Oil Depletion and Industrial Adaptation in New York State

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ABSTRACT

Global energy markets have experienced rising petroleum prices that began in 2002 and continued through 2005. During this time there has been increasing discussion of the "Peak Oil" concept, whereby global oil production peaks and begins irrevocable decline. The World is entering a period where growing global demand, OPEC dominance of oil supplies, and numerous geopolitical threats to supplies have combined to create great uncertainty about the future cost and security of oil supplies. Meanwhile, domestic natural gas production is lagging demand growth, and major expansions of LNG imports are being proposed to fill the supply gap.

This paper will review some of the literature concerning oil and natural gas production peaks and discuss how these peaks would impact New York industry. I will discuss current energy use patterns and how these might change in response to Peak Oil. My analysis of demand changes will address the opportunities for greater energy efficiency and fuel substitution and the implications of both for the gas and electric industries.

Finally, I will analyze the impact of much higher energy prices on the manufacturing sector in New York State, which would follow the onset of Peak Oil. While higher energy prices will create hardship for many industries, there are some industry segments that may actually grow in New York as the trend towards globalization and the prevailing assumption of inexpensive oil confront the reality of global oil depletion.

Introduction

The global energy markets have experienced a run up in petroleum prices that began in 2002 and continued through 2005. Prices have risen from a relatively low $20/bbl to as high as $58/bbl in early 2005. During this time there has been increasing discussion of the "Peak Oil" concept, whereby global oil production peaks and begins irrevocable decline. While this "Peak Oil" is not generally acknowledged to be a near term problem that merits concerted action, there is a growing consensus that prices are trending higher and that increasing proportions of the World's conventional oil supply will be coming from OPEC countries, especially those in the Middle East. The World is entering a period where growing global demand, OPEC dominance of oil supplies, and numerous geopolitical threats to supplies have combined to create great uncertainty about the future cost and security of oil supplies. Conventional oil is defined as the liquid and condensates that flow from conventional oil production facilities. Meanwhile, domestic natural gas production is lagging demand growth, and major expansions of LNG imports (largely from OPEC countries) are being proposed to fill the supply gap.

With these energy supply problems in mind, I will review some predictions concerning both oil and natural gas production peaks and discuss how these peaks would impact New York industry. I will discuss current energy use patterns and how these might change in response to Peak Oil. I will address the opportunities for greater energy efficiency and fuel substitution and the implications of both for the gas and electric industries. Finally, I will analyze how Peak Oil might encourage extensive structural changes to the manufacturing sector in New York State.

Definition of Peak Oil

Peak Oil is generally defined as the phenomenon in which the global production of oil peaks and begins an inevitable decline. The real energy crisis begins not when the world runs out of oil, but when global production begins an inexorable decline. It is misleading to say, "The World has 60 years supply of oil at current levels of consumption." There are two problems with such a statement. First, stating a given number of years until the last drop of oil is used is a meaningless number. The energy crisis does not begin when global oil supplies are used up. Rather, the crisis will begin when we pass the peak in global output and prices go much higher. Second, consumption will not stay at current levels, as global demand continues to rise. In fact, demand has accelerated in recent years even as prices have risen.

Theory of Peak Oil

In 1956, M. King Hubbert, a Shell Oil geologist, predicted that Peak Oil for the US would occur in the 70s, and it did, in 1970. US discoveries had peaked in the 30s. Mr. Hubbert plotted both discoveries and production as Bell Curves, with the production curve lagging by about 35 years. In recent years, some oil analysts have raised the question whether the peaking phenomenon that occurred in the United States might be approaching for the global oil market.

Global discovery of oil peaked in 1964. We are now 41 years past the peak of discovery, and the global market for oil has been extremely tight since 2002. This tightness has many causes, but the most obvious are the rapid demand growth since the global economy has picked up in recent years, especially in China, India and the United States; declining output from old producing oil fields around the world; and geopolitical events disrupting production in Iraq, Venezuela, Columbia, Nigeria, and the Sudan. Without excess production capacity, these geopolitical events contributed to the run up in oil prices from 2003 and into 2005. Geopolitical factors do not appear to be going away as we move through 2005. In fact, they may get worse.

Conventional wisdom is that higher oil prices will stimulate the oil industry to discover and produce more oil by investing in new exploration and additional production and refining capacity. But not all agree that the industry can meet future global demand reflected in current demand projections. While all recognize oil is ultimately a finite resource, the debate is about when depletion becomes an issue that must be confronted. For those concerned about Peak Oil, the problem of depletion needs to be faced now, and should have been addressed long ago.

