# Politically Contrived Gasoline Shortage

CRAIG S. MARXSEN

The 1972 book *The Limits to Growth* (Meadows et al. 1972) sensationalized the theory that natural-resource depletion and rising pollution would soon bring catastrophe. The authors theorized that, among other problems, running out of basic resources such as petroleum would cause a collapse of industrial and agricultural production as well as a resulting loss of a large part of the world's human population. An "energy crisis" immediately following the book's publication enhanced its credibility and brought it a great deal of public attention, although the energy crisis later proved to have been only a temporary anomaly caused largely by price controls. Recent, substantial increases in gasoline prices may revitalize the catastrophists' conviction that imminent fossil-resource exhaustion demands prompt substitution of renewable fuel sources, such as ethanol. Convinced that because fossil fuels apparently are nearly exhausted as a practical energy source and we can abandon them almost costlessly, opponents of fossil fuels advocate drastic reduction of their use to prevent a ruinous crisis of carbon dioxide pollution. Yet the alleged crisis requires a near-zero discount rate to raise the prorated present value of damage, per gallon of gasoline combusted, far above the relatively modest figure obtained by use of a market interest rate for discounting purposes.

A more serious potential economic crisis caused by rising motor-fuel prices, in contrast, does not spring from pollution or resource exhaustion, but from the catastrophists' mistaken belief in what has become their almost self-fulfilling prophecy (see Marxsen 2003). Through the political system, they have promoted regulatory

**Craig S. Marxsen** is an associate professor of economics at the University of Nebraska, Kearney.

*The Independent Review, v. XII, n. 4, Spring 2008, ISSN 1086–1653, Copyright © 2008, pp. 537–551.*

actions that are discouraging the investment that would otherwise have prevented today's worsening refining bottleneck. Obstruction of investments in gasoline refineries, achieved by regulatory interventions, is probably a more significant threat to the affordability of gasoline than any approaching exhaustion of gasoline's fossil sources. Reestablishment of refiners' reasonable property rights and adoption of strict liability as the major instrument for controlling carbon dioxide and refinery pollution might end what otherwise may become an ever-worsening, regulatory-induced "energy crisis."

## The Price Mechanism

Robert Solow responded promptly to *The Limits to Growth.* He explained that the price mechanism would induce substitution of alternative sources as oil became scarcer (1973, 44–47). Production methods that rely on relatively more abundant natural resources eventually will substitute for dwindling supplies of oil that had previously been cheap and easy to exploit (Solow 1974, 3–5). Now, more than thirty years later, specific forms of such substitution have become more visible to those looking ahead toward practical alternatives.

Although crude oil still appears to be relatively abundant and supplies most of the world's material from which gasoline is refined, other fossil sources of gasoline seem to offer commercially viable alternatives. These sources include methane (or natural gas), coal, bitumen obtained from tar sands or oil shale, and crude petroleum's "bottom of the barrel" components, such as asphalt. Let us ignore nonfossil feedstocks, such as corn and turkey guts, because they escape political opposition from opponents of fossil fuels and, in any event, have potential to make only a small contribution to present rates of gasoline consumption. Because available stocks of petroleum, methane, coal, tar sands, and oil shale are sufficient for centuries to come, however, the possibility of sustaining supplies of ordinary gasoline for motor fuel at reasonable prices appears virtually assured, regardless of nonfossil sources, if the political system will permit. Conversely, a complete transition to nonfossil sources at this time would doubtlessly result in much higher gasoline prices.

## Fossil-Energy Sufficiency

A great deal of fossil-fuel material remains buried in accessible places. In the U.S. Department of Energy's *International Energy Outlook 2006,* world energy use is projected to rise from 421 quadrillion Btus, or "quads," in 2003 to 722 quads in 2030 (2006b, 1). Paul Holtberg, director of the Demand and Integration Division of the U. S. Department of Energy, and Robert Hirsch, a senior energy program advisor at Science Applications International Corporation, estimate that 13,400 quads of conventional crude oil and 14,000 quads of conventional natural gas remain exploitable. At least another 15,000 quads are available from unconventional sources of crude oil, such as tar sands and oil shale. In the lower forty-eight states of the United States, geopressured brine and gas hydrates may offer as much as 335,000 quads, according to Holtberg and Hirsch (2003). Bob Williams (2003a), former executive editor of the *Oil and Gas Journal,* reports a global methane hydrate endowment more than 190 times the amount in the United States. Worldwide coal resources exceed 135,000 quads, according to Holtberg and Hirsch. At the 2003 rate of global energy use, and not counting the geopressured brine and methane hydrate endowment outside the lower forty-eight states, such fossil-fuel reserves would apparently last more than 1,200 years, and they would last more than 700 years at the projected 2030 rate of consumption. Moreover, Holtberg and Hirsch's estimates seem to be conservative ones. David L. Greene, Janet L. Hopson, and Jia Li estimate in a report prepared for the U.S. Department of Energy by Oak Ridge National Laboratory that the world's remaining supply of exploitable oil (including that from shale and tar sands) is about 106,572.2 quads, with about 32,885.6 quads recoverable under technologies and prices expected to prevail before 2050 (2003, 9). Thus, fossil hydrocarbons for making gasoline and other liquid fuels will almost certainly be adequate for centuries to come. The real obstacle is the world's political systems.

