHG emissions from carbon intensive industries: cap & trade; carbon taxes; and various GHG performance standards. Of these three, in general, cap and trade is the least preferred by the industrial sector. A declining cap challenges our ability to grow and supply the market with the products we produce. We provide products needed for economic growth and enabling solutions to reduce GHG emissions for the market. Products such as insulation, composite plastics, high performance light weight steels and fertilizer to grow crops for biofuels. It is counterproductive to limit our output. Doing so drives our production facilities offshore and results in job losses.

5. We are on record that the AEP-IBEW Proposal that is embodied in these provisions <u>will not</u> provide a level playing field against energy intensive product importers who will not be burdened by this legislation. It does not achieve global reach and we stand by our analysis, which I would like to provide for the record. This provision will not work. If

there is any doubt about this, look at the timeline. Under the bill, domestic firms will face higher energy prices, obligations to acquire allowances, and reduce emissions beginning in 2012. Our major foreign competitors doing business in the U.S. are not required to do anything until eight years later in 2020. I am no trade lawyer, but I understand that to significantly reduce this period of time may jeopardize any hope of making the provision WTO-compliant. Further, we are concerned that even if the President triggers the requirement for importers to obtain allowances from the international pool as provided in title VI, that foreign states will simply cross-subsidize the purchase of allowances. For example, eight of the ten largest Chinese steel groups are 100% owned or controlled by the Chinese government, while 19 of the 20 largest steel groups are majority owned or controlled by the government. Bringing trade cases to combat this hidden subsidy would be very difficult and time-consuming.

One more point deserves your attention. The bill invites the states to impose even tougher cap and trade programs than the federal program. What mechanism will the states use to prevent putting domestic manufacturers at a competitive disadvantage with foreign importers? Can states impose allowance requirements on foreign firms? Isn't this a federal issue?

IECA believes the following elements are essential to sound climate policy.

- Reduce GHG emissions cost effectively;
- Be transparent in order to achieve clear market signals;
- Not create winners or losers;
- Ensure that U.S. industry is not disadvantaged from competing with foreign imports of energy intensive products;
- Recognize that each sector is different and that tailored incentives combined with appropriate performance standards can achieve maximum GHG reductions at the lowest cost;
- Accelerate technology research, development and deployment to lower the carbon intensity of energy; broadens our supply options; and position the U.S. as the world's leading provider of low carbon intensive energy supply technology.
- Efficient cogeneration of steam and electricity should not become disadvantaged.

For the industrial sector, energy is a significant cost and reducing that cost is an important component of competing globally. If we fail to reduce energy costs we will fail to compete globally and cease to exist. It's just that simple. We compete in a ruthless competitive global market and the industrial sector is unique in this regard.

Manufacturers want and need to continually reduce energy consumption and it is in our government's interest to work in partnership to continue the success we have shown over the last 20 years.

Regulating carbon regulates energy consumption and regulating energy consumption regulates the economy. This would be a significant new responsibility for the EPA. These new responsibilities must be examined and delegated with great care.

America's Climate Security Act of 2007 (ACSA) is a comprehensive climate change bill. Even though our sector's GHG emissions are below 1990, we would find ourselves regulated under this bill and would be placed in a competitive disadvantage with our global competitors. The bill would require industrials to reduce GHG emissions in our internal operations and/or buy allowances through an auction. As we do, capital is expended for the purchase of carbon allowances instead of R&D, plant expansions or employee benefits.

We also find ourselves being thrown into the auction pool having to compete with electric utilities for allowances. At this point it is not clear that the necessary allowances and natural gas will be available to allow continued operation of our members' facilities in the United States. If the utilities move more electricity production to natural gas allowances should be available, but natural gas will not. If utilities continue to use coal as a fuel then emission allowances will be prohibitively expensive for industrial use.

Unlike the electric utilities, when IECA members purchase carbon allowances, it is a cost that is not recoverable unless global competitors raise the price of their products which would allow recovery of the costs. If competitors raise prices, the increased price becomes increased profit to them. For us, the increased price allows cost recovery - not increased profits.

The industrial sector 2005 GHG emissions are below those of 1990. The industrial sector is not the problem for the U.S. emission profile now or going forward and should not be placed under a cap as this legislation does. Other specific policy measures tailored to our sector will be more effective, less costly, without product market distortions and loss of jobs. Even if we are not placed under a cap, the industrial sector would bear significant increased energy costs that will impact our global competitiveness.

Climate policy by Congress can induce a move of industrial production facilities to locations outside the U.S. that provide lower costs. Companies have already demonstrated the need to move overseas to compete on a global basis. The loss of 3.1 million manufacturing jobs or 18 percent since 2000 provides evidence of this fact. Carbon costs can have the same effect.

Cap and trade climate policy rations energy use and without an existing abundant supply of low carbon intensive energy will significantly impact energy costs and the economy in ways that are impossible to predict.

This is accentuated by the starting date of 2012 and an emissions cap at the 2005 level. This is only four years away! Few economical actions can be taken in this short time frame other than fuel switching from coal to natural gas by the electric utility sector. This is exactly what happened in Europe with the EU ETS as reported by Garth Edwards, Shell Oil, Trading Manager, Environmental Products, London, England.

Mr. Edward's made the following comment during a March 26, 2007 Senate Committee on Energy & Natural Resources Hearing on European Union's Emissions Trading Scheme. He said, "The bulk of emission reductions in the EU are made actually by coal to gas (natural gas) fuel switching in power stations. And any price will start to change the dispatch of power plants…and start change away from coal into gas (natural gas)."

Fuel switching from coal to natural gas would not be a problem if it were not for the fact our supply of natural gas is very fragile. Production is down 4% since 2000 despite record well completions, imports from Canada are down since 2001 and imports of LNG are both expensive and unreliable. Utilities have alternatives such as coal, renewable and nuclear energy, industrial consumers do not. This legislation must require that power generators cannot fuel switch until there is better availability.

One important concern about this legislation and cap & trade in general is that it does not necessarily reduce GHG emissions. It regulates and adds costs. For example, the EU has not seen a reduction in GHG emissions but has seen increased costs of energy. We do know that using more low carbon intensive energy will reduce emissions.

Cap & trade does not increase the supply of low carbon intensive energy. Cap & trade does not remove the government or technological barriers that will increase domestic supply of natural gas from federal lands; increase LNG import capacity; facilitate the construction of the Alaska Natural Gas Pipeline; or facilitate the construction of a new generation of nuclear plants, IGCC (Integrated Combined Cycle) or carbon capture and sequestration. Not one.

A cap & trade mandate could be implemented and these barriers will still be in place which would significantly raise the cost of energy for home owners, farmers and manufacturers and accelerate the movement of the manufacturing sector out of the U.S.

Countries do not play fair when it comes to trade. Countries subsidize their manufacturing industries in many different ways for purposes of job creation and trade currency. Energy is high on the list of subsidies. There is little doubt that these same countries will provide carbon allowance subsidies. Subsidies are a significant factor in developing countries. Even EU countries are doing it today by buying carbon offsets through the Clean Development Mechanism and Joint Implementation programs.

In this regard, a suggestion that this subcommittee plans to markup this bill without first obtaining a political and technically realistic economic analysis and moving through appropriate hearings is troubling. The economic consequences of such legislation could be devastating.

The industrial energy users strongly encourage the committee to hold more hearings on this legislation for there are many unanswered questions and unknown consequences that need to be examined in greater detail. Here are just a few of the areas we believe need to be further explored before action is taken on this legislation.

1. What will be the impact on energy prices, specifically, electricity, oil and petroleum products, natural gas and coal for each year between 2012 and 2050?

2. Furthermore, it is imperative that a hearing be held that looks at all the ramifications of this legislation on the commodity markets. It is well known that use of the commodity markets has soared in the last few years. This legislation could result in the creation of a market for billions of units with a value in the trillions of dollars. What safeguards are needed to prevent another Enron? What percentage of those trillions of dollars will be siphoned off by the commodity traders and speculators? Should a government trading operation be established as the sole venue for trading allowances?

Industrial Energy Consumers of America (IECA)

IECA is a 501 (C) (6) national non-profit non-partisan cross-industry trade association whose membership is exclusively from the manufacturing sector and is dedicated exclusively to energy and environmental issues. Corporate board members are top energy and environmental managers who are leaders in their industry, technical experts and strongly committed to energy efficiency and environmental progress. Membership companies are from diverse industries which include: paper, steel, chemicals, plastics, food processing, industrial gases, cement, brewing, construction products, brick, aluminum, fertilizer, automotive products and pharmaceutical.

Position on cap and trade policy and legislation

IECA's objective is to work with Congress to implement policies that reduce GHG emissions without loss of manufacturing competitiveness. IECA has not taken a position in support or opposition to cap and trade as a policy, nor specific legislation that includes the policy.

However, IECA has on numerous occasions communicated to Congress the serious concerns such legislation causes the industrial sector. Our testimony today will reflect these same and growing concerns about the potential impacts.

Individual industrial companies vary in their views on policy such as cap & trade. In general, those who are mostly domestic producers exhibit the most concern about cap & trade because it can place them at a competitive disadvantage to non-U.S. producers. Other U.S. companies with large non-U.S. operations or those who have moved their energy intensive operations offshore are less fearful because capping U.S. emissions provides a competitive advantage.