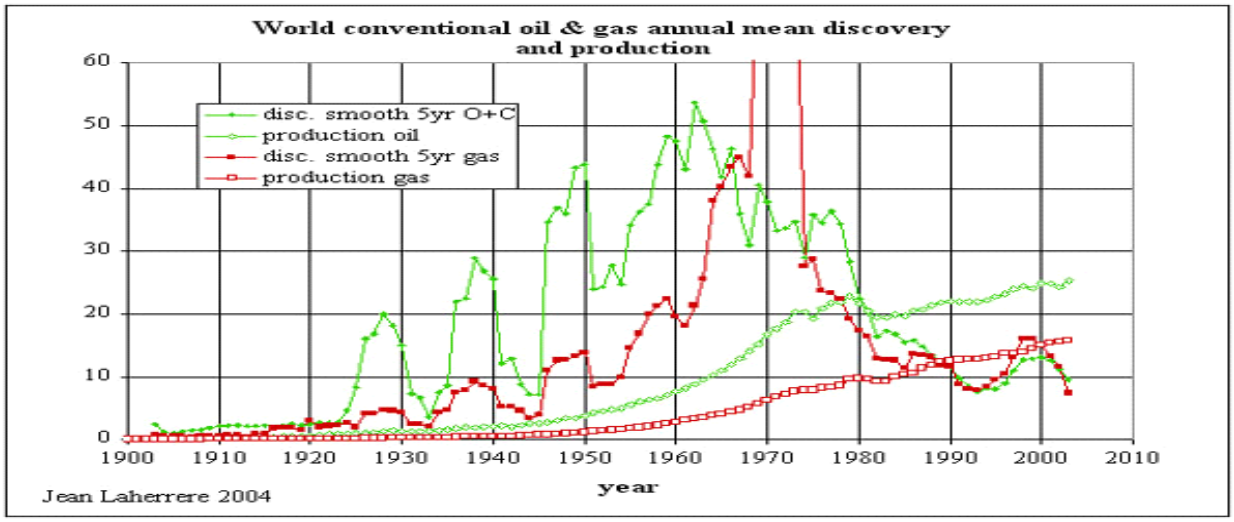
So when will Peak Oil arrive? Oil companies and OPEC generally believe sufficiently high prices will enable added supply to meet growing demand. Independent technical experts (petroleum engineers and geologists) who have studied the problem tend to believe Peak Oil is coming soon, while others place it decades away. The range of predictions are below:

- T Boone Pickens (Texas oilman), "The peak is now" (2004)
- Kenneth Deffeyes, (Petroleum geologist and Princeton professor) - 2005
- Uppsala Hydrocarbon Depletion Study Group - 2007
- US Energy Information Administration (EIA) – 2037

Similarly, there are estimates that the global peak in natural gas production will occur not long after oil peaks. Two estimates published in 2004 are 2019 (Oil and Gas Journal, 8/16/04) and 2030 (Jean Laherrere, 2004). Natural gas discovery peaked in 1973, and production has exceeded discovery since 1990. Non-OPEC gas production is expected to peak before 2015.

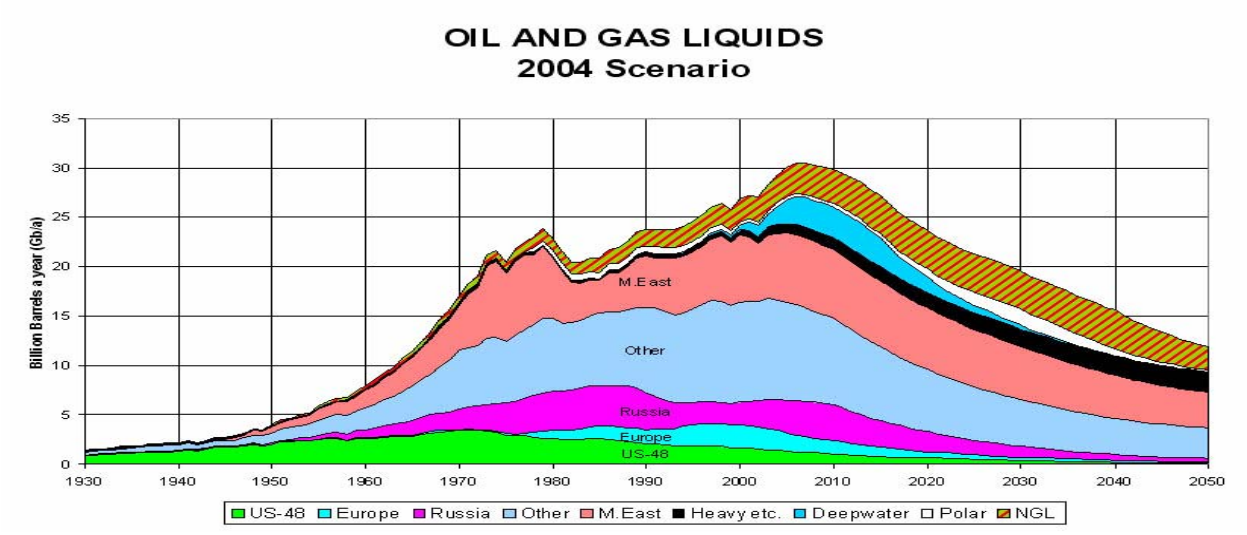
Figure 1 presents historical data on discovery and production of oil and gas (O&C refers to oil and condensates). Figure 2 presents a recent projection of a near-term peak in 2007. In Figure 3 and Table 1, EIA presents 12 projections of world oil production based on assumptions about ultimate recoverable oil and oil demand growth. While the earliest peak in the EIA projections is 2021 (assuming low recoverable oil of 2,248 Billion Barrels of Oil, or BBls, and high demand growth of 3%), its Mean projection is 2037.

