I have been conducting research, writing, teaching, and speaking on energy issues for forty-one years now as a professional economist. The first oil shock occurred roughly a year after I began. The oil price surge from $3 to $10 per barrel changed my career. For the next four decades, I watched as oil prices ratcheted higher and higher, strangling one industry after another while increasing hardship across the globe for those who could least afford the pain.

For forty years, rising oil prices have forced individuals, countries, and companies to make economic adjustments they preferred not to make. Auto firms had to redesign engine systems to economize on fuel use. Airplane manufacturers devoted countless hours and billions to build lighter fuselages for the same reason. Individuals have had to divert effort and income from important activities such as educating or feeding their families to purchasing fuel. The list goes on and on.

The adjustments were made first because fuel prices kept increasing and second because the elites kept warning that global oil and natural gas supplies were finite. The received doctrine was that scarce resources (capital) must be reallocated from activities such as constructing schools and roads to energy conservation and production projects of questionable economic merit. The citizens of many countries were told that living standards would at best increase very slowly and at worst fall because fossil fuels were scarce and prices would keep rising. Proponents for these views still exist today. Jeff Rubin, for example, wrote a very bad book, *The Big Flatline: Oil and the No-Growth Economy*, in 2012. In it, he predicted that continually rising oil prices would doom the US economy.

In *The Big Flatline*, Rubin, a journalist and former chief economist at the Canadian Imperial Bank of Commerce, warns of America’s poor prospects. His thesis is that world oil prices must rise given the consumption growth in China and other parts of the world. The higher prices will,
he asserts, sap the US economy and flatten growth. He envisions a future of energy scarcity that will alter the world we know: “We might find ourselves in that world of no growth much sooner than we ever could have thought.”

Rubin is Canadian and clearly relishes the potential problems facing the United States. Indeed, he seems to enjoy the thought of a zero-sum world where China grows at America’s expense. He titled one chapter “Why China Can Afford Triple Digit Oil Prices while America Can’t.” In it, he suggests that the crude price rise will make gasoline too expensive for Americans and precipitate an economic slowdown. He also asserts that Americans have “closed their eyes” to growing global consumption.

In a zero sum world, if Chinese oil consumption doubles over time, the number of barrels going to the United States could be chopped in half (or something close) since the energy pie is only so big. It’s a simple notion that will soon become a stifling reality for the United States and other OECD countries.

If oil is the fuel that drives economic growth and oil consumption is a zero-sum game, then so is economic growth. Ultimately, that might be all the reason China needs to abandon its cheap yuan policy and turn its back on US treasuries.³

Rubin’s book is rife with unsupported claims and outright mistakes. Still, he provides an example, even if very flawed, of the school of thought that sees dismal prospects for the United States.

Another such view comes from Robert Gordon, an academic economist. Unlike Rubin, he is a very good economist. In a recent draft study, he lays out a plausible and troublesome case for why the US may face a period of much lower growth.⁴ Gordon makes the basic point that, historically, US economic growth was “punched up” by three industrial revolutions. (His analysis focuses solely on this country.) The first occurred between 1750 and 1890 with the invention of steam engines, the cotton gin, and railroads. The second and most important took place between 1870 and 1900 when running water with indoor plumbing, electricity, and the internal combustion engine were introduced. The third began around 1960 with the advent of computers.

The first and second revolutions had “tails” that lasted decades as the economy transformed. For example, the impacts of the second revolution were still being felt between 1950 and 1970 as refrigeration and air conditioning use spread across the country.

The computer revolution, on the other hand, had a surprisingly short lifespan, as Gordon explains:

Invention since 2000 has centered on entertainment and communication devices that are smaller, smarter, and more capable, but do not fundamentally change labor productivity

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³ Rubin, p. 150.
or the standard of living the way that the electric light, motor cars, or indoor plumbing changed it.\textsuperscript{5}

Absent further innovation, Gordon suggests, growth in US real consumption per capita, which reached 2.5 percent around the turn of the last century, could easily slump to around 0.2 percent per year going forward. He warns that faltering innovation will confront six “headwinds.”