## Obstructing Refining

Government interventions have constrained the petroleum-refining industry for decades. A 2004 U.S. Department of Energy National Petroleum Council report documents a variety of impediments to expansion of refining capacity. Not a single new-site refinery has been built in the United States since the mid-1970s (Shackouls 2004, I-19). From 1981 to 2002, the average return on equity for petroleum companies was 11.3 percent, and the S&P 500 average was 12.2 percent (I-14). The return on capital employed in refining and marketing was only 5.3 percent, compared with a return on capital of 7.7 percent for the industry as a whole (I-14). The low returns reportedly derive from significant regulatory-driven investments that yield no return, combined with the highly competitive nature of the business (I-16). Building a new refinery involves a huge investment and is therefore subject to tremendous losses from any delays. Environmental regulation—including New Source Review enforcement and National Ambient Air Quality Standards—and uncertainties generated by waivers, exceptions, and amendments to regulations create strong disincentives for investment in new refineries (I-6). Ben Lieberman (2006), a senior policy analyst at the Heritage Foundation, contends that as much as 25 percent of total capital outlays in the refining sector are devoted to environmental regulatory compliance. Ever-changing specifications for reformulated gasoline and low-sulfur diesel frustrate refiners' efforts to achieve maximum volumetric efficiency during peak demand periods and further reduce the return on an investment in a new refinery (Shackouls 2004, I-18). The government's obstructions of the use of carbon fuels somewhat resembles its more visible prevention of the expansion of nuclear power in spite of engineering advances that have almost totally eliminated the more significant nuclear-safety issues that once seemed relevant.

The potential for regulatory harassment may make refiners with less-than-extraordinary prospective profits unwilling to remain in business in coming years. In a 2002 report, Jerry Hill, principal environmental engineer at Bechtel's Houston office, illustrates what had then become a strategy emphasized by the Environmental Protection Agency (EPA). The EPA's Office of Enforcement and Compliance Assurance had increased its focus on petroleum refineries, and inspection teams made a number of detailed audits, each spending many days searching for violations of federal and state pollution regulations. These armies of fault-finding inspectors compiled and submitted to the U.S. Justice Department and filed in district federal courts long lists of alleged violations of pollution laws. At the top of Hill's list of violations was failure to obtain construction permits, failure to install the best available control technology, and flaring gas that contained sulfur. Other violations included insufficient labeling of containers and inadequate record keeping. Hill describes the prompt and costly defeat of a refiner who decided to go to trial. Thirty-six refineries in nineteen states settled these actions for the most part with negotiated consent decrees that involved millions of dollars for remedial expenditures and additional millions for payment of fines. The consent decrees typically remained in force for years. Hill notes that such actions against refiners "have made them subject to additional standards and regulatory supervision without the typical rule-making process." He describes settlements as "giving the EPA joint dominion with several owners in the daily operation of a number of refineries" (2002, 76). Affected refineries account for about one-third of U.S. capacity. Fines ranging up to $10 million went to the U.S. government, with a sizeable portion going to the regulatory agency involved. Hill's report is not a polemic to sway public opinion, but only a descriptive article in the trade journal *Hydrocarbon Processing*. To an industry outsider, however, the account raises suspicion of an abuse of regulatory authority for the purpose of obtaining, by extortion, nearly unqualified pledges of compliance with bureaucrats' dictates that are unbounded by statutory limitations.

Al Gore's near victory in the 2000 presidential election suggests that opponents of fossil fuels continue to gain political traction. When subsequently asked what he would have done differently had he won the election, Gore told George Stephanopoulos, "I would have urged the Congress and done my best to lead the country to take on this climate crisis, become independent of carbon-based fossil fuels as quickly as we can, to shift toward conservation, efficiency and renewable energy" (Stephanopoulos 2006). With this expressed ambition, Gore presumably represents a powerful segment of the voting public that political candidates of both major parties seem increasingly willing to placate. This tendency suggests an increasingly effective influence of the voters lying between the median and the extreme, individuals for whom, as John Brätland observes, "environmental enjoyment may be impossible as long as the petroleum industry continues to exist" (2004, 530).