Background on the industrial sector

There are about 350,000 manufacturing facilities in the U.S. It is estimated that about 7,800 facilities would emit 10,000 tons of CO_2 per year. By itself, regulating the industrial sector presents a significant regulatory challenge for the federal government.

Energy intensive industries include chemicals, plastics, fertilizer glass/ceramics, brick, steel, aluminum, pulp and paper, cement, food processing and refining. Energy is used as both fuel and feedstock. Feedstock means the energy source (natural gas, crude oil) becomes the actual product thus there are no GHG emissions. It is for this reason that energy used as a feedstock should be exempt. Some industrial processes are very electricity intensive.

The manufacturing sector competes globally in an environment of unfair competition. Other countries value their manufacturing sector and often subsidize energy costs, provide incentives and otherwise protect the manufacturing sector.

For U.S. energy intensive industries, reducing energy consumption per unit of product produced is essential. We either continually reduce our energy cost per unit of product or we will cease to be competitive.

The performance of the manufacturing sector in reducing energy consumption and resulting GHG emissions is not new. We already have two price signals: energy prices and global competition. Energy is a significant cost of competing globally. This is one important reason that a less heavy regulatory hand is not needed. Manufacturers want to reduce energy consumption and it is to governments' advantage to work in partnership to continue this success. This is why the industrial sector does not need an additional carbon price signal.

In many ways, the industrial sector provides the U.S. with a significant success story in reducing energy consumption and GHG emissions. Total energy consumption by the industrial sector has increased only .017% since 1990.

The industrial sector's total direct and indirect carbon dioxide emissions in 2005 are below their 1990 level while GHG emissions from the residential sector increased 31.4%; commercial +34.6%; transportation +25% and electricity +31.7%. Industrial direct GHG emissions decreased by 3.4% and indirect emissions have increased by 5.4%. In 1990, the industrial sector represented 21% of the U.S. emissions and now only 17%.

The industrial sector has a history of continuous improvement in energy efficiency since the 1970's and the first oil embargo. In the 1990's when natural gas became relatively low cost, many industrial sites converted their facilities from coal to natural gas. Low natural gas prices also resulted in significant growth in the use of cogeneration of steam and power. The pulp and paper industry increased its use of biomass as a fuel and also increased its use in cogeneration facilities to more efficiently produce both steam and power. These combined actions lowered both energy consumption and GHG emissions.

Since 2000, high energy costs, particularly high natural gas costs and now rising electricity prices, have been a significant factor for the energy intensive industries. The manufacturing sector has lost 3.1 million high paying jobs or 18% of the total. To our knowledge, this is the first time in U.S. history where we have lost manufacturing jobs despite robust economic growth for four straight years. We are fearful that if Congress does not increase the availability and affordability of domestic energy, more manufacturing plants will move offshore.

Because U.S. natural gas costs have been, on average, the highest in the world and because of Congressional uncertainties regarding future supply, investment in U.S. manufacturing plants have been extremely low with the exception of energy efficiency projects. There have been almost no major energy intensive grass root plants built since 2000 and only incremental production increases. Also, high natural gas prices are making some cogeneration plants uneconomic and these industrial companies are now buying electricity for the grid which is more carbon intensive.

Lastly, the primary manufacturing processes for these industries are near their thermal limits. Significant R&D investment is necessary to achieve the next generation of processes. In the mean time, significant energy efficiency achievements are not anticipated.

IECA recommends the following climate policy options that do not cost consumers anything; present no risk to the economy; provide for increased supply of affordable and reliable low carbon intensive supply of energy; reduces

GHG emissions; increases energy security; and increases the competitiveness of the U.S.

- Support mandatory reporting for domestic and non-U.S. based companies.
- Increase supply of affordable and reliable low carbon intensive energy. Remove government barriers to increased supply of natural gas in federal lands and the Outer Continental Shelf; expedite the Alaska Natural Gas Pipeline; facilitate approval of LNG import terminals; facilitate construction of a new generation technology nuclear plants;
- Accelerate research, development and deployment of carbon capture and sequestration for use by coal fired power plants and IGCC technology for production of synthetic natural gas, feedstock and electricity.
- Take a sector approach. Each sector is different. Tailor incentives to accelerate energy efficiency in each sector. Energy efficiency is the "fifth fuel". It is particularly important to include the commercial and residential sectors where demand for electricity is soaring.
- The key to improving energy efficiency in the industrial sector is capital stock turnover. Tax credits and faster depreciation are the best options.
- Facilitate removal of regulatory barriers that impede energy efficiency in each sector. Example: New Source Review.
- Pay for the R&D and tax incentives by increasing access to the OCS which would produce significant federal revenues and increase supply of natural gas.

ADDITIONAL INFORMATION

Natural gas supply is very fragile and demand by the power generation sector is increasing.

Reserve production capacity is almost non-existent. Inventory levels are good right now but can change rapidly based on weather conditions. Supply is down 4% since year 2000 despite record well completions. Canadian imports are down by 4.9% since 2001. New Gulf of Mexico leases will not increase supply for the next five years or so. The Alaska Natural Gas Pipeline has not shown any progress. LNG remains unreliable and a potential new cartel is on horizon.

The Rocky Mountain Region has increased its production primarily due to EPAct 2005 provisions that have helped to streamline the permit process among other provisions. These are the same provisions that are slated for repeal under the currently debated energy bill. Increases in the Rocky Mountain Region have helped offset production decreases in the Gulf of Mexico.

Demand for natural gas by the power sector continues to increase the price for all consumers. Power sector natural gas demand has increased 19% since 2000 while other sectors have reduced their demand: Residential -12%; Commercial – 9%; Industrial -19%.

Natural gas fired power generation impacts on all consumers. For example, a single 500 MW rankine cycle power plant (10,000 Btu/kwh) will use the equivalent natural gas volume used to fuel 842,308 homes each year.

Power demand for our limited supply of natural gas is slated to increase even more. Proposed 2007 power plants include 16,892 MW that are natural gas fired compared to only 1,589 MW for coal and no nuclear plants. Based on 2005 EIA information, there is 436,991 MW of natural gas fired power capacity in the U.S. If utilized, they would consume about 21 trillion cubic feet of natural gas, an amount nearly equivalent to our national consumption. Congress must ensure climate legislation does not give the power generation sector an incentive to use this capacity.

High natural gas prices are impacting the price of electricity across the country. The Electric Power Research Institute said that "Even though natural gas is used to produce only 20 percent of the electricity, it accounts for 55% of the electric industry's entire fuel expense ($50B out of $91B)."

The U.S. cannot grow its economy or sustain the high quality of life that we are accustomed to without greater use of products from the industrial sector. Under a cap, the question is whether the products are produced in the U.S. or in foreign markets. A cap could restrict domestic production of these products; increase imports and GHG emissions from those imports; accelerate manufacturing job loss; increase the U.S. trade deficit and the balance of payments.

Examples of how energy intensive products are used and are integral to the growth of the U.S. economy:

- The aerospace/defense industry uses steel, aluminum, plastics and chemicals.
- The air transport industry uses steel, aluminum, plastics and chemicals.
- The auto and truck industries use steel, aluminum, plastics, chemicals.
- The beverage industry uses aluminum, steel, paper, glass and plastic.
- The biotechnology industry uses chemicals.
- The commercial and home building construction industry uses brick, steel, aluminum, wood, cement and glass.
- The oil and gas industry uses steel, chemicals, cement.
- The chemical industry uses chemicals, steel, cement and glass.
- The computer industry uses plastics, chemicals, and glass.
- The electrical equipment industry uses steel.
- The electric and gas utility sector uses steel and cement.
- The food industry uses fertilizer, chemicals, plastics and paper.
- The home furnishing industry uses wood, glass, chemicals.
- The heavy construction industry uses steel and rubber.
- The home appliance industry uses steel, aluminum, glass and wood.
- The household products industry uses chemicals, plastic; paper, glass.
- The machinery industry uses steel, chemicals and plastics.
- The maritime industry uses steel.
- The packaging industry uses plastics, paper, aluminum and steel.
- The paper / forest products industry uses steel and chemicals.
- The refining industry uses steel, chemicals and cement.
- The pharmaceutical industry uses chemicals, glass and steel.
- Railroads use steel.
- The toiletries/cosmetics industry uses chemicals, plastics, paper, and glass.

Industrial sector products are a major solution to reducing GHG emissions. It takes energy to save energy. Our products use energy in the production process but save energy when used by the commercial and retail consumer. Placing a GHG cap on the industrial sector and requiring absolute GHG reductions restricts our ability to increase production of these products in the U.S.

It takes energy to save energy. For example, insulation can be made from glass, plastic or paper, all of which is energy intensive. When used to insulate commercial and home buildings, significant amounts of energy saved go well beyond the energy to produce the product. Double pane windows are another example. Double pane windows use twice the amount of glass but save an enormous amount of energy over the life of a building. Other examples include light weighting of autos, trucks and aircraft. Key solutions are greater use of aluminum, composite plastics and different grades of steel. All are energy intensive.