Gordon and Rubin’s views reflect the thinking that has dominated macroeconomics for forty years. The “oil shock” of 1973 changed everyone’s perception permanently. Two years after the shock, Edward Fried and Charles Schultze edited a collection of essays by the best macroeconomists of the time.\textsuperscript{6} In their introduction, they made this declaration:

\begin{quote}
No event of the period following the Second World War had so sharp and pervasive an impact on the world economy as the series of shocks to the oil market that closely followed the outbreak of the Arab-Israeli War on 6 October 1973.\textsuperscript{7}
\end{quote}

The editors noted that the quadrupling of oil prices caused a sharp decline in aggregate demand, which slowed the global economy. They predicted that the economy would recover in time but that problems would remain. They made their projection assuming prices would not rise further.

Within ten years, prices had quadrupled again, this time to $40 per barrel, extending the economic slowdown. Additional increases since 2000 have been an ongoing drag on economic activity in the US and the world.\textsuperscript{8}

The continued price rise and the pinch on economic activity have prompted analysts such as Rubin and Gordon to foresee further economic troubles for the US and the world. Their assessment has been accepted as truth. National, state, and local governments responded by adopting policies to cope with permanently higher energy prices. Individual consumers changed habits and lifestyles as well, abandoning exurbia and in some cases suburbia, for example. The greatest reaction, though, occurred in the private sector. Manufacturing companies changed production processes to reduce energy consumption and make better use of computers. They also began to operate like nomads, moving from one location to another in search of low-priced energy. Transportation companies, particularly airlines, sought to reduce costs by retiring older, inefficient equipment prematurely in favor of more efficient aircraft. Office buildings were redesigned, and firms changed how they did business to cut travel costs.

Utilities also responded aggressively to rising energy prices, first by moving away from oil when the crisis started and then by constructing facilities that could use what I call “advantaged”

\textsuperscript{5} Gordon, p. 2.
\textsuperscript{7} Fried and Schultze, p. 1.
fuels. In the first years of the crunch, utilities saw their future in nuclear power and the fast breeder reactor, a generating plant that promised to produce more fuel than it consumed. Skyrocketing costs and accidents doomed the nuclear option, leaving coal as the remaining choice. From 1975 to perhaps 1995 or 2000, the US and European governments strongly pushed coal substitution for higher-cost oil and natural gas in power generation. Today, many recognize that decision as a terrible mistake due to coal’s contribution to global warming.

More recently, policymakers and the private sector have moved rapidly to reduce fossil fuel use by means of conservation and renewable fuels. One of the leaders in this push has been Amory Lovins, who cofounded and is now chairman and chief scientist of the Rocky Mountain Institute (RMI). Under his leadership, RMI has advocated these changes. A recent RMI publication, Reinventing Fire, asserts that the US economy could expand one hundred fifty-eight percent by 2050 (two percent per year) and yet need no oil or no coal, no nuclear energy, and one-third less natural gas. In a provocatively titled article, “Farewell to Fossil Fuels,” Lovins details what it would take to achieve the RMI goal.

This transformation requires pursuing three agendas. First, radical automotive efficiency can make electric propulsion affordable; heavy vehicles, too, can save most of their fuel; and all vehicles can be used more productively. Second, new designs can make buildings and factories several times as efficient as they are now. Third, modernizing the electric system to make it diverse, distributed, and renewable can also make it clean, reliable, and secure.

Some of the adjustments made and proposed to reduce oil and gas use are good and will serve the world well in the future. Some represent overkill. Theses divert scarce capital from more productive activities, effectively slowing the per-capita income growth rate. Most of the RMI proposals fall in this category, dooming millions if not billions to further decades of poverty. Lovins has been an extremist on the subject for at least thirty years.