One might expect petroleum companies simply to locate more refining facilities offshore. The *Sacramento Bee* carried a McClatchy Newspapers Washington Bureau report by Kevin G. Hall (2007) explaining that the difficulty of siting or expanding a refinery in the United States is propelling a boom in overseas refinery expansion. However, in a 2006 article in *Business Week,* Stanley Reed and colleagues emphasized that foreign governments have been increasingly nationalizing, restricting, and taxing the giant multinational petroleum companies that produce petroleum products within their borders. In 2005, the six major oil companies, motivated by increasing global politicization of petroleum-contract issues in many countries, returned through stock buy-backs more cash to shareholders than they invested in new facilities. An editorial in the *Oil and Gas Journal* ("Investing in Venezuela" 2006) suggests that only the high price of petroleum keeps the major companies from pulling out of Venezuela in the face of increasing government control and earnings takings that they have suffered since Hugo Chávez's election as president in 1998. U.S. motorists in turn are suffering at the pump as a result of the rising political risk that petroleum refiners suffer globally. Property rights are a critical issue. Petroleum companies have located very little of their costly conversion-refinery capacity outside of the advanced industrial countries of North America, Europe, Australia, the Far East, and several large developing countries where property rights are better protected than in the rest of the world. According to the U.S. Energy Information Administration (U.S. Department of Energy 2006a), the United States, despite its severe regulation, had between 32 percent and 40 percent of the world's total conversion-refinery capacity in January 2005.

## All Refineries Are Not Equal

Because crude petroleum of a given grade sells at a uniform price in the global market, gasoline is expensive everywhere in the world when the price of petroleum is high. Philip K. Verleger Jr., a former director of the U.S. Treasury's Office of Domestic Energy Policy, is one of the nation's most renowned energy authorities and has frequently testified before Congress as an expert on energy commodity markets. He notes that a refining-capacity constraint for the most part caused the huge increases in crude-oil prices since the spring of 2004, in contrast to OPEC actions that had previously driven up crude prices from about $10 per barrel in 1999 to about $35 in early 2004 (2006, 17–18, 58). U.S. refining capacity fell from 19 million barrels per day in 1981 to 15 million barrels per day by 1994 (*Economic Report of the President* 2006, 241). Expansion of existing refineries' output subsequently pushed capacity up to 17 million barrels per day by 2004, and imports of refined petroleum products increased from 11 percent of consumption in 1993 to 15 percent in 2004 (*Economic Report of the President* 2006, 241, 243). If refining capacity were inadequate, one might think that the price of crude would fall and the prices of finished gasoline and other fuels would rise so that a spike in refinery profits would appear to account for the rise in fuel prices. However, the refining industry includes many lesser facilities, some of which employ primitive technology, and their presence camouflages the deficiency of refining capacity. The lack of capacity affects the synthesization of gasoline more than it affects the overall distillation of sweet light crude (which I define and discuss more fully later).

Bernard Gwertzman, a consulting editor for the Council on Foreign Relations and a former editor and correspondent for the *New York Times,* asked Verleger in a 2006 interview how a relaxation of environmental regulations could bring down the price of crude oil if inadequacy of refining capacity drove it up to begin with. Verleger elaborated on one of the mechanisms of the refining constraint by explaining that many of the existing refineries cannot meet present regulations without buying "sweet" (low-sulfur) crude from which they can refine gasoline without much work. Only a subset of U.S. refineries has made the huge investments that enable them to meet regulatory requirements while processing less-desirable grades of crude, and they strongly oppose politically a relaxation of regulatory requirements that would reduce the profits from their investment in sophisticated refining equipment. Verleger emphasized that the demand for sweet light crude is growing explosively because refinery capacity to process less-desirable feedstock is inadequate. A larger population of refineries that can obtain motor fuel from a spectrum of inferior feedstocks would alleviate much of the rise in the price of both sweet light crude and gasoline at the pumps. So would a larger population of refineries that can get more gasoline from a barrel of sweet light crude.

In his essay "Energy: A Gathering Storm," Verleger explains how the world price of crude petroleum correlates highly with "gross product worth," a weighted average of the market values of the component distillates into which it can be fractioned (2005, 217–20). He observes that "when refining capacity constrains supply, product prices will lead crude prices" (218), referring to this petroleum-pricing principle as "arbitrage between crude and product" (219), presumably because the so-called "arbitrageur" is buying materials that are mixed together, separating them, and reselling them in other markets. The skeptical reader must understand that the competitive markets for crude and gasoline operate to deprive the owners of the lowest-quality refineries of economic profits, leaving them with only "normal profit," as economists call it.

Almost two centuries ago, David Ricardo ([1817] 1821) considered a similar enigma concerning farmland. He explained how farmers would bring poorer-quality land under cultivation as population grew, much as refiners bring poorer-quality refinery equipment to higher production rates. He explained further that rents would rise on the better-quality land, whereas the least-productive land—the land with the lowest marginal product—would earn no rent. Similarly, refinery equipment that gets the least amount of gasoline from an average barrel of crude earns no economic rent because owners of such equipment competitively drive up the price of crude oil in response to rising gasoline prices until economic rents accrue to the suppliers of crude oil rather than to the owners of this least-effective refining equipment.

