State of Strategic Sourcing 2007

Energy Prices Re-Shaping the Supply Chain: Charting a New Course?

Boston Strategies
Global Supply Chain Economists™

In collaboration with:

CAMBRIDGE SYSTEMATICS

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1 EXECUTIVE SUMMARY

Boston Strategies International's 2007 study of executive perspectives on Strategic Sourcing focused on how to manage energy expenditures given recent price volatility. This annual study has received approximately 350 responses since its inception in 2003, many of which come from major global companies.

This year's study involved a survey of shippers and carriers, interviews with over 50 practitioners and subject matter experts, and simulation modeling of the cost-effectiveness of eight different sourcing strategies for buying oil and natural gas. Based on our results, we offer ten recommendations for shippers, carriers, and policy makers:

Shippers:

1. Don't reverse Lean. Energy price concerns dwarf in comparison to the benefits of being lean.
2. Establish a balanced program to manage energy spend that includes supply chain, financial, and pricing strategies. Any strategy for managing energy spend is preferable to none, with savings ranging from 10% to nearly 100% of price increases.
3. Re-assess transportation mode and frequency quarterly. With unpredictable fuel prices and surcharges, shippers need to be on alert.
4. When making offshoring decisions, consider whether a doubling of oil prices would change the decision. Dual sourcing becomes necessary at higher oil prices.

Carriers:

1. Don't rush to develop Alternative Fuel Vehicles. Most AFV technologies are in their infancy and many companies cannot justify investing in them.
2. Actively manage fuel spend. Carriers, especially airlines and ocean shipping lines, that proactively manage fuel expenditures save 10-15% on fuel.
3. Reduce dependence on petroleum. Airports and airlines can cost-effectively modify or replace ground handling equipment to operate on LPG, ethanol, or electricity.
4. Assess routes and services for profitability. Carriers should analyze the profitability of routes and services to determine when, where, and how much to refuel based on regional fuel cost advantages.

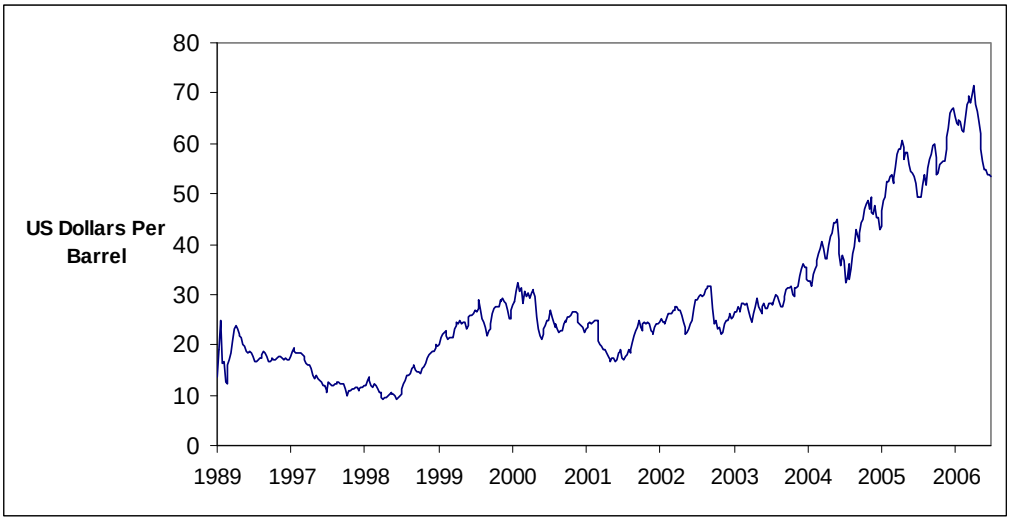
Policy Makers:

1. Consider supply chain costs and benefits when setting policy for infrastructure and alternate fuel technology. Policies that affect the efficiency, speed, and convenience of supply chains come with an added economic cost.
2. Don't jeopardize infrastructure programs to fund alternative fuels. Tax breaks for ethanol should not be funded from Federal or State Highway Trust Funds, which are needed to address growing highway infrastructure gaps that cause congestion.