Clearly, the substitution of renewables for fossil fuels can be justified given the clear and present problem of global warming and the extraordinarily compelling evidence that humans have caused much of the harm. However, many adjustments made in response to the energy crisis that began in 1973 have been a mistake. (Many—perhaps most—of Lovins’ proposals would be disastrous.) Forests have been denuded in nations such as the Philippines by those who are desperate for fuel but cannot afford kerosene. Billions of tons of coal have been consumed to produce electricity by utilities wrongly required to abandon oil and gas. Trillions of dollars have been needlessly allocated to projects to produce substitutes for oil and natural gas.

Ten years from now, historians will ask, “What was that all about?” They may also ask, “How could officials support policies that caused such serious long-term damage for so little short-term

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9 Below I note that US refiners today speak of processing “advantaged” crudes, meaning feedstocks that for logistical reasons can be purchased at a discount to prices charged for oil moving freely in international trade. The term “advantaged” seems particularly appropriate in describing responses to the energy crisis.

gain?” President Jimmy Carter’s push to increase coal use in particular will be challenged even though the decision was taken before the impacts on global warming were understood.

Historians will be so curious because by 2020 or 2025 the crisis associated with natural gas and petroleum shortages will have ended. Prices for these fuels will have sunk to extremely low levels. Natural gas prices in the United States have already dropped as much as ninety percent from peaks that once approached $20 per thousand cubic feet (mcf), which is the equivalent of $120 per barrel for oil, to as low as $2 per mcf. Crude oil prices are falling as well. Prices peaked at over $145 per barrel in June 2008. Today, some crudes can be purchased for less than $50. These prices will decrease further.

Credit for the end of oil crisis belongs to the scientists and engineers who developed new technologies to tap shale oil and gas reserves. We have known about these reserves for decades. They were not counted, though, in the data published by the Department of Energy or the American Association of Petroleum Geologists because they could not be produced.

One person who anticipated the oil crunch demise was Morris Adelman. Adelman was a student of the oil industry long before the subject became popular.11 Trained in industrial organization, he wrote in the 1960s that oil industry costs would decline and that prices would decrease slowly over time. He was wrong for about forty years. As he later explained, prices were held higher because low-cost producers operated a joint monopoly.12

Adelman asserted the absence of a resource constraint as far back as 1970:

In the United States, annual crude production is about three billion barrels, “proved reserves” about 30 billion, oil-in-place about 300 billion barrels. I cannot emphasize too strongly that the 300 billion represents conventional oil deposits now known and previously exploited. It has nothing to do with deposits “to be discovered,” nor with oil shales.13

In a 1991 essay, he expanded on this view, noting that few agreed with him. (He might have added that consensus does not determine a proposition’s truth. If it did, Columbus would have fallen off the edge of the world.)

My view of supply has not been shared by all. The 1973 price explosion was greeted by many economists, and not the least distinguished, as the long-delayed inevitable scarcity. In this view, temporary forces had just happened to keep all mineral prices flat or declining—for a remarkably long time. A great structure of the theory and calculation now arose as an upside-down pyramid, resting on one assumption. As a Nobel Laureate wrote: [Hotelling] “applied the calculus of variations to the problem of

11 Morry was a professor at MIT where I received my Ph.D. I did not study with him then. However, I became a friend and student in the 1970s and remained a friend for years. In 1990, I helped the MIT Press organize a set of his essays. Morry is perhaps the only true living scholar of the oil industry.
allocation of a fixed stock over time.” All of the recent literature is essentially based on Hotelling’s paper.\(^\text{14}\)

Adelman then added this observation:

The fixed stock does not exist. We cannot rescue the concept by making the “economic proportion” of the unknown total in-ground. That is circular reason. For the economic proportion is an implicit unverifiable forecast of all future output, of what will be worth producing through time. That depends on changes in science and technology [emphasis added], which will determine future costs and price, hence future output. One cannot estimate these costs and prices by starting with their assumed result. In fact, ultimate production is unknown. The much larger amount in the ground is unknowable and irrelevant, a nonbinding constraint.\(^\text{15}\)

The two words “science” and “technology” highlight the transformation that has occurred over the last twenty-four months. As West explains,