"A good example comes from one of our member companies and it's 'Near Zero-Energy Home' in Paterson, New Jersey. This project demonstrates how good chemistry helps make healthy, energy-efficient and affordable homes better. Chemistry helps the building materials in the near-zero-energy home not only delivers superior thermal insulation, but also contributes to the missing performance ingredient – resistance to uncontrolled air leakage that can waste up to 40 percent of the energy used to heat and cool a home."

"The demonstration project scored an impressive 34 on the HERS Index, a tool used by ENERGY STAR® to measure a building's energy performance, making it 80% more efficient than a typical home. The project was the first on the East Coast to receive a Platinum score from the U.S. Green Building Council LEED for Homes rating system and is currently serving as a model for several hundred homes being built in an economically challenged neighborhood in East Parkside, Philadelphia."

IECA companies have many more examples that can be shared with the Congress.

The EU Emissions Trading Scheme (EU ETS) significantly increased the price of electricity from about 34 to 69 euros per kwh or 76%.

The EU ETS started in January of 2005. The European Commission (EC) granted carbon allowances to the electric utilities, in fact, too many of them. The utilities priced the market value of these carbon allowances into the price of their electricity which increased the price of electricity to consumers even though the European Commission gave them to the utilities at no charge. The higher the price of carbon went up - the higher the electricity prices rose. This raises the question of whether U.S. electric utilities will be able to do the same thing.

Prices of electricity in the EU rose from January 2005 to April 2006 as follows in euros per mwh:

Country	Price in January 2005	Price in April 2006	% Change
Germany	34	61	+79%
France	34	63	+85%
Netherland	38	51	+34%
Skandanavia	25	51	+104%
UK	41	83	+102%

In this same time period high carbon prices provided an incentive for electric utilities to switch from coal to natural gas which increased natural gas demand significantly and increased the price of natural gas throughout the market for electricity generators but also for every home owner, farmer and manufacturer who uses natural gas.

The high prices of carbon provided an incentive for the utilities to fuel switch from coal to natural gas lowering their carbon emissions and allowed them to either sell carbon allowances or help them keep under their GHG reduction obligation to the European Commission.

This is consistent with comments by Garth Edwards, Shell Oil, Trading Manager, Environmental Products, London, England. Mr. Edward's made the following comment during a March 26, 2007 Senate Committee on Energy & Natural Resources Hearing on European Union's Emissions Trading Scheme. He said, "The bulk of emission reductions in the EU are made actually by coal to gas (natural gas) fuel switching in power stations. And any price will start to change the dispatch of power plants…and start change away from coal into gas (natural gas).

There is more to it. Just like in the U.S., natural gas fueled power generation sets the electricity market marginal price. The higher the natural gas price goes, the higher the electricity marginal price becomes.

The marginal price of electricity is the last increment of power that is needed by the grid to fulfill consumer demand. The price of this last increment sets the price of electricity for not just that portion of the power, but for <u>all</u> of the power that is sold to consumers for a given period of time. If a utility is a low cost producer using coal or nuclear, they want to see natural gas prices go up and natural gas fired generation setting the marginal price of electricity because it increases their profitability. In the U.S. as well as in the EU the cost of producing electricity from coal or nuclear are significantly below that of natural gas fired generation.

EU industrial companies report that later, after relatively high marginal prices were set, the electric utility industry began to maximize coal-based generation with lower costs to maximize profits. This would also increase GHG emissions. Please note the electricity market in the EU and in the U.S. is not transparent such that anyone other that the ISO operators really know what prices are bid by the electric utilities or what specific production units were utilized.

On April 25, 2006, the EC released their report that concluded too many allowances were given to the utility sector and the price of carbon fell sharply from about 30 to 12 euros per ton. Although electricity prices fell, they did not fall as much and later continued their upward climb. Interestingly, natural gas demand and prices fell. It appears that with lower carbon prices, more money could be made from low cost coal generation than selling carbon. There is a strong correlation between carbon prices and natural gas demand from fuel switching. Higher carbon prices means more demand for natural gas.

In the October, 2006 timeframe, the Langeled Norwegian natural gas pipeline began to deliver supplies to the UK which resulted in lower natural gas and electricity prices across the EU. This example further illustrates the importance of increased natural gas supply. Greater supply means lower prices.

Core industrial sector processes (the processes used to make our products) are near their energy efficiency engineering limits. Significant investment in technology is needed to achieve new technology that will allow significant GHG reductions.

This legislation does not direct recycled auction income to assist the industrial sector in developing such technology and we encourage it to do so.

Section 3401 Revenue Decoupling Will Not Promote Industrial Energy Efficiency - Stick to traditional utility rate making.

Advocates of utility rates based on “revenue decoupling” believe it will remove economic incentives that work against energy efficiency. The rate design for regulated utilities typically rewards utilities for selling more power, while energy efficiency projects result in decreased power sales. “Revenue decoupling” would break -- or “decouple” -- the link between the amount of power sold and the revenue (and profit) realized by utilities, thereby supposedly removing the economic incentives against energy efficiency. The advocates are wrong.

Industrial companies have made great strides in improving their energy performance and reducing their reliance on fossil fuels. Revenue decoupling, however, would penalize future industry energy efficiency efforts:

With decoupling, utilities are supposedly compensated for revenue lost when customers’ efficiency projects reduce demand. However, measurement and verification protocols often cannot distinguish between lower sales generated by energy efficiency from other causes. Hence, utilities also are often compensated for reduced power sales due to factors unrelated to efficiency, such as weather that depresses sales or economic downturns, or even customer funded energy efficiency projects.

Because it is difficult to track where savings come from, utilities are often simply compensated for lost revenue generally. Industrial consumers therefore often lose the financial reward and a primary motivator of efficiency projects—reduced energy bills. For example, if a manufacturing company installed more efficient boilers in response to rising fuel prices, it would purchase less power from its utility, and should see lower bills. However, because the utility is to be compensated for the lost revenue, that same facility would end up paying a higher rate on a lesser level of purchases under decoupling, thereby totally undermining the motivation for the investment in the energy efficiency project.

Eight states have established third-party entities whose mission is to promote incentives for energy efficiency for industrial and other power consumers. If Congress desires a mechanism to promote energy efficiency, it should investigate the programs in these states to learn more about programs that treat all stakeholders fairly and provide incentives -- instead of penalties -- for industrial users.

It is important that coal stay in the supply mix and compete with other alternatives energy sources for power generation. It is both important to help keep the cost of electricity down but it is also an energy security issue. However, the technology, costs, transportation, permitting and liability issues must be resolved before implementation of a cap and trade system for the power generation industry.

These five critical elements must be achieved before implementation of a cap and trade program on the power sector. Without them, the cost of electricity will rise unnecessarily.

- **CO2 capture technologies must be widely deployable**
  Current CO2 capture technology is limited to small demonstration projects. Commercial scale demonstrations are needed to help prove which capture technologies are technically feasible, economically sound and available from multiple competitive vendors

- **Energy penalties must be reduced**
  Current capture technologies reduce net energy output by 15-35%. Additional research and technology advances are needed to bring down these penalties otherwise more new generators will need to be built.

- **A dedicated CO2 transportation system must be built in areas beyond the current EOR zones**
  A new and expanded pipeline infrastructure dedicated to transport captured CO2 must be sited, permitted and constructed to provide ready access by power plants.

- **CO2 storage permitting & liability must be in place**
  Suitable geologic storage areas must be identified and tested. Once located, these sites need to be permitted for commercial operation at federal, state and local levels, and long-term storage liability must be assumed by the Federal Government. Pipeline access must be assured.

- **GHG regulations must be uniform and provide for preemption**
  The creation of one overriding federal regulatory control regime will not only result in enforcement efficiency, it will provide business certainty.

LEGISLATION SPECIFICS

- The legislation does not have a safety value, an essential element of any cap and trade system.

- The criteria to be used to award any such extra allowances to the states, if these are to awarded at all, should be based on how the manufacturing industries subject to global competition in that state are projected to fare under a cap and trade regime. So presumably states whose economies may be jeopardized because they have industries at risk, can use the allowances to retain jobs.

- The legislation does not preempt states from establishing their own climate programs. In fact, the legislation gives states an incentive to establish their own GHG reduction programs with tougher reduction targets than at the federal. This leads to higher costs for every manufacturer.

- Section 3301 provides credit for early action with a base year of 1994. Projects that resulted in GHG reductions that early were not done with climate change in mind. We encourage use of 2000.

- Money raised from auctioning should be used to compensate industries such that will incur significant "stranded costs" when certain pieces of equipment are retired before they have lived their useful lives.

Who Are
Energy Price Sensitive Industries?