2 LOTS OF BUZZ AROUND ENERGY

With oil prices topping $75 per barrel late this summer, energy has been on the mind of supply chain professionals. Fuel surcharges and related price increases, and the indirect economic effects of rising energy costs, have made 2006 a challenging year. Bill Northup, Director of Sourcing at Hubbell, Inc, notes that energy expenditures at his company have approximately doubled over the past 3-4 years. Figure 1 shows the recent increase and volatility in the price of oil.

Figure 1: Weighted Average World Oil Spot Prices 1989-2006



Source: US Energy Information Administration

Surely, Hurricanes Katrina and Rita had a devastating effect, but the trend is broader than that. Hurricane Katrina, which hit the US Gulf Coast last fall, caused natural gas prices to double from seven to fourteen dollars per million British Thermal Unit (BTU) at the market-making Henry Hub in Louisiana last winter, despite relatively mild temperatures. But experts are concerned about the long term. Researchers at the Massachusetts Institute of Technology (MIT) have cautioned about the possibility of extreme oil price scenarios. The Stern report, commissioned by the United Kingdom, has also stimulated awareness of fossil fuel consumption and possible regulation. Economists at Global Insight project a further increase of about five percent during 2007.

Practitioners are taking action. Innovators such as Dell have restructured operations to minimize shipping distances. At a recent Council of Supply Chain Management Professionals (CSCMP) forum in Cleveland, Ray Archer, Vice President of Americas Manufacturing for Dell, outlined how Dell has adopted a more flexible manufacturing strategy to decentralize to reduce transportation costs. Airports and airline-related ground handling companies are weaning themselves from a dependence on conventional fuels. Toyota sold 750,000 hybrid-powered Prius automobiles by August of 2006, capitalizing

on energy awareness in consumer markets and putting fuel-saving hybrid technology on the map. Combined with instability in the Middle East and OPEC's production quota reductions, energy has become a hot topic.

Despite the visibility of energy and the recent price spikes, only 25% of the companies surveyed for this report had established specific purchasing functions for energy.

- Gemalto, a manufacturer of security card solutions, analyzed its energy expenditures and found that it was spending 20% more at one manufacturing plant than at an identical one in another state.
- K. Hovnanian, a US homebuilding company, has 18 regional business units in the US and each one is responsible for its own energy expenditures, according to Bryan Warshofsky, Director of Purchasing Applications. K. Hovnanian also pays for many energy-related expenditures through its subcontracts, and energy is not broken out on the bills.
- Latham Plastics has just begun to examine the impact of energy costs across its 22 manufacturing plants, according to Director of Purchasing Joe Valerio.
- A Corporate Purchasing Manager at a US consumer electronics retailer described the energy purchasing function as having "a lot of gray area." It is often fragmented among Facilities, Transportation, Indirect, Manufacturing, Logistics, and Operations.

Of the companies actively managing their energy buy, however, savings of 10-15% were not uncommon. Eastern Europe discount airline Wizzair saved eight to nine percent simply by managing their fueling strategies, according to Ground Operations Director Tony Colliss.

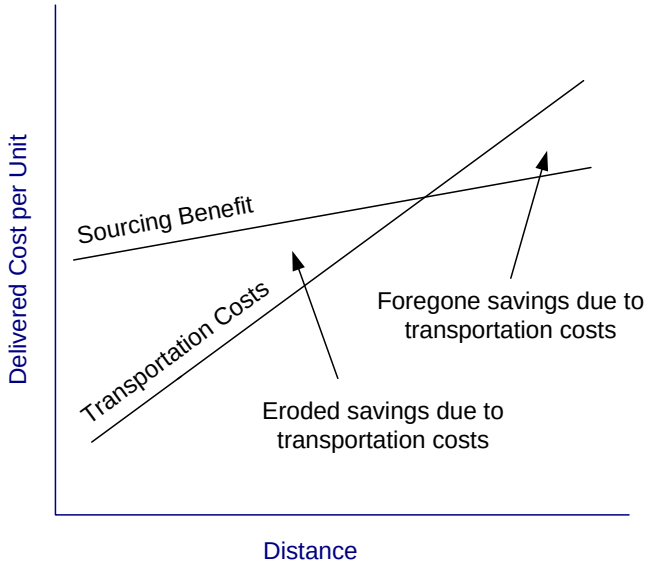
3 Losing Ground: The Collapse of Lean?

Are companies increasing buffer stocks and shipping larger loads to save money on transportation due to fuel surcharges? Are they shifting manufacturing closer to the point of consumption to minimize transportation cost?