It was [George] Mitchell and other small companies (not the government or the large oil companies) that, by trial and error and a concentrated focus first on the Barnett Shale near Fort Worth, Texas, were able to combine horizontal drilling (originally pioneered offshore and perfected in the nearby Austin Chalk play) hydraulic fracturing and other technologies to force gas from shale and other tight formations.\(^\text{16}\)

Lovins and the RMI experts have predicted that technological applications will make oil and natural gas unnecessary. Indeed, Lovins chides the United States for moving too slowly: “The United States cannot afford to keep waiting for a gridlocked Congress to act while the global clean-energy revolution passes it by.”\(^\text{17}\) RMI is correct in the sense that technology has solved the energy crisis. However, the success has occurred on the supply rather than the demand side.

The recent flood of shale reserve production comes from the small entrepreneurial firms West describes being able to drill horizontally for greater and greater distances. The drillers guide their drill strings through very narrow shale layers. As Kemp notes, their productivity has increased thanks to silicone-controlled rectifiers and the replacement of DC motors on rigs with AC motors, which offer better precision and flexibility.\(^\text{18}\) Down-hole instrumentation has also enabled drillers to keep strings moving horizontally in close contact with the shale layer. In other words, technology has made it economically possible to produce large volumes of crude oil and natural gas originally thought unreachable. These are now flowing from the Bakken shale in North Dakota (oil) and the Marcellus Shale in Pennsylvania (natural gas). They will soon flow from other areas.

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\(^\text{15}\) Adelman, p. xiii.


\(^\text{17}\) Lovins, p. 145.

The increased oil and gas supplies will bring an economic renaissance to the United States. Energy independence, once thought unrealistic, will be achieved. Moreover, firms operating in the United States will enjoy unique access to oil and gas supplies at lower cost than their counterparts in Europe, China, Japan, or other countries. The advantage will be greatest in natural gas, where costs in the United States for at least the coming decade will be one-half to one-quarter of those paid by firms elsewhere. Oil refiners and some oil consumers will also benefit.

As is often the case, some regions will gain more than others. Pennsylvania has at least three important advantages. First, one of the major sources of low-cost natural gas is the Marcellus Shale, which stretches across the state. Second, unique rail networks built over one hundred years ago provide a way to bring crude from North Dakota and Colorado shale fields to Pennsylvania refineries, as well as to refineries in southern New Jersey and Delaware. Third, eastern Pennsylvania is not exposed to extreme weather, unlike businesses in other coastal states such as Connecticut, Massachusetts, New Jersey, and New York. These circumstances give Pennsylvania a unique opportunity.

The availability of low-cost natural gas to Pennsylvania will reverse a sixty-year trend in regional energy markets that systematically discriminated against the state. Natural gas has been an important fuel for the United States for more than seventy years. In 1960, Theodore Levitt noted the natural gas industry’s emergency after World War II as a competitor to heating oil. Gas was more convenient, cleaner, and less expensive. Unfortunately, in 1962 the US Supreme Court ruled that natural gas shipped in interstate commerce was subject to federal regulation. Officials at the Federal Power Commission (now the Federal Energy Regulatory Commission) set very low prices. These were based on production costs. Producers quickly stopped shipping new natural gas supplies to interstate markets, choosing instead to sell them in unregulated intrastate markets.

Pennsylvania’s competitive position was undercut by these federal regulations. As early as 1973, consumers in the state were paying $0.77 per mcf while their counterparts in New Orleans paid $0.35. Furthermore, incremental gas supplies were available to firms in Texas, Louisiana, and Oklahoma. Such supplies often were not available to new customers in Pennsylvania nor could businesses in the northeast acquire extra volumes if they expanded. In addition, access to low-cost gas allowed utilities in states with unregulated supplies to offer lower prices. Buyers in Pittsburgh, for example, paid $1.69 per one hundred kilowatt hours while those in Texas paid $1.30.