Figure 1. Discovery and Production of Conventional Oil and Gas



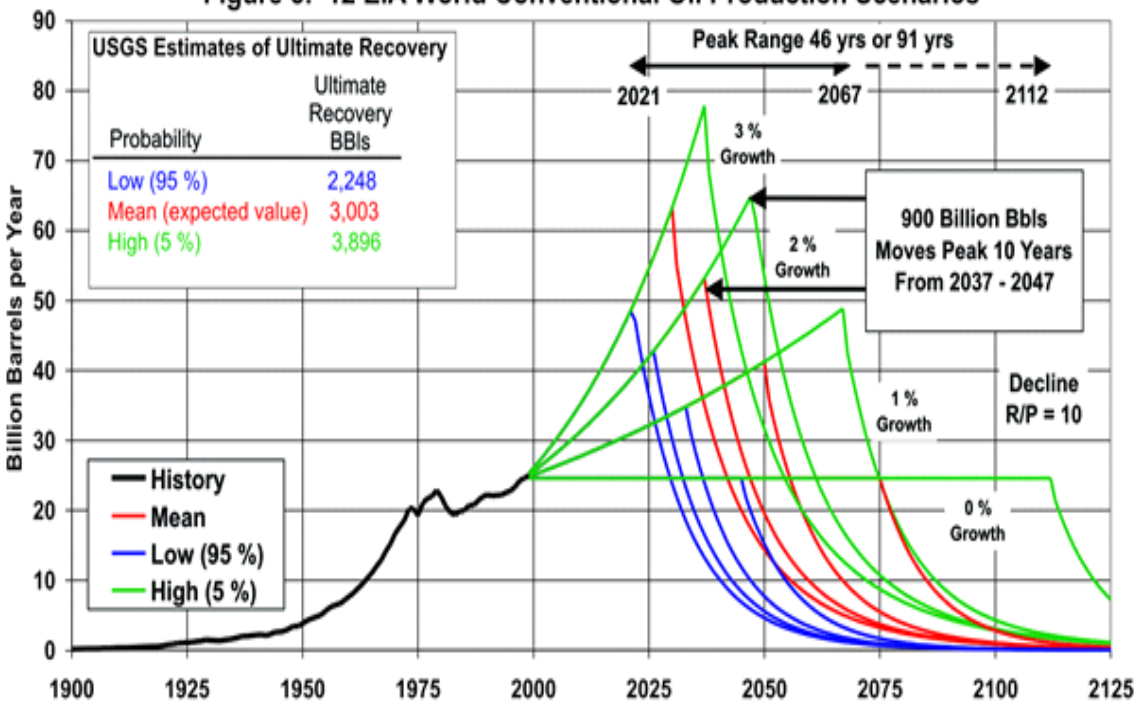
Source: Jean Laherrere Presentation

Figure 2. Projection of Future Oil and Gas Liquids Production



Source: Uppsala Hydrocarbon Depletion Study Group, 2004

Figure 3. 12 EIA World Conventional Oil Production Scenarios



Source: Energy Information Administration
Note: U.S. volumes were added to the USGS foreign volumes to obtain world totals.