Distillation processes that merely separate the components of crude oil constitute the most basic refining operations undertaken all over the world. These "topping refineries," as they are called, tend to be the least profitable to operate. Expanded refining capacity in the form of "conversion refineries," which get more gasoline per barrel of crude, would increase the supply of gasoline and reduce the demand for crude at the same time, causing the price of crude (and hence the price of gasoline) to fall. Conversion refineries employ topping, hydroskimming, catalytic cracking, hydrocracking, olefin conversion, and coking processes to eliminate the production of low-value residual products. Fully two-thirds of output from a conversion refinery can take the form of unleaded gasoline, with jet fuel, liquefied petroleum gas, low-sulfur diesel fuel, and a small amount of coke constituting the rest of the output. Massive investment is required to bring conversion refineries and other sophisticated fuel-producing capital into existence, and command-and-control regulation discourages such investment. The Energy Information Administration (U.S. Department of Energy 2006c) lists refinery yields for the year 2004 by region and shows that performance varied considerably: New Mexico refinery yield was 55.9 percent high-value, finished motor gasoline and only 6.3 percent low-value asphalt and road oil; in contrast, northern Louisiana and Arkansas refinery yield was 21.1 percent finished gasoline and a whopping 23.3 percent asphalt and road-oil residual.

Capabilities vary within individual refineries as well as among them. An individual refinery generally has a substantially higher barrel-per-day capability for distillation than for catalytic cracking, hydrocracking, or coking, so higher outputs can be achieved beyond a certain point only with reduced yields of the highest-value products. As demand for refined output grows, the industry wastes more input as unconverted outputs of low value, such as asphalt. Expanded utilization of U.S. distillation refinery equipment appears to have offset any recent expansion of conversion-refinery capacity. U.S. Department of Energy (2007) figures show that total U.S. refinery yields for gasoline have exhibited a mild downward trend since 2001. The trend line for the average U.S. refinery has gone from near 47 percent finished motor gasoline per barrel of crude oil in January 2001 to near 46 percent in March 2007. Discouragement of future investment in conversion-refinery equipment will cause the price of gasoline to rise by ensuring that yields do not rise and that cheaper feedstocks cannot provide an increasing amount of gasoline output.

## All Refinery Feedstocks Are Not Equal

Crude petroleum varies considerably in its components. The most desirable crude is "sweet light," which has low sulfur content ("sweet") and is less viscous ("light") because more of it can be inexpensively distilled into high-value fuel components (Hamilton 2005). "Heavy sour" crude requires expensive equipment to remove the sulfur and has more viscous components that require a conversion refinery to transform them into lighter fuel components. Late in June 2006, Nigerian Bonny [Sweet] Light had a spot price of $71.65 per barrel, whereas Saudi Arabian Heavy [Sour] sold for $13 less, at $58.70, well below the $5.00 historical average spread between sweet light and heavy sour (Jubak 2006). Near the end of 2004, Steve Everly discussed the world's limited capacity to refine heavy sour crude as supplies of sweet light crude dwindle: at a time when sweet light constituted only about 30 percent of the world's oil reserves, although more than three-fourths of U.S. refineries could handle heavy sour crude as a fraction of their input, only about 45 percent of all the refineries worldwide and about 30 percent of refineries in Asia could refine heavy sour crude at all. Companies capable of refining heavy sour crude achieve their capacity output by operating marginal equipment that requires sweet light crude, and they have invested in only a limited amount of internal conversion-refinery capacity. For example, in 2005, Valero's refinery throughput was about 50-50 sweet and sour crude, and Premcor was running the highest fraction of heavy sour at 55 percent of its throughput—the highest percentage of sour throughput of all American refiners (Markey 2005). The world's marginal refining capacity cannot refine heavy sour crude at all, let alone refine it into sweet light products. Converting such capacity to make it capable of refining heavy sour crude is a multiyear, multi-billion-dollar project, and owners of marginal refineries have in many cases opted to refine only sweet light crude or to retire refining equipment altogether, according to Harry Chernoff (2004). James Hamilton (2005) explains that the rising difference between the prices of sweet light and heavy sour crude reflects dwindling supplies of sweet light, rising demand for the distillates of sweet light, and an absence of adequate investments to cope with the need to obtain sweet light distillates from heavy sour crude. He also emphasizes that environmental regulations have significantly hindered such investment.

In the future, refinery feedstock will require increasing amounts of conversion-refinery equipment relative to distillation equipment. Topping refineries cannot obtain gasoline from tar sands or oil shale. Transformation of bitumen from Canadian tar sands yields "synthetic" crude oil, so called because the end-product fuels differ so much from the input with which the process starts. When world crude-oil prices were in the neighborhood of $10 or $15 per barrel, this approach was not economically feasible because the market value of inputs exceeded the market value of the final output of motor fuel. In a U.S. Congress Energy and Commerce Subcommittee hearing on December 7, 2005, Representative Roscoe G. Bartlett (R., Md.) unwittingly confused the issues in noting that Canadians use more energy from gas to retrieve oil from tar sands than the Btu content of the resulting synthetic oil produced (Snow 2005). Energy accounting is largely irrelevant. In the remote locations where the Canadians are exploiting the tar sands, the gas has relatively little value, and hence its use in the process makes economic sense.