High transportation costs can result in sourcing closer product, even at higher prices (see Figure 2).

If so, this substitution of inventory and asset costs for operating costs could represent a structural adjustment to high energy costs. That could wash away the gains from the Lean movement. Lean supply chains depend on cheap transportation to bring down inventory requirements. Lean theory and practice evolved when oil, which accounts for 98% of transportation energy consumption, was around $25 per barrel.

Figure 2: Strategic Sourcing Savings vs. Transportation Costs



Source: Boston Strategies International

Supply chains could feel the pain. Carriers especially are extremely sensitive to the price of fuel and heavy manufacturing has seen escalating energy surcharges applied in the recent past. For example, fuel comprises 35-45% of operating cost for many airlines. For non-carriers, this means rising travel costs. But manufacturers are not immune, either: Massachusetts-based Instron Corporation, a manufacturer of materials testing solutions, says that its casting and plating suppliers are passing on surcharges. K. Hovnanian has seen a stream of 5-10% surcharges, according to Warshofsky.

3.1 Fuel surcharges

The level of long-term price uncertainty in the energy market is a concern to most supply chain professionals. Tony Colliss, Director of Ground Handling at Wizzair, says his staff complains of headaches at the mere mention of fuel surcharges. Rich Walters, North American Distribution Manager at Air Products, estimates recent motor carrier fuel surcharges at 18-20%.

Figure 3 summarizes recent fuel surcharges for selected Express carriers.

Figure 3: Fuel Surcharges for Selected Express Carriers
August through December 2006

	August	September	October	November	December
UPS	N/A	N/A	16.5%	12.5%	11.5%
FedEx	N/A	17.0%	16.5%	12.5%	11.5%
DHL	18.0%	19.0%	18.5%	14.5%	13.5%

Source: Boston Strategies International

3.2 Buffer inventory and safety stocks

High or uncertain energy costs contribute to the growth of inventory. As transportation becomes more expensive, managing a just-in-time supply chain becomes more challenging. In response, shippers carry extra inventory, order less frequently, or choose a slower and cheaper mode of transportation. Survey respondents cited these as their second and third most popular strategies behind passing the cost on to their customers.

French semiconductor manufacturer Gemalto's Purchasing Manager Jacques Lalauze explains that, with millions of dollars of spend every year tied up in fuel-intensive freight and air travel, fuel surcharges are unavoidable.

Switching to more energy-efficient modes can save money. The Logistics Director at a US paper products company notes that switching from truck to intermodal helps to mitigate the impact of fuel surcharges.

But the most common strategy for dealing with energy cost increases is to pass the increases along to customers. Sixty percent of companies interviewed for this study pass the cost on to their customers in one way or another.

3.3 Sourcing Impact

As the cost of transportation is a significant factor in global sourcing, increases in transportation and hence landed cost can influence sourcing decisions. When the price of oil was about $30 per barrel, transportation was 20% of the cost of importing from Asia, according to Boston Strategies International's 2005 State of Strategic Sourcing Study. It has increased since then. Several manufacturers interviewed acknowledged the potential impact of freight rates on their sourcing and logistics decisions.

4 SUPPLY AND DEMAND IMBALANCES

4.1 Demand on the rise

Global demand for energy is projected by the Energy Information Administration (EIA) to grow at two percent per year through 2030, with non-OECD Asia accounting for most of that with a compound annual growth of 3.7%. Figure 4 shows the projected growth of global energy demand through 2030.

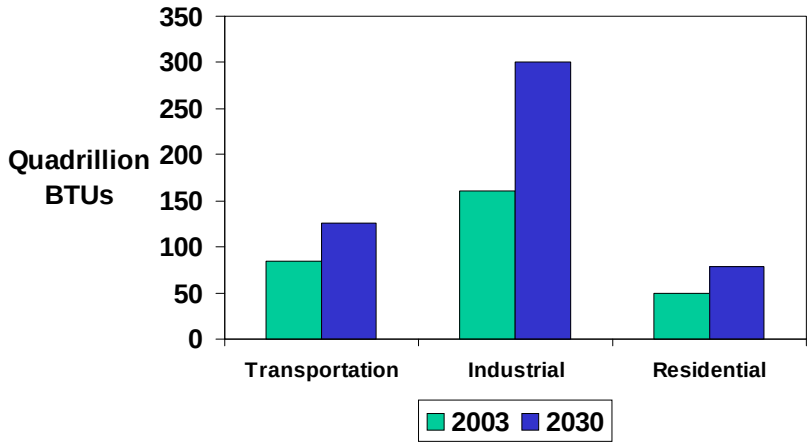
Figure 4: Global Energy Demand Growth, 2003-2030