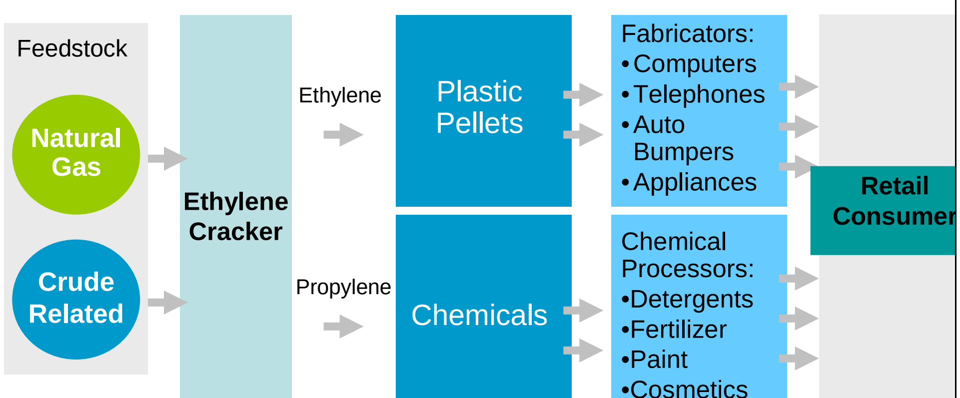
Building Block Industries — Convert to → **Commercial & Consumer Products**

Building Block Industries
- Chemicals
- Plastics
- Fertilizer
- Glass / ceramics
- Brick
- Steel
- Aluminum
- Pulp and Paper
- Cement
- Food Processing

Commercial & Consumer Products
- Food Production
- Detergents
- Automobiles
- Computers
- Construction
- Medical Supplies
- Paint
- Pharmaceuticals
- Cosmetics
- Telecommunication

When Plants Move Over Seas, They Often Take Their Customers With Them

Example



Moving the Ethylene Cracker offshore increases the potential for all downstream industries to move also.

3.1 Million Manufacturing Jobs Lost

(Millions)

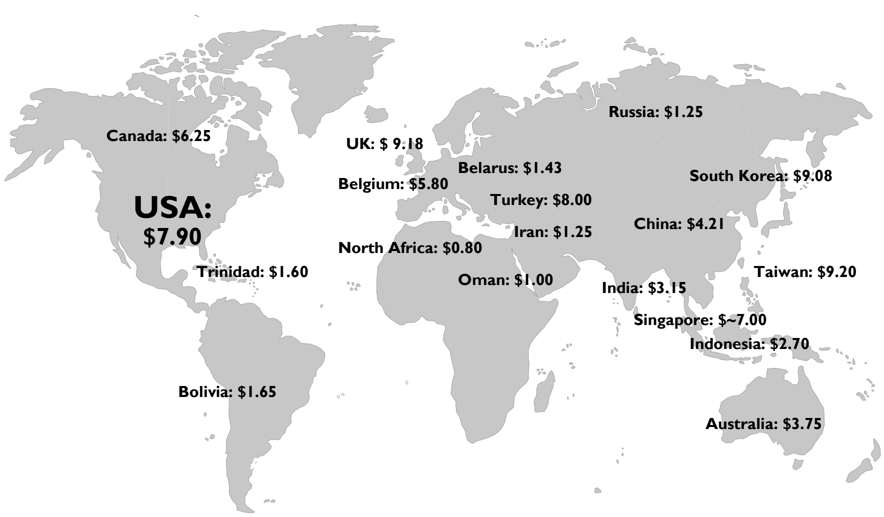
2000	2001	2002	2003	2004	2005	2006	Difference
17.2	16.4	15.2	14.5	14.3	14.2	14.1	-18%

Source: U.S. Dept. of Labor

Natural Gas Prices Around the World

2006 Average

($US per million BTUs)



Planned Nameplate Capacity Additions from New Generation (MW)

Energy Source	2006	2007	2008
Coal	602	1589	1056
Petroleum	269	78	168
Natural Gas	10657	16892	15050
Other gases	0	391	1160
Nuclear	0	0	0
Hydro	8	3	4
Other Renewable	3027	2454	695
Total	14573	21407	18133

Source: EIA

Natural Gas Prices

(Dollars per Thousand Cubic Feet)

	2000	2001	2002	2003	2004	2005	2006	Difference
Residential	7.8	9.6	7.9	9.6	10.8	12.8	13.8	+77%
Commercial	6.6	8.4	6.6	8.4	9.4	11.6	12.0	+82%
Industrial	4.5	5.2	4.0	5.9	6.5	8.6	7.9	+76%
Electric Power	4.4	4.6	3.7	5.6	6.1	8.5	7.1	+61%

Source: EIA

Electricity Retail Prices

(cents per kwh, including taxes)

	2000	2001	2002	2003	2004	2005	2006	%
Residential	**8.24**	**8.58**	**8.44**	**8.72**	**8.95**	**9.45**	**10.40**	**+26%**
Commercial	**7.43**	**7.92**	**7.89**	**8.03**	**8.17**	**8.67**	**9.36**	**+26%**
Industrial	**4.64**	**5.05**	**4.88**	**5.11**	**5.25**	**5.73**	**6.09**	**+31%**

Source: EIA

Existing Electricity Generation Capacity 2005 (MW)

Full utilization of the 436,991 MWs of natural gas fired power plant capacity would consume about 21 TCF of natural gas, an amount nearly equal to our national consumption.

Energy Source	Nameplate Capacity
Coal	335,892
Petroleum	64,845
Natural Gas	436,991
Other Gases	2,293
Nuclear	105,585
Hydro	77,354
Other Renewable	23,553
Pumped Storage	19,569
Other	928
Total	1,067,010

Source: EIA

Natural Gas Production

(Volumes in Trillion Cubic Feet)

	2000	2001	2002	2003	2004	2005	2006	Difference
Dry Production	**19.2**	**19.6**	**18.9**	**19.1**	**18.6**	**18.1**	**18.5**	**- 4%**

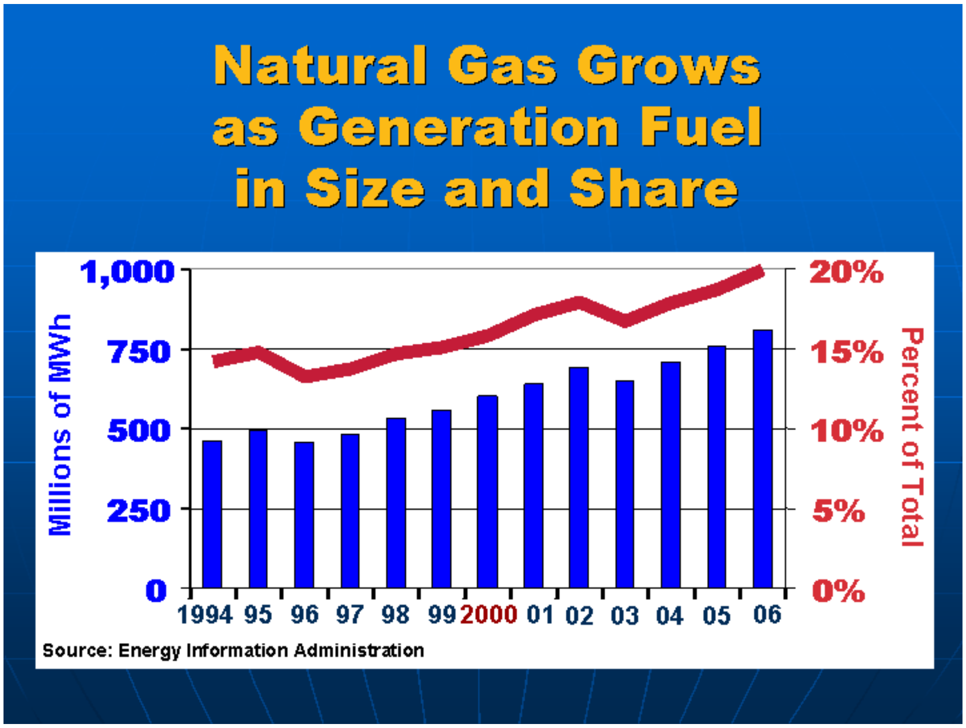
Source: EIA

Natural Gas Consumption by End Use

(Trillion Cubic Feet)

	2000	2001	2002	2003	2004	2005	2006	Difference
Total Consumption	**21.5**	**22.2**	**23.0**	**22.3**	**22.4**	**22.2**	**21.9**	**+1.9%**
Residential	**5.0**	**4.8**	**4.9**	**5.1**	**4.9**	**4.8**	**4.4**	**-12%**
Commercial	**3.2**	**3.0**	**3.1**	**3.2**	**3.1**	**3.1**	**2.9**	**-9%**
Industrial	**8.1**	**7.3**	**7.5**	**7.2**	**7.2**	**6.7**	**6.6**	**-19%**
Electric Power	**5.2**	**5.3**	**5.7**	**5.1**	**5.5**	**5.9**	**6.2**	**+19%**

Source: EIA



Total "Direct" Carbon Dioxide Emission
(Million Metric Tons of Carbon Dioxide)

	1990	2005	Difference
Residential	339.5	368	+8.4%
Commercial	223.5	229.5	+2.7%
Industrial	1055.2	1019.5	-3.4%
Transportation	1566.8	1953.2	+24.7%
Electricity	1803.1	2375	+31.7%
TOTAL	4988.1	5945.2	+19%

Source: EIA

Total “Indirect” Carbon Dioxide Emission

(Million Metric Tons of Carbon Dioxide)

	1990	2005	Difference
Residential	614.2	885.8	+44.2%
Commercial	557.2	821.1	+47.4%
Industrial	628.4	662.8	-5.4%
Transportation	3.2	5.4	+68.8%

Source: EIA

Total Carbon Dioxide Emission

(Million Metric Tons of Carbon Dioxide)

	1990	2005	Difference
Residential	953.7	1253.8	+31.4%
Commercial	780.7	1050.6	+34.6%
Industrial	1683.6	1682.3	< 0%
Transportation	1566.8	1958.6	+25%
Electricity	1803.1	2375	+31.7%