Recent crude-oil prices easily justify the more expensive production processes by which Canadians now produce outputs with greater market value than the inputs required, energy accounting notwithstanding. Bob Williams contrasts other unconventional energy sources with tar sands and shale oil, explaining, "Heavy hydrocarbons are already making a robust, economically viable contribution to the world's oil supply today" (2003b, 20). He notes further that with global heavy-hydrocarbon resources exceeding 6 trillion barrels by some estimates, improvements in production technology have made today's significant commercial production levels sustainable at oil prices that previously would have halted heavy-hydrocarbon exploitation.

## Fuel Alchemy

As capital intensity and the size of investments increase, remarkable transformations can result. A modern conversion refinery exists in a logical continuum through a broader category that encompasses additional processes that convert carbonaceous materials into motor fuel. These processes will become increasingly prevalent in fuel "refineries" of the future. "Nonconventional oil" can be "refined" not only from bitumen, such as asphalt and tar, and from oil shale and tar sands, but also from coal and natural gas and from thermal depolymerization of organic materials, such as waste from meatpacking plants and other biofuel sources, including corn and manure. The Fischer-Tropsch process, developed at the Kaiser Wilhelm Institute in the 1920s, converts hydrogen, natural gas, or coal gas into gasoline or diesel oil. The natural gas required to make a gallon of gasoline from the Fischer-Tropsch process has historically been worth more when marketed as natural gas. Much natural gas exists beyond pipeline reach to markets (called "stranded gas"), and political obstacles sometimes drive up the value of gasoline in particular locales. The South African company Sasol has developed two new-generation Fischer-Tropsch processes and has profitably produced liquid fuels with them for decades. Low-temperature carbonization, a process originated early in the twentieth century by Lewis Karrick, extracts liquid fuels efficiently from coal, leaving a smokeless coke residue that has been a preferred fuel for power plants in Great Britain. These processes proved viable in circumstances in various places in the past, but their practicality at present hinges not only on the price of crude oil and the efficiency achieved by the processing plant or refinery, but also on political constraints (Peters 1982). Claude Corkadel III (2005), a representative for Rentech Inc., has shown that a ton of coal that can generate $59 worth of electricity when burned converts to $135 worth of Fischer Tropsch fuels, fertilizers, and electricity when transformed by a suitable Rentech Poly-Generation plant.

Montana governor Brian Schweitzer (2006) provides an informative Web site devoted to Fisher-Tropsch liquids, such as gasoline, diesel, and jet fuel made from coal or natural gas. He boasts that, in liquid terms, Montana's coal is equal to one-fourth the entire Middle East oil reserve. He notes that South Africa, Qatar, Malaysia, and China are currently investing in such synthetic fuel production and that Germany powered most of its war effort from synthetic diesel during the 1940s. The U.S. secretary of defense has recently proposed that our entire military adapt to operating on a single fuel synthesized from coal to reduce U.S. vulnerability to supply disruption from foreign energy sources. Petroleum prices of $35 per barrel or greater make such synthetic fuels competitive (Schweitzer 2006). John Adams reports that China is investing $15 billion in new coal-to-liquids plant projects, and Royal Dutch Shell and Sasol have been building ten coal-to-liquids plants in China (2006, 2–3). Opponents of synthesizing motor fuel from coal emphasize that this source entails greater carbon dioxide emissions than petroleum-derived fuels. The threat of an ever-tightening regulatory attack on investment in coal-to-liquids conversion facilities may produce the same results as its legal prohibition.

The expansion of industries that make gasoline from the lower-value constituents of crude oil and from tar sands, oil shale, coal, and natural gas would expand the world's supply of motor fuel and halt the rise of both gasoline and crude-oil prices, perhaps even pushing motor-fuel prices down substantially. A sufficient expansion of fossil-energy-converting facilities would almost certainly prolong the era of relatively inexpensive gasoline for centuries. However, at present, a "refining bottleneck," broadly speaking, threatens to cause a continued and politically manufactured run-up of gasoline prices. Those who want to push fossil fuels above the average person's reach can probably succeed by discouraging the building of refineries and synthesizing plants. Opponents of carbon fuels, by promoting ever-tightening regulation, can probably drive motor-fuel prices much higher than they are at present. The economic repercussions are potentially devastating to the prosperity and even the security of the United States and the rest of the world.