Table 1. WORLD OIL PRODUCTION FORECAST

Probability Estimate	Ultimate Recovery BBbls	Annual Demand Growth, %	Peak Year	Peak Rate, MMBbls/yr	Peak Rate, MMBbls/day
Low (95%)	2,248	0.0	2045	24,580	67
	2,248	1.0	2033	34,820	95
	2,248	2.0	2026	42,794	117
	2,248	3.0	2021	48,511	133
Mean (expected value)	3,003	0.0	2075	24,580	67
	3,003	1.0	2050	41,238	113
	3,003	2.0	2037	53,209	146
	3,003	3.0	2030	63,296	173
High (5%)	3,896	0.0	2112	24,580	67
	3,896	1.0	2067	48,838	134
	3,896	2.0	2047	64,862	178
	3,896	3.0	2037	77,846	213

Source: Energy Information Administration

To understand the different projections, one must analyze the technical assumptions and political considerations behind the numbers. The critical technical assumptions are:

- Reserve Base (1,800-3,900 Bbls)
- Demand Growth (1 – 3%/yr)

The most important assumption is the demand growth rate. The higher the growth rate, the sooner we reach the Peak. This can be seen in the EIA projections. Recent demand growth suggests that a growth rate under 2% is unlikely under current circumstances. The 2004 growth rate was 3.4%, primarily due to high growth in China, India and the United States, and current globalization trends would suggest that oil demand in the developing world may accelerate.

The Reserve Base assumption remains important. The EIA uses higher Base numbers than independent analysts (2,200 to 3,900 BBls vs. 1,800 to 2,000 Bbls). A downward trend in discoveries since 2000 will lead to a downward trend in large production additions between 2005 and 2010. While 18 large production projects will come online in 2005, only 3 will do so in 2009 and 2 in 2010 (Petroleum Review, 2004 and ODAC, 2004). This suggests the Reserve Base may be on the lower end of the range reflected in the different projections in Figures 1, 2 and 3. A Reserve Base below 2,200 Bbls and growth above 3% bring the onset of Peak Oil before 2020.

There are also political considerations that influence the projections. The Reserve Base numbers provided by the OPEC countries are highly suspect because they all increased after OPEC established its system of production quotas for each country *based on each country's Reserve Base.* The EIA projections have been criticized for establishing unrealistic technical assumptions so as to avoid the political problem of confronting the Peak Oil issue and considering policy choices that would be unpopular with special interests or the American voter.

Global Implications of Peak Oil

Oil producers were all producing at full capacity in 2004 except for reasons due to weather or geopolitical events. OPEC has not been able to maintain target prices of 22 to 28$/bbl. Economic growth has slowed as prices have climbed above 55$/bbl. Geopolitical instability continues to threaten supplies around the globe. Some analysts have predicted increasing instability and new global hotspots as various interests compete to control oil supplies. Numerous sources believe Non-OPEC production will peak on or before 2010 and future oil and gas production will come increasingly from the Middle East (PFC Energy, September 2004).

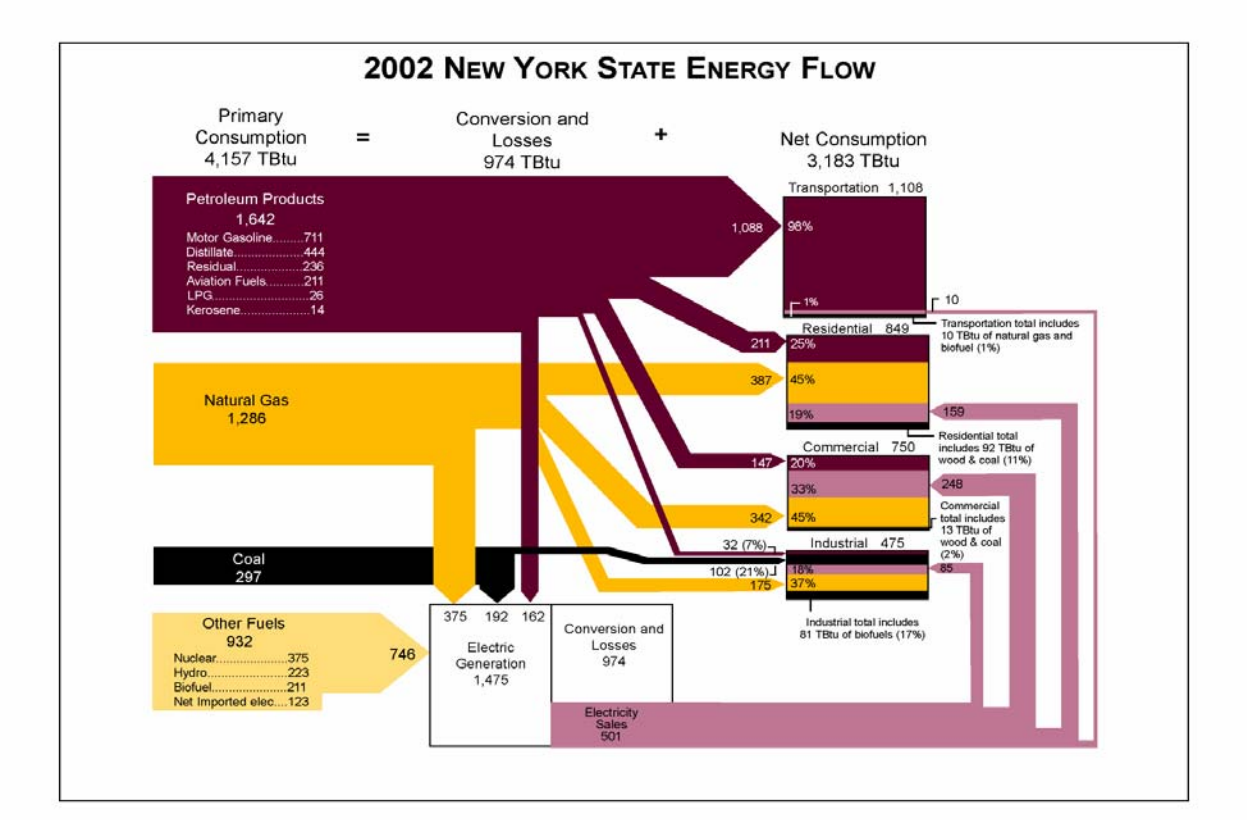
All of these issues and concerns discussed in 2004 and 2005 will get worse once Peak Oil is broadly recognized (like the acknowledgment of global warming, there will never be total consensus). More dependence on oil (and LNG) from the unstable Middle East will create greater risk to the security of America and other nations. The stagflation of the 1970's and early 80's after previous oil shocks (1973 Oil Embargo and 1979 Iranian Revolution), may well return with unprecedented price increases for oil (over 100$/bbl.) and natural gas, only tempered by global economic contraction. A more pessimistic prediction is that declining oil production will lead to aggressive international relations, up to and including resource wars, in an effort by consuming nations to maintain access to and control of remaining oil and gas resources.