Source: EIA

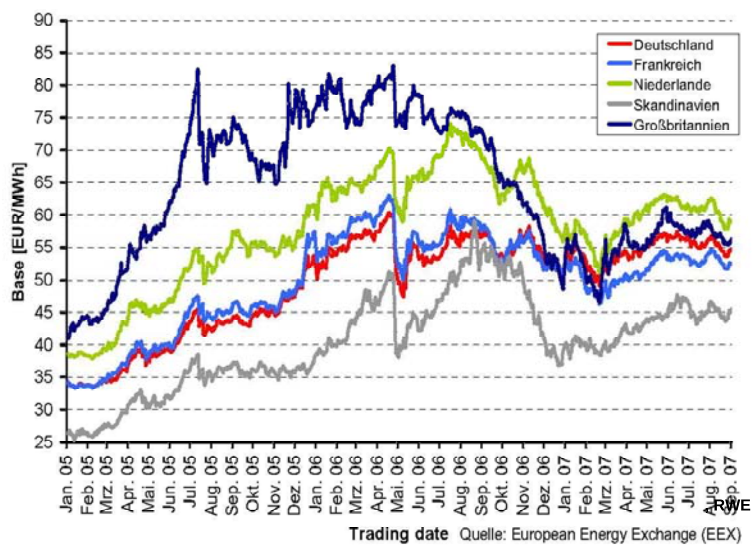
Industrial Energy Consumption

(Trillion BTUs)

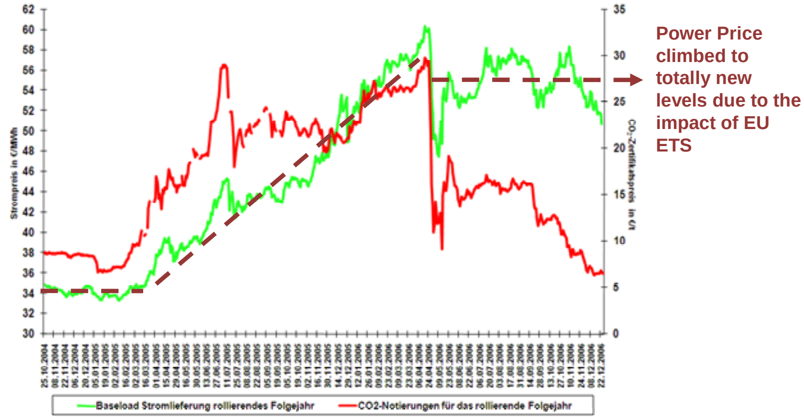
Year	Coal	Natural Gas	Renewable	Electricity	Petroleum	TOTAL
1990	**2756**	**8451**	**1716**	**3226**	**8278**	**24,427**
2005	**1954**	**8064**	**1636**	**3477**	**9714**	**24,845**
Difference	**-802**	**-387**	**-80**	**+251**	**+1436**	**+418**
						+.017%

Source: EIA

Power Price development in the EU electricity markets since start of Eu ETS



The development of power and CO_2-certificates prices in Germany



September 25, 2007

The Honorable Barbara Boxer
Chairman
Committee on Environment and Public Works
U.S. Senate
Washington, DC 20510

The Honorable John D. Dingell
Chairman
Committee on Energy and Commerce
U.S. House of Representatives
Washington, DC 20515

The Honorable James M. Inhofe
Ranking Member
Committee on Environment and Public Works
U.S. Senate
Washington, DC 20510

The Honorable Joe Barton
Ranking Member
Committee on Energy and Commerce
U.S. House of Representatives
Washington, DC 20515

The Industrial Energy Consumers of America (IECA), whose membership competes globally and are from the energy intensive industrial sector have significant concerns about the well intentioned AEP-IBEW Proposal that is designed to achieve “global reach” in U.S. climate legislation. It will not assure a level playing field between U.S. produced energy intensive products and those that are imported. The U.S. industrial sector carbon emissions are below 1990 levels.

IECA is a 501 (C) (6) national non-profit non-partisan cross-industry trade association whose membership is exclusively from the industrial sector. IECA membership represents a diverse set of industries including: plastics, cement, paper, food processing, aluminum, chemicals, fertilizer, brick, insulation, steel, glass, industrial gases, pharmaceutical, construction products, automotive products and brewing.

There are several major reasons why the AEP-IBEW Proposal as conceptualized in S.1766, will not provide a level playing field or provide “global reach”.

First, while climate greenhouse gas reduction caps on U.S. manufacturers would be highly prescribed and enforceable, the requirements on our foreign competitors importing into the U.S. are highly uncertain. Will the President seek carbon allowance requirements on them at all? What requirements, if any, will survive lengthy multilateral and bilateral international negotiations? Will the program achieve the necessary GATT exception to be deemed GATT compliant?

Second, the playing field will be tilted against us. While we are affected as early as 2012, nothing affects foreign competitors until 2020. Many U.S. companies will have been damaged by then. It took only six years (2000 – 2006) to lose 3.1 million manufacturing jobs. There is no obligation on foreign competitors if their ghg emissions from national production of a given energy intensive product post 2020, remains below their average emissions from that product’s national production for the period 2012-2014. This incentivizes them to expand capacity and keep their old polluting facilities to raise their ghg baseline by 2014, just the opposite of what we want. Foreign competitors get credit for carbon allowances given to domestic manufacturers to offset higher U.S. energy costs under cap and trade, even though foreign competitors do not have these costs. They can use their own foreign carbon allowances and credits with scant U.S. review or recourse from us. Also, we cannot expect the subsidized purchase of carbon allowances that their state-owned or controlled firms will enjoy.

Third, in the case of S. 1766, which does not now impose emissions caps on the industrial sector other than for coal, adopting the Proposal will require modification of the bill to impose cap and trade requirements on domestic manufacturers. Otherwise, the Proposal is, with certainty, not GATT compliant.

The industrial sector carbon dioxide emissions in 2005 are below 1990 levels. This is a terrific track record when one considers that the total industrial value of shipments (in 2000 dollars) increased by 31.6 percent in that same time frame. Total carbon dioxide emissions from other sectors of the U.S. have not performed as well. Comparing 1990 versus 2005, total direct and indirect carbon dioxide emissions are: residential +31.4%; commercial +34.6 transportation +25%; and electricity +31.7%.

The U.S. industrial sector must be assured of a level playing field with energy intensive imports. If not, more high paying manufacturing jobs will be lost; global greenhouse gas emissions will rise as they shift to other countries who are most likely less energy efficient than U.S. industry; U.S. imports of energy intensive products will continue to surge increasing the trade deficit and balance of payments; and the U.S. industrial sector will be penalized for the tremendous investment and success in reducing energy consumption and carbon dioxide emissions.

Lastly, IECA member companies continue to be of the belief that no U.S. climate legislation can be successful until affordable supplies of low or no greenhouse gas emitting fuels like natural gas are expanded.

Sincerely,

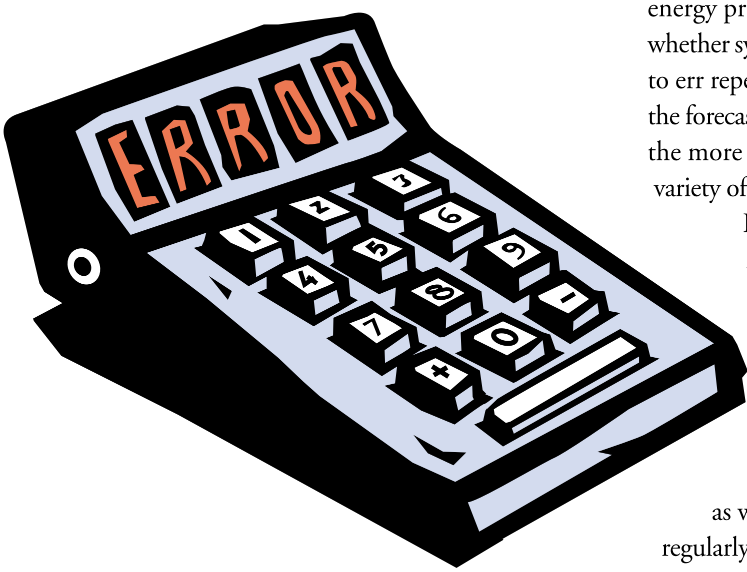
Paul N. Cicio
President

cc: Members of the Senate Committee on Environment & Public Works
Members of the House Committee on Energy and Commerce
The Honorable Jeff Bingaman, Chairman, Senate Committee on Energy and Natural Resources
The Honorable Pete V. Domenici, Ranking Member, Senate Committee on Energy and Natural Resources
The Honorable Samuel W. Bodman, Secretary, U.S. Department of Energy

Gas-Market Forecasts

BETTING ON BAD NUMBERS

Why predictions from the Energy Information Administration may contain systematic errors.



The difficulties of predicting future trends in energy are widely recognized (*see Reference [4], p. 61*). Even the most sophisticated of forecasting models cannot account fully for a myriad of complex and generally uncontrollable variables. Thus, energy policy-makers necessarily must anticipate a wide range of possible outcomes in formulating energy plans.