In another example, a 1998 study benchmarking metropolitan areas on the cost of doing business found energy costs among Philadelphia’s greatest disadvantages, ahead of taxes and labor costs. Philadelphia ranked second highest (after New York) in the Middle Atlantic States, and its

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energy costs were far higher than in major cities in other regions like Houston, Nashville, and Seattle.\textsuperscript{23}

The energy price advantage in Texas and Louisiana triggered an exodus of manufacturing from the Northeast to the Southwest. In his concise, insightful essay on Philadelphia’s economic history, Joseph Gyourko of the University of Pennsylvania describes the movement out of Philadelphia at the time but misses the impact of lower-cost energy, which clearly contributed to the shift.\textsuperscript{24}

The development of natural gas production in the Marcellus Shale will reverse this trend. Prices in Pennsylvania are low today and will likely remain low for the foreseeable future, at least compared to Gulf Coast states. Pennsylvania will enjoy this advantage because there are currently no natural gas export facilities near the Marcellus gas, whereas several plants on the Gulf Coast are being reconfigured for exports. The lack of export facilities in Pennsylvania will effectively trap the gas in the state for five to ten years, giving manufacturers there an advantage.

A number of firms have already recognized the change. Shell, for example, has announced it may build an ethylene cracker in Beaver Falls. Its consideration of the project demonstrates the dramatically different circumstances in Pennsylvania. Other manufacturing facilities are expanding and new ones opening to take advantage of low-cost natural gas.

Gyourko and others have warned that the City of Philadelphia’s future is limited because the educational levels in the area fall below those of Boston and New York and the city’s tax structure inhibits growth.\textsuperscript{25} He may be correct. However, the skilled workforce required to build and operate complex energy facilities is highly mobile. The best workers have moved over the decades regularly from Louisiana to Texas to northern Canada to Alaska and to the Middle East. Recently, firms operating in Canada’s oil sands reported they were paying skilled welders $100,000 every three months. Labor will not be a constraint should firms seize the chance offered by Pennsylvania’s access to low-priced gas. Furthermore, industrial development may create training and career opportunities for younger people in Southeastern Pennsylvania.

Of course, Pennsylvania residents may not welcome an influx of workers from states such as Texas. They will no doubt ask, “Why can’t we get the jobs?”

The answer is the energy revolution will offer enormous employment opportunities for those living in Pennsylvania if the state’s schools and businesses institute the necessary training programs. I will leave it to the experts on our panel to discuss their view of the strategies needed to help local residents connect to the new jobs in energy and manufacturing.

Historically, exploration for oil required few workers but enormous amounts of capital. The shale revolution is different. It is a manufacturing business. Production from a new well starts at a high level and quickly falls off. This means that firms must keep drilling to hold output.

\textsuperscript{23} Greater Philadelphia First’s Regional Economic Development Benchmarks, April 1998.


\textsuperscript{25} See, for example, Gyourko, pp. 28-33.
constant. Capital requirements are lower but labor requirements much higher. There is a huge opportunity here if Pennsylvania mobilizes its schools as states such as Wyoming have.

One can argue that Pennsylvania’s good fortune came about due more to serendipity than planning. But then, it is always better to be lucky than smart. The job now is to make the most of the luck.

The existence of several refineries in eastern Pennsylvania and Delaware provides the second great opportunity for Pennsylvania. There were four major refineries in eastern Pennsylvania and Delaware in 2000. Their combined distillation capacity was nine hundred thousand barrels per day, six percent of the nation’s refining capability. If things had gone according to plan, all of this capacity would now be closed. However, again thanks to serendipity and the successful political mobilization described in the Temple case study, it is still open.

The refineries should have been shut down because their past owners had not invested in them over the years. A 1983 *Wall Street Journal* article by Steven Mufson provides the background. The four East Coast refineries were built to manufacture gasoline. All are “cracking refineries” and all were designed to process very light sweet crude. As environmental regulations tightened, the operators shifted to crudes containing lower sulfur to meet the tighter standards rather than invest in desulfurization equipment. Mufson describes the philosophy behind the decision-making using Sun Oil, Sunoco’s predecessor, as an example: “In 1975, Sun Co decided to become something of an oil snob: it wasn’t going to let just any old crude into its refineries.” Then he continues: “Eight years later, the choice still goes against the industry’s conventional wisdom. But it still looks good.”