The Implications of Peak Oil for the New York Industrial Sector

What are the implications of Peak Oil for the New York State economy, especially manufacturing and agriculture? I will discuss current energy use patterns and how these might change in response to Peak Oil. I will address the opportunities for greater energy efficiency and fuel substitution, and the implications of both for the gas and electric industries. Finally, I will analyze how Peak Oil might encourage extensive structural changes to the manufacturing sector.

Energy in the New York State economy. The 2002 New York State Energy Flow Chart (Figure 4) provides an overview of primary energy supplies, by fuel type, coming into the State, and how these supplies are consumed either in power generation or in an end use sector, such as transportation, residential or industrial.

Figure 4: 2002 New York State Energy Flow Chart



Source: NYSERDA, 2004

The two most important observations from the Energy Flow Chart are that most primary energy consumed in New York State (about 71%) is either oil (40%) or natural gas (31%), and that industrial energy use (475 Trillion Btu or TBtu) represents only 15% of net energy consumption in the State. Furthermore, the 2002 data show how oil and natural gas supplies are consumed within each end use sector. Direct industrial use of oil represents only 2% of all oil use in the State, and the largest consumers of oil are the transportation (66%) and residential (13%) sectors. This indicates that much higher oil prices will impact the cost to transport manufactured goods more than the cost to produce them. In contrast to oil, natural gas consumption by industry is significant, both directly (14%) and after gas has been used to produce electricity. Natural gas is a critical fuel for power generation in New York State.

More detailed information on industrial energy use is available from the EIA's Manufacturing Energy Consumption Survey, or MECS. The 1998 data in Tables 2 and 3 includes New York and New England. No such data is available for New York State alone.

Table 2. Fuel Consumption, 1998

Level: Northeast Census Region
Row: NAICS Codes; Column: Energy Sources;
Unit: Trillion Btu.

NAICS Code(a)	Subsector and Industry	Total	Net Electricity(b)	Residual Fuel Oil	Distillate Fuel Oil(c)	Natural Gas
311	Food	78	20	3	W	47
312	Beverage and Tobacco Products	12	2	1	*	0
313	Textile Mills	32	7	8	1	8
314	Textile Product Mills	4	W	*	W	W
315	Apparel	13	3	1	1	8
316	Leather and Allied Products	2	W	*	*	W
321	Wood Products	24	5	*	2	3
322	Paper	**346**	**34**	**81**	2	**51**
323	Printing and Related Support	19	9	*	*	8
324	Petroleum and Coal Products	**322**	11	**20**	**10**	W
325	Chemicals	**171**	**46**	W	W	**72**
326	Plastics and Rubber Products	56	30	1	W	21
327	Nonmetallic Mineral Products	142	21	W	**3**	**70**
331	Primary Metals	**253**	**57**	W	W	**89**
332	Fabricated Metal Products	69	24	1	W	39
333	Machinery	31	15	1	W	12
334	Computer and Electronic Products	47	28	1	1	16
335	Electrical Equip., Appliances, and Components	19	10	W	W	8
336	Transportation Equipment	44	13	3	2	W
337	Furniture and Related Products	9	W	*	W	W
339	Miscellaneous	21	W	1	W	W
	Total	1,713	349	135	33	534