The issue here, however, is not how difficult it is to predict energy prices, supply, and demand. Our question, rather, is whether systematic biases are built into forecasts, causing them to err repeatedly in the same direction. And the more visible the forecast (and the more likely also that it will be used), then the more likely it is that the error will be compounded in a variety of settings.

In the case of the U.S. Energy Information Administration (EIA), for example, natural gas (NG) data and projections are used widely in regulatory proceedings, energy planning, scientific research, investment decisions, litigation, and legislation. In such cases, systematic bias can have profound socioeconomic implications—not only within the United States but in other nations as well. Indeed, the National Energy Board of Canada regularly includes EIA NG forecasts in its projections. Even OPEC scholars use EIA projections as a benchmark in their research.

This widespread use of EIA forecasts follows the organization's own view of its nature and purpose. In fact, the EIA has

By Timothy J. Considine, Ph.D. and Frank A. Clemente, Ph.D.

indicated that it designs its forecasts specifically to aid policy-makers by providing "a policy-neutral reference case that can be used to analyze policy initiatives." However, while the EIA may strive to make its reference case forecasts "policy neutral," the question still remains: Are they "substantively neutral" in a forecasting sense? In other words, are they removed from the sort of systematic bias in which predictions deviate from actual observations in a distinct pattern?

Over the past decade, it increasingly has become apparent that EIA forecasts for NG differ substantially from actual outcomes. Some commentators [1] have suggested that EIA forecasts present a consistently "optimistic" view of NG that, for instance, underestimate price and overestimate supply. On the surface, this concern has face validity based upon forecasts from the EIA's *Annual Energy Outlook* series:

- In 2002, the EIA projected the cost of NG to electric generators in 2006 would be $ 3.82 per thousand cubic feet (Mcf). Actual cost per Mcf was $7.15 (all in 2006 dollars)
- In 2003, the EIA overestimated domestic NG production in 2006 by almost 2 trillion cubic feet—more than the annual production of Oklahoma.
- In 2005, the EIA projected liquefied natural gas (LNG) imports would reach 1,140 bcf in 2006. Actual imports in 2006 were only 583 Bcf—off by more than 550 Bcf just one year out.

To shed light upon the question of bias, we conducted an error decomposition analysis of EIA NG projections of key variables—price, supply, and consumption—from 1998 to 2006. Error-decomposition analysis is used commonly to evaluate economic forecasting models by identifying those components of the forecast errors or the proportions attributed to bias, the model, or randomness. A reliable model would display random errors with no discernable pattern of consistent under- or over-predictions. Thus, the proportions of forecast errors attributed to bias and model components would be minimal.

In our case, we evaluated one-, two-, three-, and four-year-ahead forecasts made by EIA from 1998 to 2006 for six key variables: (1) wellhead price; (2) price to electric generators; (3) consumption by electric generators; (4) domestic production; (5) imports from Canada; and (6) LNG imports.

Selecting Data for Review

Bolinger and Wiser [5] provides a graphical illustration of how EIA wellhead-gas prices forecasts going back to 1985 track actual prices. Their graph clearly illustrates that price forecasts during the 1980s turned out to be too high while forecasts made during the early 2000s appear too low. Graphical techniques, however, do not quantify the size or systematic tendencies of these forecasts errors. This study attempts to extend their analysis by applying the error decomposition methods discussed above.

During December of each year, EIA publishes a forecast that forms the basis of the *Annual Energy Outlook,* or *AEO*, [8] for the subsequent year. (Note: The EIA each year releases its reference case in December. Then in the following February, the EIA releases its full report, with sensitivity cases.)

So, for example, the 2006 *AEO* report released in December 2005 [9] contains a forecast of 2006 prices. This study examines their forecasts published from 1998 to 2006 because EIA posts the detailed forecast tables on its Web site, which is accessible to the public. Auffhammer [2] uses a larger sample and finds that the EIA forecasts of NG consumption, production, imports, and prices do not exhibit the necessary conditions for rationality under symmetric loss. (*Note: The EIA uses the National Energy Modeling System, or NEMS. See "Appendix: Methods of Forecast Evaluation," p. 58, describing our evaluation of EIA's forecasting methods.*)

While each EIA forecast extends 20 years or more, the maximum length of the forecast horizon examined in this study is four years. A three- to four-year forecast for prices is likely of most interest to industry because natural-gas-fired electricity generating plants take roughly three years to build. Moreover, going any more than four years out would not be meaningful given the small size of our sample. Given the sample of forecasts from 1998 to 2006, there are nine one-year-ahead forecasts, eight two-year forecasts, seven three-year forecasts, and six four-year forecasts. While comparing each published *AEO* forecast with actual data over its entire forecast horizon is insightful, economists typically stratify forecasts by length of time not necessarily when they are made. Hence, the forecasts are sorted by length of forecast horizon.

Evaluating the EIA Forecasts

To keep the analysis manageable and comprehensible, our decomposition analysis is conducted for three pairs of variables in the natural-gas market involving prices, domestic flows, and imports. The two prices are the average wellhead price and prices paid for natural gas by electricity producers. The flow variables include dry natural-gas production and consumption by electricity producers. The later was selected because the electricity sector comprises the most dynamic, market-sensitive component of natural-gas consumption along with industrial sector use. Imports include those from Canada and imports of LNG.

Prices. The EIA forecasts natural-gas prices in constant dollars. To establish a consistent basis for comparison, these constant price forecasts are inflated by the corresponding forecasts for the price deflator for gross domestic product (GDP). Once the forecasts are sorted, the prices are converted back to 2006 dollars using the latest GDP price deflator.

The forecast evaluation metrics for the one- through four-year-ahead forecasts from 1998 to 2006 appear in Table 1. On average, the one-year-ahead average percentage forecast error for the wellhead natural-gas price is 16 percent with an absolute error of $1/Mcf. These errors steadily rise and reach more than 45 percent with the four-year-ahead forecast and $2.60/Mcf.

The RMSE (root mean squared error), which penalizes large errors more severely than the average percentage error (*see "Appendix," p. 58 for full explanation*), is almost 35 percent for the one-year-ahead forecast. Like the average percentage error, it too rises with the forecast horizon, reaching more than 57 percent with the four-year-ahead forecasts.

The decomposition of the MSE (mean squared error) for the one-year-ahead wellhead natural-gas price forecast errors indicates that 54.7 percent of the errors can be attributed to systematic bias. This bias crests to almost 88 percent for the three-year-ahead forecasts. While random disturbances are substantial for the one-year-ahead forecast, the large proportion attributed to bias is noteworthy. A plot of the actual time series for wellhead natural-gas prices and the four different forecasts appears in Fig. 1 and illustrates the tendency of the EIA price forecasts to systematically under-predict actual prices. The results for electric generator's natural-gas costs are very similar to those for wellhead natural-gas prices.

TABLE 1 — EVALUATION OF EIA NATURAL GAS-PRICE FORECASTS, 1998-2006

	Years Ahead			
	One	Two	Three	Four
	Average Wellhead NG Prices			
Average Percentage Error	-16.0%	-30.3%	-41.8%	-45.5%
Average Absolute Error ($/Mcf)	1.055	1.749	2.340	2.652
Root Mean Squared Error	34.9%	48.9%	54.3%	57.3%
Decomposition of MSE (proportion)				
Bias	0.547	0.651	0.876	0.845
Model	0.006	0.013	0.029	0.027
Random	0.447	0.336	0.095	0.128
	Electric Generator's NG Prices			
Average Percentage Error	-16.0%	-29.1%	-39.5%	-43.0%
Average Absolute Error ($/Mcf)	1.153	1.893	2.537	2.861
Root Mean Squared Error	33.4%	44.8%	50.8%	52.5%
Decomposition of MSE (proportion)				
Bias	0.565	0.672	0.868	0.854
Model	0.024	0.006	0.022	0.014
Random	0.412	0.322	0.110	0.131

Source: Annual Energy Outlook (annually, 1998-2006), U.S. Energy Information Administration, Table 14.

TABLE 2 — EVALUATION OF EIA GAS CONSUMPTION AND PRODUCTION FORECASTS, 1998-2006

	Years Ahead			
	One	Two	Three	Four
	Electric Generator's NG Consumption			
Average Percentage Error	-15.3%	-15.0%	-14.6%	-14.7%
Average Absolute Error (TCF)	0.913	0.871	0.800	0.816
Root Mean Squared Error	19.7%	21.4%	20.1%	17.9%
Decomposition of MSE (% Contribution)				
Bias	0.575	0.548	0.577	0.704
Model	0.353	0.390	0.348	0.234
Random	0.072	0.062	0.075	0.062
	Dry NG Production			
Average Percentage Error	1.6%	4.1%	5.5%	7.8%
Average Absolute Error (TCF)	0.590	1.053	1.152	1.527
Root Mean Squared Error	3.9%	6.1%	7.0%	9.2%
Decomposition of MSE (% Contribution)				
Bias	0.189	0.444	0.615	0.707
Model	0.472	0.417	0.285	0.221
Random	0.340	0.139	0.100	0.07

Source: Annual Energy Outlook (annually, 1998-2006), U.S. Energy Information Administration, Table 13.