Region	2003	2010	2015	2020	2025	2030	Average Annual Percent Change
OECD	**234.3**	**256.1**	**269.9**	**281.5**	**294.4**	**308.7**	**1.0%**
North America	118.3	131.4	139.9	148.4	157.0	166.2	1.3%
Europe	78.9	84.4	87.2	88.7	91.3	94.5	0.7%
Asia	37.1	40.3	42.8	44.4	46.1	48.0	1.0%
Non-OECD	**186.4**	**253.6**	**293.4**	**331.5**	**370.9**	**412.6**	**3.0%**
Europe	48.5	56.5	62.8	68.7	74.0	79.0	1.8%
Asia	83.1	126.2	149.4	172.8	197.1	223.6	3.7%
Middle East	19.6	25.0	28.2	31.2	34.3	37.7	2.4%
Africa	13.3	17.7	20.5	22.3	24.3	26.6	2.6%
South America	21.9	28.2	32.5	36.5	41.2	45.7	2.8%
Total World	**421.7**	**510.7**	**563.3**	**613.0**	**665.3**	**721.3**	**2.0%**

Source: US Energy Information International Energy Outlook 2006

As China becomes an increasingly important player in the global economy, its energy needs are increasing dramatically. The Asian industrial sector is forecasted to nearly double its energy consumption by 2030 (see Figure 5).

Figure 5: Growth in Non-OECD Asian Energy Demand by Sector



Source: US Energy Information Administration

To fuel this growth, China will compete with the United States for oil. There is already political tension between the US and China over Chinese oil markets such as Iran and Sudan. This increased competition for resources will drive costs up unless supply can grow with demand.

4.2 But production progressively more difficult

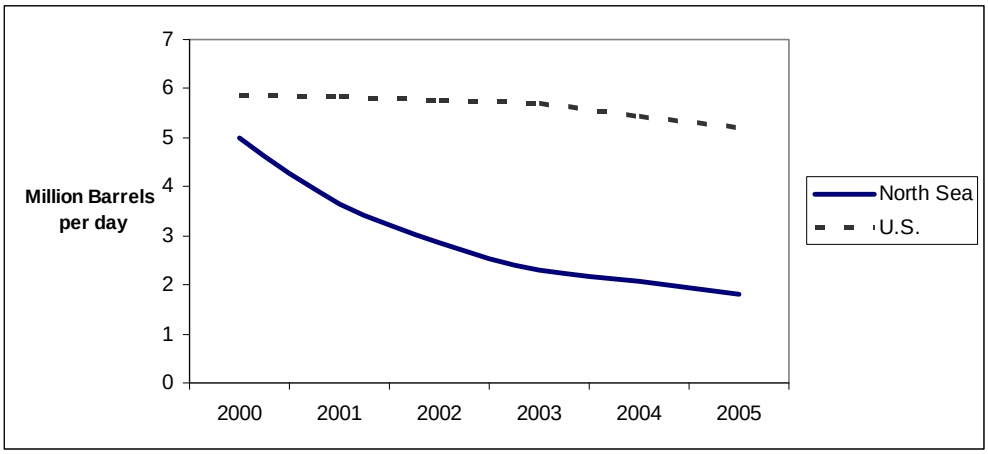
As resources diminish, production is getting more difficult. While total world oil reserves, discovered and undiscovered, are estimated at almost three trillion barrels, existing oil fields are maturing and new oil resources are becoming harder to exploit. According to ExxonMobil's spokesman in Angola, William Cummings, "All the easy oil and gas in the world has pretty much been found. Now comes the harder work in finding and producing from more challenging environments and work areas."

Oil extraction cost increases are already in the news. Shell Oil recently increased its budget for one joint project with the Russian government from $10 billion to $22 billion.

However, despite these initiatives, most large, mature oil fields are experiencing a decline in production already. Production at two of the largest three – Cantarell in Mexico and Burgan in Kuwait – is declining at up to 13% per year. North Sea Oil production is trailing off as well (see Figure 6). And despite commitments on the part of the U.S. government to energy independence, America imports two thirds of its oil and domestic production is projected to continue decreasing.