As Mufson notes, Sun declined to invest in facilities to upgrade crude. Such investments would have allowed the refinery to process any type of crude and produce gasoline and diesel fuel meeting market expectations. Sun was just not interested, as Mufson observes.

    Sun, based in Radnor Pa., never went along [with the industry consensus to upgrade refineries] – and it has never looked better for it. Nigeria, Great Britain, and the US have led the decline in international oil prices, and all three produce the high-quality oil that Sun needs. Some industry experts think that Sun will eventually be proved wrong. But they also acknowledge that, at least temporarily, its strategy paid off.”

Sun’s chairman told Mufson, “We’re delighted that are competitors are out there spending money. The more they spend, the more (high-quality) crude will be out there for us.” The chairman added that Sun had used the additional cash flow to pay down debt in an era of high interest rates and to boost exploration. (Later, the company sold its exploration operations.)

The light crude strategy paid off for at least two decades. However, it began to degenerate early in the twenty-first century when environmental regulators mandated sulfur removal from gasoline and diesel fuel oil. Lacking the capacity to remove sulfur from crude, the owners of these refineries had to find supplies that contained essentially no sulfur. Nigeria was the ideal

source. However, Nigerian crude prices rose in 2008 due to escalating internal strife. About the same time, Europe’s environmental regulators mandated sulfur removal from diesel fuel. The EU standards boosted demand for Nigeria’s very low sulfur crude just as civil war there and then later in Libya cut the supply. These factors reduced refining margins for sweet crude refiners on the US East Coast. The losses for the Pennsylvania facilities were huge. The proposed closure of ConocoPhillips’ Trainer facility, Sunoco’s Philadelphia plant, and the Delaware refinery owned by Valero threatened to create serious dislocations for refinery employees and consumers.

The refineries did not close. Instead, as recounted in the Temple case study, Delta Airlines purchased the Trainer refinery and has put it back into operation. PBF, chaired by Tom O’Malley, one of the oil industry’s greatest innovators, has kept the Delaware refinery working. Finally, the Carlyle Group bought Sunoco’s Philadelphia facility and kept it open. In a December 22, 2012 article for The Washington Post, Mufson (who interviewed the CEO of Sun’s refinery twenty-nine years earlier) wrote that Carlyle planned to use low-cost Marcellus natural gas and process crude from North Dakota. The low-cost gas would reduce operating costs. The North Dakota crude could be obtained at a discount of as much as $30 per barrel to Nigerian crude. Circumstances had changed. It was serendipity again.

The new owners benefitted from a decision by Warren Buffett’s Burlington Northern Santa Fe to invest heavily in capacity to move crude by rail from North Dakota. Historically, crude oil pipelines in the United States have been built to move oil from south to north or north to south. For years, Midwest refineries obtained supplies via pipelines that brought imported crude up from the US Gulf. Then, as Canadian tar sand and domestic shale output surged, the pipelines were reversed to move oil north to south. If completed, the contentious Keystone XL Pipeline will expand this north-south flow.

Pipelines do not exist to move crude from the Gulf or the Midwest to the east. Refineries on the East Coast could be supplied only by moving crude to the Gulf Coast and transporting it on US-flagged ships. Such transactions are not economic. Thus the surging output from the Midwest might have been shut in (some Canadian output is at this date) had not entrepreneurs and the railroads stepped in. BNSF will expand its facilities from North Dakota to the east or the west. Philadelphia is uniquely situated in that both Norfolk Southern and CSX have routes from the Midwest to its facilities.

The opportunity is so great that Delta Airlines, which owns the Trainer refinery, proposes to ship crude from North Dakota to the reactivated facility and then ship jet fuel back to its Minneapolis hub. Serendipity indeed.