Market Flows. Table 2 shows the forecast errors for natural-gas consumption by electricity generators and for dry natural-gas production. The forecast errors are much smaller than those associated with the forecast errors for prices, which is a common phenomenon. Price forecasting often is more difficult than forecasting demand and production series, which often contain a sizeable trend component or signal. Nevertheless, the forecast errors for these two key natural-gas market flows are substantial.

The EIA forecasts for natural-gas consumption in electricity generation consistently are below actual observations of gas use in this sector (*see the average percentage errors in Table 2*). This is somewhat counter-intuitive because given that EIA under-estimates prices paid for natural gas by electric generators, it would seem that lower prices would imply higher, not lower, natural-gas consumption, all other things held equal. One of the big changes affecting the electricity sector's use of fuels has been the sulfur-dioxide emissions-trading program. That program has exerted a dramatic effect on the opportunities for fuel substitution in power generation, as shown by Considine and Larson [6]. Whether the NEMS correctly mod-

TABLE 3 **EVALUATION OF EIA NATURAL GAS IMPORT FORECASTS, 1998-2006**

	Years Ahead			
	One	Two	Three	Four
	NG Imports from Canada			
Average Percentage Error	-4.4%	-3.1%	2.0%	4.9%
Average Absolute Error (TCF)	0.184	0.245	0.285	0.347
Root Mean Squared Error	8.1%	8.9%	8.8%	10.9%
Decomposition of MSE (% Contribution)				
Bias	0.464	0.126	0.044	0.205
Model	0.246	0.613	0.669	0.625
Random	0.290	0.261	0.287	0.170
	LNG Imports			
Average Percentage Error	-11.2%	-5.6%	-7.1%	-25.1%
Average Absolute Error (TCF)	0.146	0.160	0.193	0.155
Root Mean Squared Error	65.6%	53.4%	67.4%	59.8%
Decomposition of MSE (% Contribution)				
Bias	0.151	0.104	0.093	0.420
Model	0.455	0.255	0.515	0.036
Random	0.394	0.641	0.393	0.544

Source: *Annual Energy Outlook* (annually, 1998-2006), U.S. Energy Information Administration, Table 13.

els the role of permits in power-sector fuel demand and fuel switching could be an important question.

The absolute error for the one-year-ahead forecast for electric generators natural-gas consumption is more than 900 billion cubic feet, which is more than 15 percent of consumption in this sector. In addition, the RMSEs are around 20 percent, nearly four times the errors found in econometric forecasting models of energy demand. [7] Like prices, the error decomposition analysis for natural-gas consumption by electric generators reveals a substantial bias across all four forecast horizons.

The forecast errors for dry natural-gas production reveal further problems. As the average percentage errors indicate, EIA consistently over-predicts dry natural-gas production. The absolute errors are quite sizeable in relation to marginal supplies of gas, specifically imports of LNG. For example, the one-year-ahead forecast error for production is 590 billion cubic feet, which is about equal to LNG imports in 2006. The two- through four-year-ahead forecast errors exceed one trillion cubic feet.

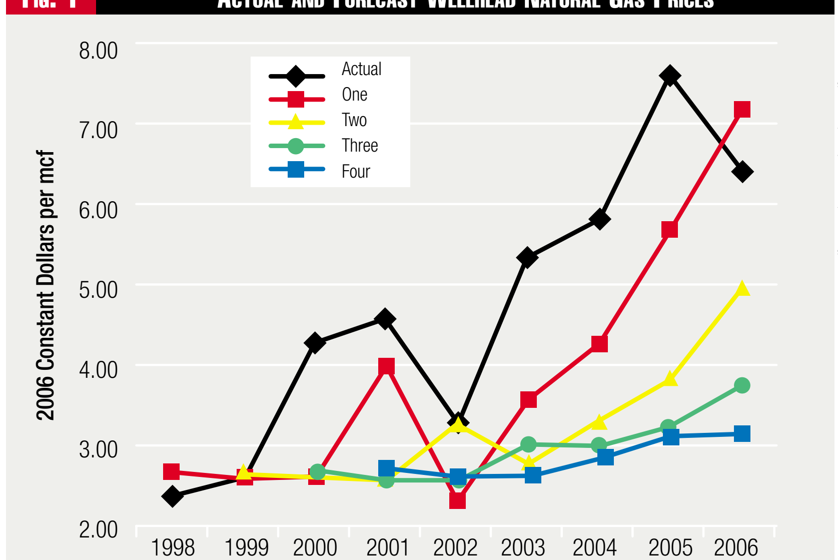
The mean squared error decomposition for natural-gas production also reveals sizeable bias, especially for the three- and four-year forecasts. Unlike prices and consumption forecast errors, the model component of the errors is more than 40 percent for the one- and two-year forecasts. This fact suggests that the model itself is generating systematic errors for the near-term forecast horizon. The time path of each forecast depicted in Fig. 2 illustrates that even though EIA has been scaling back its projections of natural-gas production, the model still portrays an upward track for production albeit from a lower base during each forecast year.

Imports. Another important factor influencing natural-gas markets is imports. The largest external source of natural gas into the United States is Canada, although EIA expects imports of LNG to become significant in the future. Among the forecast errors examined in this study, those associated with EIA's projection of imports from Canada are the lowest. Similar to the other forecast errors, however, the forecasts contain either bias or systematic errors arising from the model.

The projections of LNG imports are not as accurate as those for Canadian imports. The RMSEs are quite large and, while the bias components are relatively small, the proportion of the forecast errors associated with the model remains substantial, especially for the first and third year-ahead forecasts. This finding could be associated with the rather idiosyncratic nature of the LNG import forecasts.

To understand what is happening in the LNG forecast error decomposition, a scatter plot of the actual versus predicted LNG imports appears in Fig. 3. A perfect forecast in which the predictions are equal to the actual observations is plotted on the solid line. A "good" forecasting model should generate

FIG. 1 **ACTUAL AND FORECAST WELLHEAD NATURAL GAS PRICES**



Note: Forecast published in January

Fig. 1 Source: *Annual Energy Outlook* (annually, 1998-2006), U.S. Energy Information Administration, Table 14.

forecasts close to the line of perfect forecasts and randomly scattered around it. As Fig. 3 illustrates, there are several very large over-predictions of LNG imports. The small number of these very large errors most likely accounts for the erratic swings in the mean squared error components reported above in Table 3. Indeed, as Fig. 4 illustrates EIA substantially over-estimated LNG imports in each of the preceding three years.

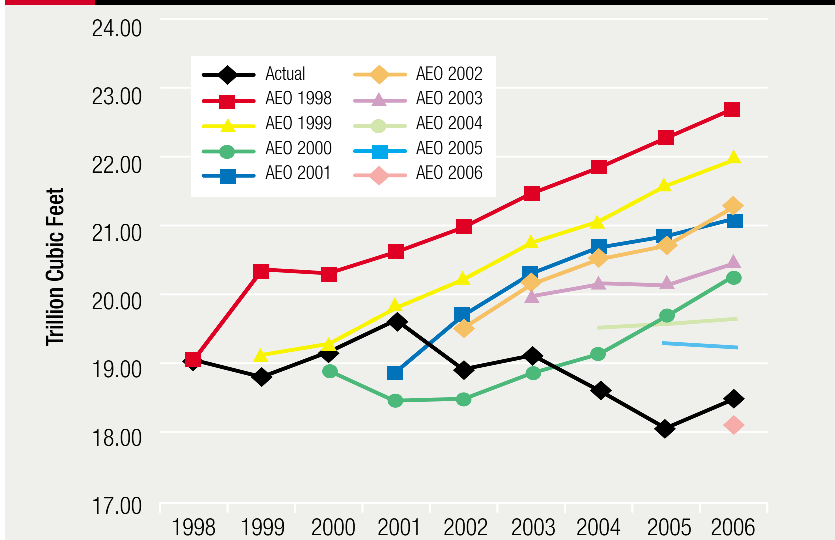
Policy Implications

As the independent research branch of the Department of Energy, the EIA forecasts for NG possess an imprimatur that stretches across the panorama of energy policy and analysis. Thus, the socioeconomic implications of systematic bias are profound indeed.

Several important conclusions can be drawn from this research. First, the NEMS model used by EIA to generate the *AEO* forecasts tends to over-estimate NG production and to under-estimate NG consumption by electricity producers. While EIA forecasts of NG imports from Canada fare somewhat better, projections of LNG imports are over-estimated substantially. These errors are associated with significant under-predictions of market prices. Hence, the overall optimistic picture of ample NG supplies, and growing consumption with either falling or constant real prices has not been supported by actual experience.