The net result of decreasing reserves and increasing resources spent on tapping those reserves is that throughout much of 2004 and 2005, excess oil production capacity was less than 1 million barrels per day, sometimes as low as half a million.

Figure 6: North Sea and U.S. Oil Production 2000-2005



Source: US Energy Information Administration

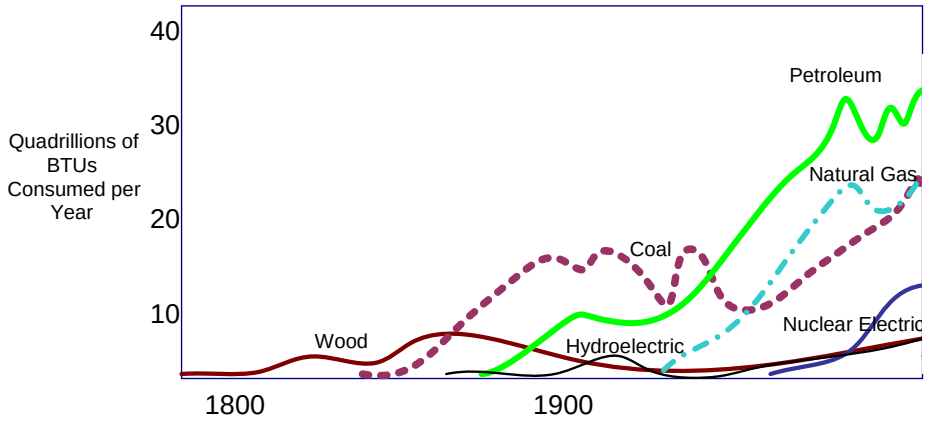
4.3 Peak oil?

The Hubbert Peak Oil theory, which successfully predicted peak production of US oil in 1971 models global "Peak Oil" production anywhere between 2005 and 2025, and some alarmists contend that world oil production has already peaked.

This theory is far from proven, and neither the US Energy Information Administration nor the International Energy Agency predict imminent world oil production decline.

Figure 7, which shows the pattern of energy consumption in the U.S. from 1800-2000, demonstrates how energy technologies quickly adapt to consumption patterns and industrial economics.

Figure 7: U.S. Energy Consumption 1800-2000



Source: Boston Strategies International analysis of US Energy Information Administration data

The fact remains, however, that much of the easily exploitable oil and gas resources are in decline and progressively more expensive projects must be taken to ensure the continued supply of oil. "Pretty soon the dinosaurs are going to run out," quips Ron Dintemann, Vice President of Operations for Key Essentials, a US flavor development company. "It's going to get worse before it gets better," adds a Corporate Purchasing Manager for a US consumer electronics retailer.

4.4 Geopolitical unrest tightens market

Even as technology adjusts to fit demand in the long run, geopolitical instability continues to be a major concern for the supply of oil in the short and medium term. As shown in Figure 8, 18% of the world's oil reserves are in areas of major political unrest.

Figure 8: Global Reserves by Region (Billion Barrels)

Region	Proved Reserves	Reserve Growth	Undiscovered	Total	Percent of Total
OECD					
United States	21	76	83	180	6%
Canada	179	13	33	224	8%
Mexico	13	26	46	84	3%
OECD Europe	15	20	36	71	2%
Japan	0	0	0	1	0%
Australia/New Zealand	2	3	6	10	0%
Non-OECD					
Russia	60	106	115	282	10%
Other Non-OECD Europe	19	32	56	107	4%
China	18	20	15	53	2%
India	6	4	7	16	1%
Other Non-OECD Asia	10	15	24	49	2%
Middle East	743	253	269	1265	43%
Africa	103	74	125	301	10%
Central and South America	103	91	125	320	11%
Total World	1293	730	939	2962	
OPEC	902	396	401	1698	57%
Non-OPEC	391	335	538	1264	43%

Source: US Energy Information Administration International Energy Outlook 2006

Iraq is struggling to produce two million barrels of oil per day when it has the potential to produce six million. Nigeria's oil-rich Niger Delta is under increasing assault by the Movement for the Emancipation of the Nigerian Delta (MEND), and no negotiated end to the conflict is in sight. In Sudan, the rebellion in Darfur began by threatening oil production and will continue to do so until the violence subsides.