The oil industry has always been characterized by the existence and exercise of market and political power. It was once said that John D. Rockefeller’s Standard Oil “did everything to the

Pennsylvania legislature except refine it.”30 Pennsylvania, ironically, is now playing an important role in breaking monopolies, both those enjoyed for forty years by oil-exporting countries and those enjoyed by Middle America refiners.

Finally, although Pennsylvania’s refineries are in river flood plains, they are protected from the giant storm surges associated with superstorms such as Sandy. The human contribution to global warming has been subject to much debate for more than a decade. Whether fossil fuel use has played a part is irrelevant here. Instead, I simply note that meteorologists expect North Atlantic cyclonic activity to increase in coming years.31

Refineries in eastern Pennsylvania have a decided advantage if such forecasts prove correct. Superstorm Sandy demonstrated the vulnerability of the petroleum infrastructure in New York Harbor. Coastal infrastructure north to Boston suffers the same exposure. New York is particularly at risk, as Sandy showed, because most of its petroleum refining and distribution facilities lie on the Arthur Kill, the narrow strip of water that separates Staten Island and New Jersey.

Two days after Sandy, ninety percent of the New York and New Jersey distribution facilities were disabled. Two weeks later, thirty percent was out of service. As November ended, thirty percent was still out of service. To repeat, one month after Sandy hit, thirty percent of the major petroleum facilities that supply New York were still closed.

New York’s exposure to storms can be remedied only by constructing extraordinarily expensive storm gates such as those in Rotterdam or at the mouth of the Thames River. As Crooks and Wright report, experts believe New York Harbor could be protected by putting up barriers at the Verrazano Narrows, the Arthur Kill, and the north end of the East River for a cost of roughly $20 billion.32

Given the United States’ current budget problems, it seems unlikely that plans to protect New York Harbor will be fulfilled. Instead, the petroleum infrastructure north of Philadelphia will remain vulnerable.

As a consequence, one should expect a rebirth of petroleum refining in Pennsylvania and Delaware. Facilities there enjoy unique access to crude from Midwest shale production, transportation services based on its extensive rail infrastructure, including the lines built as part of the Pennsylvania Railroad more than 100 years ago, and protection from hurricane-related storm surges. Again, Pennsylvania will benefit not from planning but from serendipity.

Pennsylvania also could maximize its opportunities through a variety of steps to expand the market for natural gas and lower the cost of doing business in the state. These steps include

- providing tax incentives for convenience stories to install natural gas refueling facilities,
- converting to natural gas vehicles in state and municipal fleets and in the mass transit system,
- providing tax incentives for owners of commercial fleets to convert to natural gas or purchase natural gas vehicles,
- lowering registration fees for natural gas vehicles, and
- offering guaranteed fuel purchase agreements to companies that install natural gas refueling stations.

Finally, another major legacy of Pennsylvania’s railroad past is its fixed-rail mass transit system, which, if well maintained, will give the state a competitive advantage over many other regions.

Conclusion

The oil crisis that has constrained economic activity in the United States, Europe, and Asia for forty years is waning. Entrepreneurs and engineers have cracked the access code for oil and gas trapped in shale. The resource constraints that have bedeviled the world for four decades have been eliminated.

This is a change of tectonic proportions. Just as the development of the cotton gin facilitated the South’s growth before 1860, and the quadrupling of oil prices in 1973 stimulated an economic surge in certain Middle Eastern countries, the technological breakthroughs that opened shale oil and gas production will yield great benefits to certain regions. Southeastern Pennsylvania stands to be one of the luckiest regions in the United States and the world. It will grow despite difficulties associated with governance in Philadelphia, problems with education, and other well-known issues. Growth will occur because fuel prices in the area will be very low, because railroad lines built during a boom one hundred years earlier will provide access to low-priced crudes that perfectly meet the needs of local refineries, and because other East Coast areas will be increasingly exposed to extreme storms.

This outcome could not have been predicted. It could not have been planned. It now is up to the private sector and governments to make the best of it.