Main Fuel Users by Fuel Type	Paper = 20%	Primary Metals = 16%	Paper = 60%	Petroleum and Coal Products = 30%	Primary Metals = 17%
	Petroleum and Coal Products = 19%	Chemicals = 13%	Petroleum and Coal Products = 15%	Nonmetallic Mineral Products = 9%	Chemicals = 13%
	Primary Metals = 15%	Paper = 10%			Nonmetallic Mineral Products = 13%
	Chemicals = 10%				Paper = 10%

Source: Energy Information Administration, MECS, 2001

Table 3. End Uses of Fuel Consumption, 1998

Level: Northeast Census Region;
Row: End Uses;
Column: Energy Sources, including Net Electricity;
Unit: Trillion Btu.

End Use	Total	Net Electricity(a)	Residual Fuel Oil	Distillate Fuel Oil and Diesel Fuel(b)	Natural Gas(c)
TOTAL FUEL CONSUMPTION	1,713	349	135	33	534
Indirect Uses-Boiler Fuel	--	2	**102**	11	**196**
Direct Uses-Total Process	--	258	27	10	256
Process Heating	--	**46**	23	8	**241**
Process Cooling and Refrigeration	--	21	*	*	1
Machine Drive	--	**167**	4	1	11
Electro-Chemical Processes	--	23	--	--	--
Other Process Use	--	1	*	1	3
Direct Uses-Total Nonprocess	--	77	6	9	73
Facility HVAC (f)	--	**37**	3	4	**58**
Facility Lighting	--	**32**	--	--	--
Other Facility Support	--	7	*	*	4
Onsite Transportation	--	1	--	4	*
Conventional Electricity Generation	--	--	2	1	10
Other Nonprocess Use	--	*	*	*	1
End Use Not Reported	570	11	*	2	8

Source: Energy Information Administration, MECS, 2001

In analyzing the data presented, there are three recurring themes regarding energy prices and availability to keep in mind as we predict the impact of Peak Oil on the New York industrial sector: 1) all fuel prices will increase significantly, not just oil; 2) fuel switching and dual fuel capability will increase; and 3) natural gas curtailments for industry will be more frequent.

Peak oil and industrial energy costs. Rising energy costs will not only be felt by industries that use oil directly, but across the industrial sector as costs for natural gas and electricity rise in tandem with rising oil. One reason is the potential for fuel substitution amongst these fuels.

Fuel switching and dual fuel capability. Oil and natural gas have always competed in the residential, commercial, and industrial sectors. When boiler operators have access to natural gas, they can switch fuels either with dual fuel burners or with conversions from one fuel to the other. Based on EIA data on fuel oil use in manufacturing (www.eia.doe.gov), manufacturers have shown a strong trend to convert from oil to gas or to have dual fuel capability with oil as the back up fuel. This is one reason oil and natural gas prices have always moved in tandem. It should be anticipated that Peak Oil will reinforce this trend from oil to gas, assuming gas is available.

A second type of dual fuel capability that will expand is for interruptible gas customers to adopt propane as a back up fuel for direct process heating loads. Until recently, interruptible gas was rarely curtailed, but with it now more frequent, the interest in propane has increased. With Peak Oil raising the price and cutting the availability of gas, the interest in propane back up will grow. However, this approach will be limited by both the price and availability of propane.

Peak Oil will also encourage switching from oil or gas to electricity for process loads. While happening already for reasons of energy efficiency, productivity, and pollution prevention, this trend will accelerate as price and availability of oil and gas worsen. The electric utility system will strain, and it could face severe strain if the residential and commercial sectors use significantly more electric space heating, or increase other electric loads, in response to Peak Oil.

Natural gas curtailments. If sufficient commercial and residential heating loads switch from oil to gas, and/or significant new power generation capacity is fueled by natural gas, industry in New York may find serious constraints on its use of natural gas. Interruptible gas customers will be curtailed more frequently. Others with firm contracts may be curtailed on an emergency basis during peak periods. On the other hand, very high prices for natural gas and energy efficiency improvements by existing customers in all sectors will reduce demand from existing loads.