## Property Rights

John Brätland observes that command-and-control regulation facilitates indirect intervention by people who actually suffer little or no real damage from the exercise of petroleum producers' legitimate property rights (2004, 532). The instigators of this "political externality" problem (527) ignore the trade-off between development of valuable petroleum-supply capabilities and a realistic valuation of environmental amenities. The political process empowers rudimentary "general animosity toward the petroleum industry" (532), which is "vented as adversarial political pressure brought to bear on the legislative and regulatory organs of government." Most important, Brätland emphasizes, the people inflicting regulatory restrictions through the political process bear little or none of the opportunity costs that such restrictions impose (527, 532). They get a "free ride" (532), in contrast to property owners who bear the costs of such political activism. Brätland proposes, as a major part of the solution, that intervention be limited to "strict liability," whereby property owners such as petroleum refiners must pay only for actual damages to property of others or for damages to their persons.

Advances in technology have greatly diminished local emission problems in modern refineries, and halting the imposition of tighter inspection standards might alleviate some of the discouragement among those who would invest in them. Global warming allegedly threatens to cause modest but widespread damage for people all over the world, but ruining the refining industry seems an inappropriate response. What is the extent of the prospective damage when an additional gallon of gasoline is combusted and thus adds carbon dioxide to the global atmosphere, allegedly contributing to the harm from future warming? Beginning in the 1970s, William Nordhaus originated what Robert Hahn (2005) calls "probably the best researched" models for studying the cost of global warming. Nordhaus estimates in his 2007-updated DICE Model that as of 2005 the "social cost of carbon" is about $28 per metric ton, or slightly more than eleven cents per gallon of gasoline (2007a, 34–35). This figure represents the present value of the incremental economic harm to the global economy from the carbon dioxide emitted when carbon fuels are burned. To get this figure, Nordhaus projected the likely reduction in gross world product that future warming might cause. In earlier work of my own (Marxsen 1996), I showed that a discrete summation approach vaguely similar to Nordhaus's earlier control-theory modeling techniques can provide a spreadsheet tally more comparable to what lawyers typically present in liability cases, such as for wrongful death suits. Nordhaus's analysis would thus support an eleven cents per gallon strict liability claim, perhaps in a global class-action suit. His estimates of the value of the damage from a unit of carbon burned were lower in the past (for example, four cents, as reported by Hahn) and have tended to increase in part because gross world product has been adjusted upward. The British government in 2006 released *The Stern Review on the Economics of Climate Change,* which provided a much higher estimate of the value of such damage, but Nordhaus (2007b) has recently shown that this result depends almost entirely on assumptions inconsistent with the interest rates actually observed in global capital markets. Unrealistically low discount rates produce grossly exaggerated estimates of the present value of future prospective damage from global warming and exaggerate the liability for which emitters of carbon dioxide might justly be required to pay compensation. Nordhaus discusses the imperative of using market-determined interest rates as a basis for discounting. Brätland has noted the absurdity of using zero discount rates in this general context (2006, 27). Market-determined interest rates, like market-determined prices, come about by bringing to bear information that no other method can effectively weigh—government technicians in particular cannot calculate any valid alternative rate that represents the preferences and production possibilities embedded in market interest rates. Judges presiding over tort cases rightly reject the use of zero or near-zero discount rates. Basing the assessment of anticipated global warming damage on a zero discount rate is like awarding tort plaintiffs the undiscounted sum of payments from an allegedly lost consol or perpetuity and would seem an arguably crooked practice. If the time horizon is infinite, so is the undiscounted sum of the perpetuity's future payments, no matter how small the perpetuity's original purchase price.

To compensate people for damage from global warming, Robert Hahn (2005), director of the AEI-Brookings Joint Center for Regulatory Studies and a resident scholar at the American Enterprise Institute, concedes that a gasoline tax might stand on an "economically respectable argument." AEI scholars Kenneth P. Green, Steven F. Hayward, and Kevin A. Hassett (2007) have considered the merits of carbon taxes compared with regulatory carbon caps, which they regard as less desirable. However, gasoline taxes already total substantially more than eleven cents per gallon in most locations in the United States. Moreover, no one is compensating refinery owners or motorists for the damage they are suffering because of unjust regulatory harassment.

Regulatory discouragement of investment in refining capacity seems already to have added much more than eleven cents to the price of a gallon of gasoline and may add several dollars per gallon more in coming years. In contrast to gasoline taxes, past decades of harassment by command-and-control regulation attempts to achieve carbon control by means analogous to spiking trees in order to save forests by wrecking sawmills. Although petroleum company officers may perceive what is causing them serious harm, motorists and nearly all others are suffering a substantial externality paid for at the pumps that they do not appear to understand. The public is so bamboozled by the fighters of global warming that it almost seems to regard the destruction of refining capacity as a good thing.