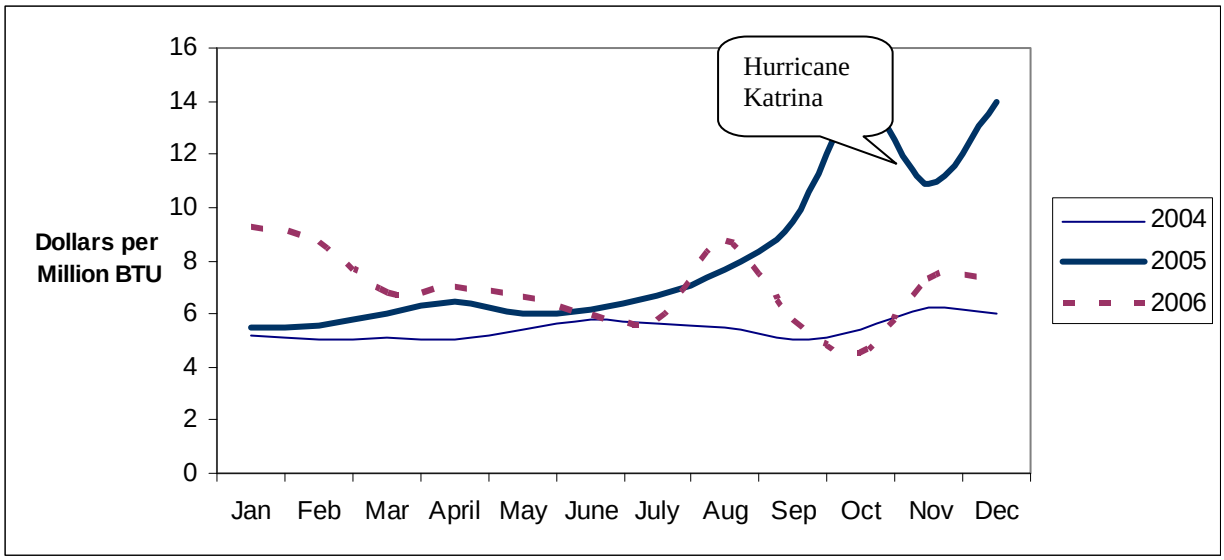
The Vice President of Strategic Sourcing at a US grocery chain expresses concern that even the slightest news item about North Korea corresponded directly to a spike in the crude oil market. Political conflicts will continue to affect global production capacity, and a worsening of any of these conflicts will result in heightened uncertainty for oil markets.

4.5 And nature adds to the uncertainty

After Hurricane Katrina, natural gas and, to some extent, oil prices spiked in response to damaged facilities supplying the market-making Henry Hub in Louisiana (see Figure 9).

Bill Northup, Director of Sourcing for US electronics manufacturer Hubbell, explains that "last year was a total wipeout – nobody expected [Hurricanes] Katrina or Rita."

Figure 9: Henry Hub Spot Prices 2004-2006



Source: US Energy Information Administration

A mild winter following the hurricane and continued warm temperatures in the US have contributed to a recent decline in prices as reserves increase, with oil hovering just over $60 per barrel in December 2006. Warm winter weather will continue to help energy prices this year.

However this price level may not continue longer term. For example, according one major airline, it is preparing for sustained higher fuel prices despite the recent price dip Economists at Global Insight project a 36% spike during 2007. Lance Grenzeback, Senior Vice President at transportation policy think-tank Cambridge Systematics, expects fuel prices will continue to rise in the long term.

5 THE IMPACT IS LIMITED SO FAR

Even now with oil prices at more than sixty dollars per barrel, consumers and businesses seem willing to pay for the transportation needed to support "just-in-time" inventory. For branded products, the costs of transportation are viewed as negligible**.** One retailing executive explains: "We are not going to shift brands because of fuel cost."

5.1 Energy not a "top-three" cost for most companies

Direct energy costs typically represent approximately three percent of a company's sales, and indirect energy purchased as part of other external materials represents about three to four percent, according to this year's survey. Only one company surveyed reported that natural gas expenditures accounted for as much as 12%. Indirect energy costs – those that are embedded in a company's purchasing math – often amounted to approximately the same figure. As such energy comes out below the top spend categories that get visibility to senior management. Manufacturers will be affected by expensive energy more than most, as they consume more energy-intensive materials and operate on typically thin margins in competitive industries.