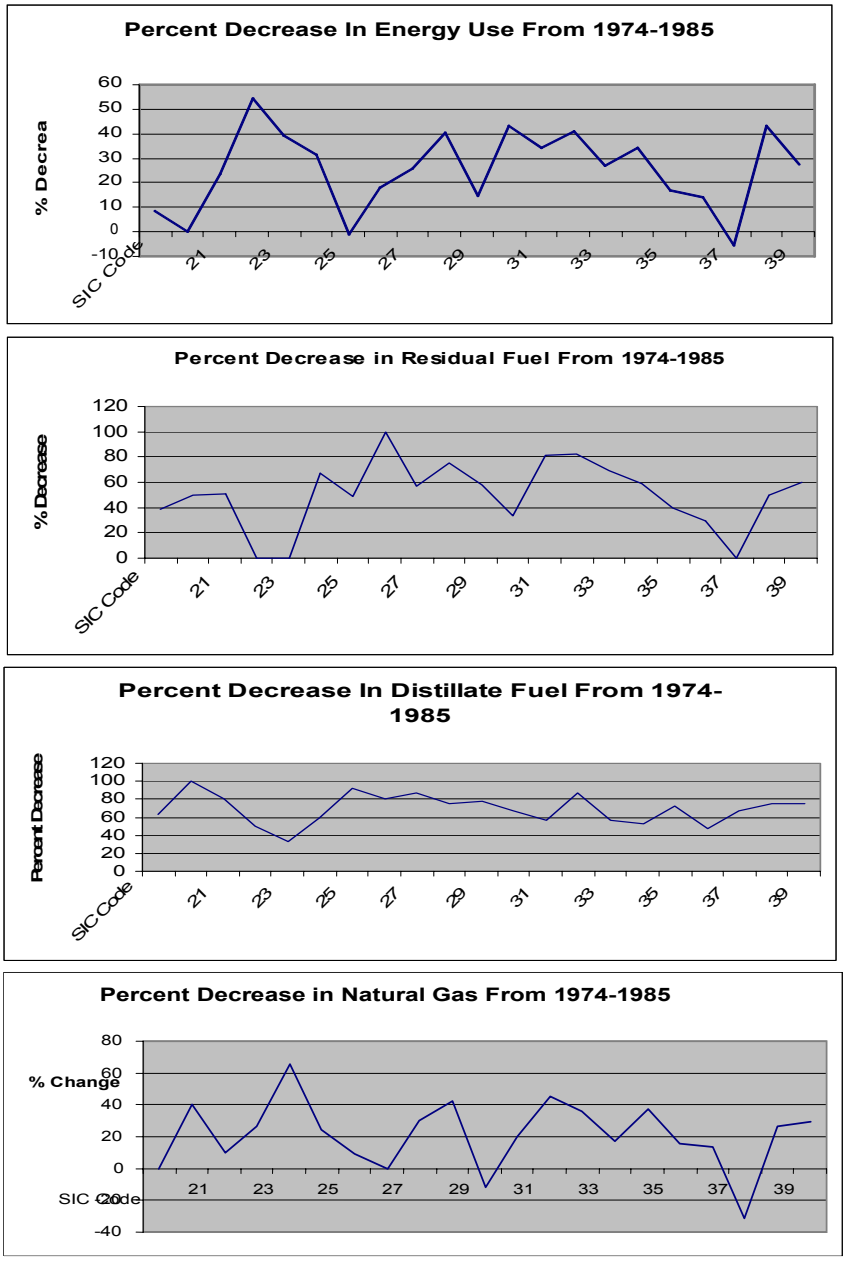
Looking at the MECS data in Table 2, the data in bold print and highlighted at the bottom of each data column represent industrial sub sectors that offer the largest opportunities for efficiency improvements or fuel switching. For example, residual oil use by the paper industry represents 60% of all residual oil use in the Northeast in 1998. In Table 3, end uses are disaggregated and several of the largest loads are again highlighted in bold. The largest loads are process heating, boiler fuel, and machine drive, followed by HVAC, lighting and the rest.

While these two tables have identified apparent industrial opportunities for efficiency improvement and fuel switching away from oil and/or natural gas, how can one assess the real potential for efficiency gains and fuel switching? One way is to look at historical data from the last time this country experienced oil price shocks, between 1974 and 1985. NYSERDA has analyzed national data from EIA (www.eia.doe.gov) to identify trends in energy use and specific fuel use by 2 digit SIC Code between 1974 and 1985. The results are presented in Figure 5. The data show significant reductions in distillate and residual oil with somewhat lower, but still

sizable, reductions in total energy use and natural gas. These results are consistent with energy efficiency occurring simultaneously with fuel switching from oil to natural gas and electricity.