## Conclusion

The earth is hardly exhausting the resources to make abundant, affordable gasoline. The technology to make gasoline, even when oil wells run dry, already exists. Rising gasoline prices will automatically set the stage, so that synthesizing gasoline from a wide variety of source materials will become increasingly profitable. However, the enjoyment of plentiful gasoline may not be in our future in spite of its feasibility. Political interference with the construction and operation of refineries and synthesizing plants places the world at the mercy of those who believe they must deprive humankind of cheap fossil fuels. Their persistent obstruction of the construction and expansion of petroleum refineries has already proved capable of contriving a mild energy crisis. Because of the hidden causality of our presently looming, more serious energy crisis, such investment-inhibiting interventions are apt to go far beyond the imposition of deprivations that an enlightened public would willingly tolerate.

The alarming rise in the price of gasoline and other motor fuels thus is hardly the result of running out of materials available in the earth's bounteous fossil deposits—the natural-resource exhaustion that *The Limits to Growth* predicted. Nor does the world face an imminent apocalypse from carbon dioxide "pollution." Substantial projected costs per capita from carbon dioxide emissions remain so remote that virtually zero discount rates are required to give them more than modest present values today. The imminent pollution crisis foretold in *The Limits to Growth* has proved to be a phantom. Ironically, gasoline prices are rising for the most part because of a belief in an almost self-fulfilling doomsday forecast. Devotees of the collapse hypothesis have helped propel a regulatory campaign to discourage investment in petroleum-refining capacity, naïvely hoping both to head off exhaustion of fossil resources and to prevent an alleged global-warming crisis they fear will come after the lifetimes of people now living. The real threat of economic collapse, however, springs from the fright-induced failure to invest in refining and fuel-synthesizing capacity. Belief in the catastrophists' collapse hypothesis thus itself threatens to bring real catastrophe to our modern industrial world.

## References

Adams, John S. 2006. Coal Rush. *Missoula Independent* 17, no. 22 (June 1): 1–6.

Brätland, John. 2004. Externalities, Conflict, and Offshore Lands: Resolution Through the Institutions of Private Property. *The Independent Review* 8, no. 4 (spring): 527–48.

———. 2006. Toward a Calculation Theory and Policy of Intergenerational Sustainability. *Quarterly Theory of Austrian Economics* 9, no. 2 (summer): 13–45.

Chernoff, Harry. 2004. The Marginal Price of Oil. *Energy Bulletin* (December 14). Available at: http://www.energybulletin.net/print.php?id=3639.

Corkadel, Claude, III. 2005. FT Fuels from Low Ranked Coals—An Economic Proposition. Paper presented at the Montana Symposium: Energy Future of the West, Montana State University, Bozeman, Montana, October 18–19. Available at: http://energyfuture.mt.gov/presentations/Claude Corkadel—MT Symposium 10-18-05.pdf.

*Economic Report of the President.* 2006. Washington, D.C.: U.S. Government Printing Office.

Everly, Steve. 2004. U.S. Refiners Get Rid of Sour Oil. *Alexander's Gas and Oil Connections* 9, no. 24 (December 9). Available at: http://www.gasandoil.com/goc/news/ntn44964.htm.

Green, Kenneth P., Steven F. Hayward, and Kevin A. Hassett. 2007. Climate Change: Caps vs. Taxes. *AEI Online: Environmental Policy Outlook,* no. 2 (June 1). Available at: http://www.aei.org/docLib/20070601_EPOg.pdf.

Greene, David L., Janet L. Hopson, and Jia Li. 2003. *Running Out of and Into Oil: Analyzing Global Oil Depletion and Transition Through 2050.* Prepared by the Oakridge National Laboratory for the U.S. Department of Energy, ORNL/TM-2003/259 (October). Available at: http://www.cta.ornl.gov/cta/Publications/Reports/ORNL_TM_2003_259.pdf.

Gwertzman, Bernard. 2006. Verleger: Oil Prices Peaking, but Hurricanes or Other Events Could Send Them Higher: Council on Foreign Relations Interview of Philip K. Verleger Jr. May 4. Available at: http://www3.cfr.org/publication/10602/verleger.html.

Hahn, Robert W. 2005. Energy Conservation: An Economic Perspective. *AEI Online* (October). Available at: http://www.aei.org/publications/pubID.23375,filter.all/pub_detail.asp.

Hall, Kevin G. 2007. Foreign Refineries Will Supply More U.S. Gas. *Sacramento Bee,* May 31.

Hamilton, James. 2005. Sweet and Sour Crude. *Econbrowser,* August 21. Available at: http://www.econbrowser.com/archives/2005/08/sweet_and_sour.html.

Hill, Jerry. 2002. Consider New Refinery Standards Now Being Set Through Litigation Actions. *Hydrocarbon Processing* 82, no. 8 (August): 75–79.

Holtberg, Paul, and Robert Hirsch. 2003. Can We Identify Limits to World-Wide Energy Resources? *Oil and Gas Journal* (June 30): 20–27.

Investing in Venezuela. 2006. *Oil and Gas Journal* (April 10): 17.