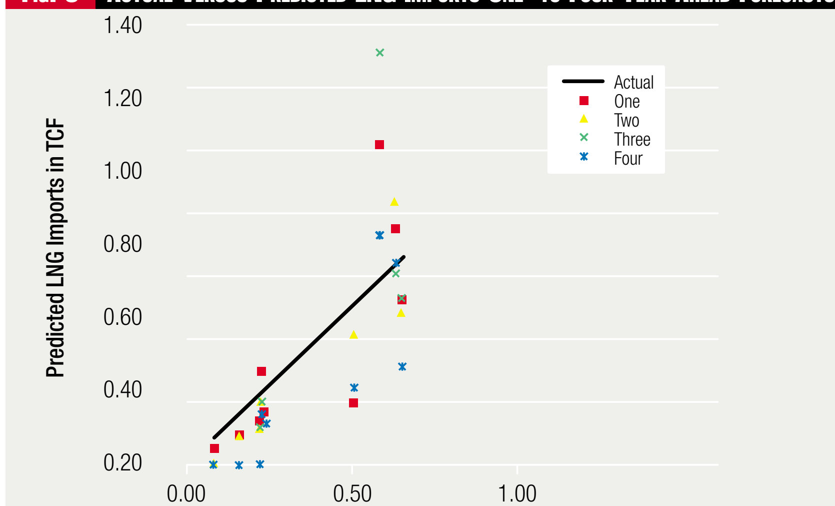
Moreover, an error-decomposition analysis demonstrated that the variation in EIA's forecast errors generally are not reflective of random chance but instead contain evidence of systematic bias, either arising from a fixed, linear bias or

FIG. 2 ACTUAL AND FORECAST DRY NATURAL-GAS PRODUCTION



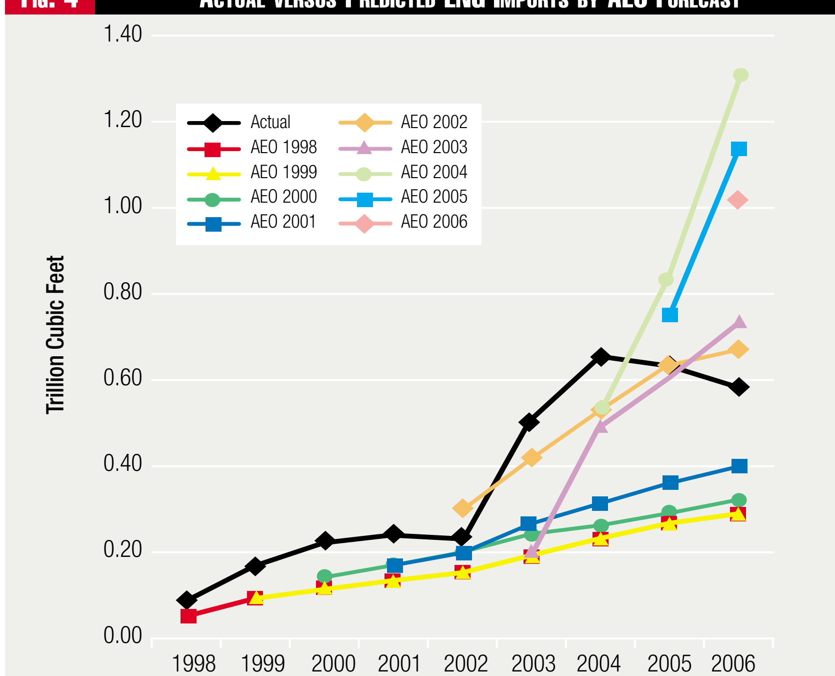
Source: Annual Energy Outlook (annually, 1998-2006), U.S. Energy Information Administration, Table 13.

FIG. 3 ACTUAL VERSUS PREDICTED LNG IMPORTS ONE- TO FOUR-YEAR-AHEAD FORECASTS



Source: Annual Energy Outlook (annually, 1998-2006), U.S. Energy Information Administration, Table 13.

FIG. 4 ACTUAL VERSUS PREDICTED LNG IMPORTS BY AEO FORECAST



Source: Annual Energy Outlook (annually, 1998-2006), U.S. Energy Information Administration, Table 13.

APPENDIX

Methods of Forecast Evaluation

There are a variety of metrics available to evaluate forecasts. No one measure tells the complete story but rather a suite of metrics and graphics must be employed to evaluate forecasts.

Since the National Energy Modeling System (NEMS) used by EIA to generate its forecasts equilibrates supply and demand, it seems most appropriate here to employ methods of economic-forecast evaluation in order to evaluate EIA forecasts of natural-gas markets. These methods all involve the computation of a variety of metrics that compare actual observations with predicted values.

The first metric is the average percentage error defined as:

$$APE_t = \frac{1}{n}\sum_{t=1}^{n} 100 * \frac{(P_t - A_t)}{A_t}$$

where t denotes the time period for a forecast horizon of n periods, P_t is the prediction from the model for period t, and A_t is the actual realized value of the variables in that period. As Auffhammer (*see Reference [2], p. 61*) observes, the problem with this metric is that large positive and negative values can cancel each other out. A similar metric is the average absolute error:

$$AAE = \frac{1}{n}\sum_{t=1}^{n} |A_t - P_t|,$$

which provides an estimate of the average magnitude of the forecast errors.

The third measure employed in this study is the mean squared error, which is defined as

$$MSE = \frac{1}{n}\sum_{t=1}^{n}\left(\frac{(P_t - A_t)}{A_{t-1}}\right)^2 = \frac{1}{n}\sum_{t=1}^{n}(p_t - a_t)^2$$

where $p_t = (P_t - A_{t-1})/A_{t-1}$ and $a_t = (A_t - A_{t-1})/A_{t-1}$. Notice unlike the common average percent error, the mean square error compares predicted versus actual changes. In addition, squaring the errors has the effect of disproportionately penalizing large errors, either negative or positive. The square root of the mean squared error, often referred to as the root mean squared error (RMSE), is more commonly reported because the square root operator on changes closely approximates percent change.

Ideally, model forecast errors should be random, displaying no discernible tendencies to either over or under-predict, or no patterns of either getting smaller or larger over time. Economists and statisticians have developed a variety of methods to determine whether forecast errors exhibit randomness or systematic bias. These methods involve decomposing the mean squared error into various error components. There are a variety of methods to decompose the MSE into its various components. An approach devised by Theil [14], and later recommended by Maddalla [13], and subsequently used in many studies since involves the computation of the following three components:

$$B = Bias = \frac{(\bar{p} - \bar{a})^2}{MSE}$$

$$M = Model = \frac{(S_p - rS_a)^2}{MSE}$$

$$R = Random = \frac{(1 - r^2)S_a^2}{MSE}$$

where S_p is the population standard deviation of p, r is the correlation coefficient between p and a and S_a is the standard deviation of a, and all three measures sum to one, *i.e.* $B + M + R = 1$. Maddalla and Theil note that the bias and the model components measure what can be called "systematic" errors. If B is large, then the average predicted change deviates substantially from the actual average change. This is a serious error because forecasters should be able to reduce such errors in the course of time. In short, if B is close to 1, the forecast is considered biased. The model component of the forecast error reflects the linear association between the actual and predicted values. If M is relatively large then this would suggest that the model itself is generating systematic errors. In a perfect forecast, both M and B would be zero so that if the following regression was estimated:

$$A_t = \alpha + \beta P_t$$

$\hat{\alpha} = 0$ and $\hat{\beta} = 1$ so that $A_t = P_t$. A regression model is not estimated in this study because our sample of forecasts is relatively small. Therefore, we do not attempt to estimate statistical confidence intervals around our forecast evaluation metrics because the power of these tests would be weak given the small sample.—***TJC, FAC***

from a systematic error coming from the model itself. This evidence of forecast bias arising from perhaps the most comprehensive energy market forecasting system in the world illustrates the enormous difficulty of forecasting these markets. The emergence of a natural-gas cartel will add even greater uncertainty to the forecasting.

These results offer several lessons and suggest certain concerns about current and future forecasts at EIA:

1. Gas Production. First, the consistent over-predictions of NG production in the United States should raise serious questions about the reliability of the premise that large supplies would become available with higher prices.

2. Gas Use for Generation. Second, the under-prediction of NG use in electric-power production even with unrealistically low prices suggests that other factors, such as sulfur-dioxide pollution permit costs, may be stimulating NG use in this sector. (This lesson suggests that the NEMS may not be adequately modeling factors that determine the electric-power sector's consumption of NG.)

3. LNG Imports. Third, the large over-estimates of LNG imports suggest fundamental problems with the trade side of the model. Each of these three problems presents daunting challenges for energy market modelers.

4. A Bias Toward Optimism. Current EIA forecasts exhibit a continuing optimism. In the 2007 *AEO*, for example, NG prices are forecasted to decline over the next decade—despite the fact that wellhead prices have increased more than 100 percent in the last five years and that the EIA did not project the vast bulk of those increases. Further, the EIA forecasts that NG production will increase 11 percent by 2020. Yet the EIA has overestimated production substantially in virtually every forecast since 1998.

5. A Failure to Recognize the Problem. Despite the biased divergence between their NG forecasts and actual outcomes, the EIA has published virtually nothing on the question of asymmetrical error. In fact, EIA's model evaluation methodology may itself camouflage the problem. For example, Auffhammer [2] has commented that, "The EIA conducts its own forecast evaluation…[but] this type of evaluation ignores potentially persistent biases in the forecasting model."

The analysis reported here suggests that considerable caution should be exercised when using EIA forecasts relating to the future price, supply, and consumption of NG. Similar caution should be exercised when using NEMS to assess the broader economic impacts of energy policy initiatives, *e.g.*, carbon cap-and-trade programs.

Climate-change proposals currently before Congress [3] depend heavily on predictions of the response of natural-gas supply and prices to carbon-permit prices. The actual capability of the NG supply network both here and abroad will be a critical factor in how economies adjust to such climate-change policies. Overestimating the supply capabilities of this network (as EIA has done over the past decade) could lead to underestimating the costs of carbon regulations.

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