While some of these fuel reductions were due to industrial contraction and structural shifts due to high energy prices, NYSERDA has data for New York that show net industrial consumption of energy per manufacturing $ of gross state product (GSP) declined 34% from 1980 to 1987. This demonstrates that energy efficiency did improve the last time industry experienced a prolonged period of high oil prices.

Figure 5. Fuel Use Trends by 2 Digit SIC 1974 - 1985



Source: New York State Energy Research and Development Authority, 2005

The energy efficiency response to peak oil. Peak Oil will cause all energy forms to become more expensive. These price signals, a more favorable regulatory environment supporting distributed generation and combined heat and power (DG/CHP), the ongoing development of new energy efficient technology and applications, and proactive market transformation initiatives by the public and private sectors will combine to significantly reduce the future consumption of energy per manufacturing $ of GSP in New York.

The two largest industrial loads, boiler fuel and direct process heating, will be transformed by the major adoption of two existing trends, **DG/CHP** and energy efficient **electrotechnology** for process loads. Compared to US manufacturing, these trends are already further along in Europe and Japan where fossil fuels are more expensive and regulations encourage these trends. The spread of DG/CHP will also provide improved reliability of electricity supply for the industry using it and grid support for the electric utility system.

The greater electrification of industry and other sectors will lead to **great strain on the electric utility system** with the following results. Electric utilities will move away from natural gas for power generation due to supply constraints, price, and/or regulation. Coal and nuclear power will be reconsidered, but will continue to suffer from public opposition for environmental, health and safety reasons. A new constraint for nuclear plants will be fear of terrorist attack. New power generation investment will be hindered by financial uncertainties of high interest rates and stagflation that many predict will come with Peak Oil. Interest in renewable forms of power generation will grow, and large industry or groups of smaller industries will consider investing in renewable generation as a hedge against higher-cost conventional power supplies.

Despite the loss of customer loads to DG/CHP and significant improvements in electrical energy efficiency, the electric utilities will nevertheless face the need for **major investments in transmission and distribution (T&D) networks and controls** as the trend towards greater electrification in all sectors strains the utility grid. Thus, programs and policies to **encourage electrical energy efficiency** and **peak load management** will become more pervasive to reduce overall energy cost burdens on consumers and the economy, and to mitigate the investment burdens on the utilities for T&D reinforcement. For industry, the greater focus on energy efficiency and peak load management will induce more plants to have energy managers on staff, and the use of energy consultants will increase dramatically.

Peak oil and structural changes in the New York industrial sector. There will be winners and losers due to Peak Oil. Globalization and its reliance on cheap transportation of goods around the globe will change. Some goods will be manufactured closer to their markets to avoid very high transportation costs, especially goods that are now moved by air and truck. A variety of imported and exported products may lose their competitive advantage and see markets shrink.

Nationwide, and in New York, the biggest losers will be the transportation equipment sector and construction equipment. Transportation, except rail freight, mass transit and bicycles, and new construction will suffer in the economic contraction. Likewise, energy intensive process industries such as Food, Chemicals, Paper, Metals, and Stone, Clay and Glass will shrink as their products become more expensive and transportation costs hurt their competitive position versus domestic or foreign competitors in distant markets. Consumer product industries like electronics will see their markets fall because consumer spending will suffer due to high energy prices and higher unemployment. Conventional agriculture with its heavy reliance on oil to grow and transport food products will undergo major change. Energy intensive meat production will decline as costs escalate.

In New York, electric utilities will do well if they can manage their growth. Food processing and agriculture can target large East Coast markets and compete with both foreign and distant domestic producers. Greenhouse production agriculture of food crops and floral products will thrive. Recycling and remanufacturing industries will increasingly substitute their products for imported commodities and manufactured goods that have high transportation costs, ranging from paper, metal and glass to auto parts, furniture and appliances. The alternate energy industry, producing biofuels and components for solar, wind and other renewable systems will grow as will advanced materials companies satisfying the demands for high strength, light weight materials for transportation industries, and other advanced products to satisfy market demands for energy efficiency, energy storage and demand management products.

Higher investment for R&D and market transformation in energy efficiency, renewable energy markets, and the electric utility system should all be happening now. According to the Rocky Mountain Institute (Winning the Oil Endgame, 2004), it typically takes 12 to 15 years for major technological transformations to go from 10-90% adoption.

Conclusion

In summary, Peak Oil will bring considerable change to the industrial sector in New York. New growth industries can help mitigate the job losses brought on by the structural shifts described above. But it is imperative to prepare for Peak Oil before it arrives. According to many estimates, Peak Oil and much higher fuel prices will arrive within 15 years and perhaps much sooner. As a society, we must confront the implications of Peak Oil and prepare for the era of oil depletion. As is often true in life, denial will only make things worse.

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