Jubak, Jim. 2006. Three Ways to Win from the Oil Glut. *Jubak's Journal,* MSN Money (July 13). Available at: http://articles.moneycentral.msn.com/Investing/JubaksJournal/3WaysToWinFromTheOilGlut.aspx?page=all.

Lieberman, Ben. 2006. Congress Should Streamline Regulatory Impediments to Refinery Expansions. *Web Memo,* Heritage Foundation, no. 1112 (June 5). Available at: http://www.heritage.org/research/EnergyandEnvironment/wm1112.cfm.

Markey, Michele. 2005. Topic Report: Impact of Refinery Capacity on Crude Oil Prices—Part 2. *Explore* (Apache Corporation), March 14. Available at: http://www.apachecorp.com/Explore/Explore_Features/200601/Topic_Report_Impact_of_Refinery_Capacity_on_Crude_Oil_Prices_Part_2/.

Marxsen, Craig S. 1996. 3¢ Worth of Global Warming. *Oil & Gas Tax Quarterly* 45, no. 1 (September): 211–14.

———. 2003. Prophecy de Novo: The Nearly Self-Fulfilling Doomsday Forecast. *The Independent Review* 7, no. 3 (winter): 325–42.

Meadows, Donella H., Dennis L. Meadows, Jorgen Randers, and William W. Behrens III. 1972. *The Limits to Growth.* Washington, D.C.: Potomac Associates, New American Library.

Nordhaus, William D. 2007a. The Challenge of Global Warming: Economic Models and Environmental Policy in the DICE-2007 Model. Yale University, May 26. Available at: http://www.econ.yale.edu/~nordhaus/DICEGAMS/dice_mss_060707_pub.pdf.

———. 2007b. The *Stern Review* on the Economics of Climate Change. Yale University, May 3. Available at: http://www.econ.yale.edu/~nordhaus/homepage/stern_050307.pdf.

Peters, Alexander R. 1982. A Long-Lost Synfuels Process. *Nation* 234, no. 16 (April 24): 487–89.

Reed, Stanley, Christopher Palmeri, Peter Coy, and Rose Brady. 2006. Why You Should Worry about Big Oil. *Business Week* 3984 (May 15): 66–70.

Ricardo, David. [1817] 1821. *On the Principles of Political Economy and Taxation.* 3rd ed. London: John Murray, Albemarle-Street.

Schweitzer, Brian. 2006. Frequently Asked Questions about Synthetic Fuels. Available at Montana's official state Web site: http://governor.mt.gov/hottopics/faqsynthetic.asp.

Shackouls, Bobby S. 2004. Observations on Petroleum Product Supply. National Petroleum Council, U.S. Department of Energy, December. Available at: http://www.npc.org/reports/R-I_121704.pdf.

Snow, Nick. 2005. Lawmakers: US Should Prepare for Global Oil Flow Peak. *Oil and Gas Journal* (December 19): 33.

Solow, Robert M. 1973. Is the End of the World at Hand? *Challenge* (March–April): 39–50.

———. 1974. The Economics of Resources or the Resources of Economics. *American Economic Review* 64, no. 2 (May): 1–14.

Stephanopoulos, George. 2006. This Week: Al Gore. *ABC News Transcripts,* June 4, 10:31 A.M. EST.

U.S. Department of Energy. 2006a. *Crude Oil Refining Capacity by Process, January 1, 2005.* Washington, D.C.: Energy Information Administration. Available at: http://www.eia.doe.gov/pub/international/iea2004/table36.xls. Posted June 9, 2006.

———. 2006b. *International Energy Outlook 2006.* Washington, D.C.: Energy Information Administration, June. Available at: http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2006).pdf.

———. 2006c. Refinery Yield (by Region). Custom Table from the Energy Information Administration, Washington D.C. Available at: http://tonto.eia.doe.gov/dnav/pet/pet_pnp_pct_a_EPM0F_YRY_pct_a.htm.

———. 2007. *Refinery Yield of Petroleum Products.* Washington, D.C.: Energy Information Administration. Available at: http://tonto.eia.doe.gov/dnav/pet/xls/PET_PNP_PCT_DC_NUS_PCT_M.xls.

Verleger, Philip K., Jr. 2005. Energy: A Gathering Storm. In *United States and the World Economy,* edited by C. Fred Bergsten, 209–46. Washington, D.C.: Institute for International Economics.

———. 2006. Hundred Dollar Oil, Five Percent Inflation, and the Coming Recession. *The International Economy* 20, no. 1 (winter): 16–25.

Williams, Bob. 2003a. Debate Grows over US Gas Supply Crisis as Harbinger of Global Gas Production Peak. *Oil and Gas Journal* (July 21): 20.

———. 2003b. Heavy Hydrocarbons Playing Key Role in Peak-Oil Debate, Future Energy Supply. *Oil and Gas Journal* (July 28): 20.