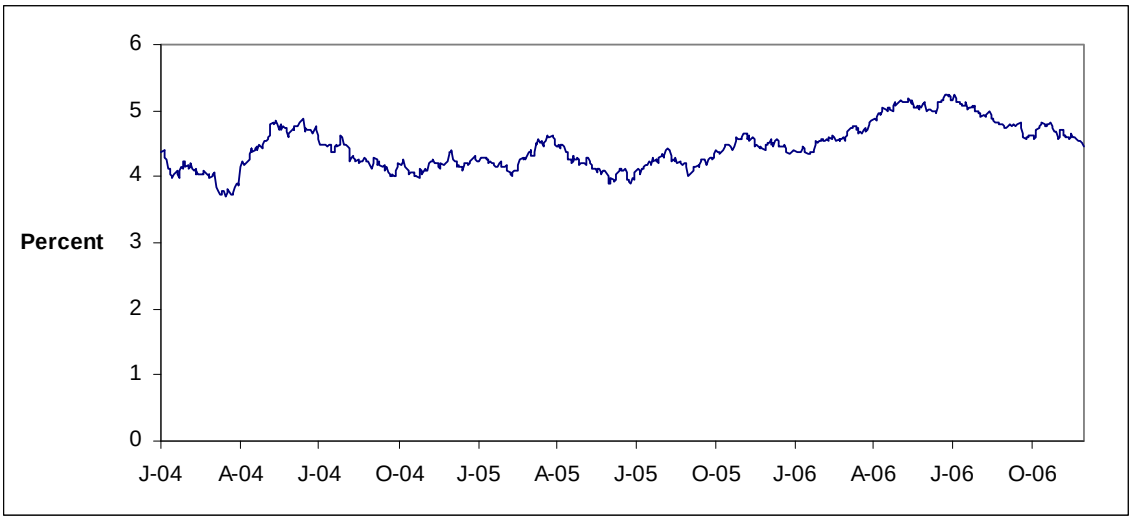
5.2 Fuel surcharges being "passed through"

Our analysis shows that transportation cost increases can be passed through the supply chain to consumers with almost no price elasticity due to their small net effect. Transportation makes up approximately 6% of the economy, and fuel about 20% of that. A 15% increase in the cost of fuel would thus only pass along a 0.2% total cost increase. In fact, simply passing on cost increases was shown to be the most common and the most effective method of dealing with energy cost increases across the board. Motor carriers have passed through 18-20% surcharges in the last year, according to Rich Walters, Manager of North American Distribution for US-based Air Products Corporation, a distributor of compressed gases.

5.3 Inventory carrying costs holding steady

The cost of carrying inventory will not increase appreciably as long as obsolescence remains an important driver and interest rate growth is slow and incremental, which it has been over the past two years (see Figure 10). Interest rates, which determine 86% of changes in inventory carrying cost according to our analysis, are projected to rise only slightly.

Figure 10: Long-Term Treasury Interest Rates 2004-2006



Source: US Treasury

5.4 Minimal impact on offshoring decisions

The savings that most companies realize by using China as a low-cost sourcing platform far exceed the recent energy cost impact, so offshore sourcing will not be affected in the near term due to energy prices unless a major geopolitical or economic event occurs. Based on Boston Strategies International's 2005 analysis of The Asian Sourcing Boom (which was conducted when oil was about $30 per barrel), freight from China represents 20% of the landed cost, on average. Therefore, assuming fuel at 20% of transportation costs (one auto manufacturer estimated fuel costs at 15-25% of its freight bill), a 15% increase would only raise the cost of goods sourced from China by 0.8%.

Compared to the 18% cost savings many companies get from outsourcing this loss is not significant enough to change behavior. Richard Goyette, Materials Manager at Speedline Technologies, says the total cost of sourcing from China would have to rise more than 25% before his company would even take a second look at its decision to source offshore. Bill Northup, Director of Sourcing at US electrical supplies manufacturer Hubbell, adds, "I don't see them talking about needing to change DC strategies due to fuel costs."

Moreover, offshoring sourcing at most companies is driven at least in part by the desire to increase sales in fast-growing markets like China. This motive would further mute the impact of fuel costs on the sourcing decision.

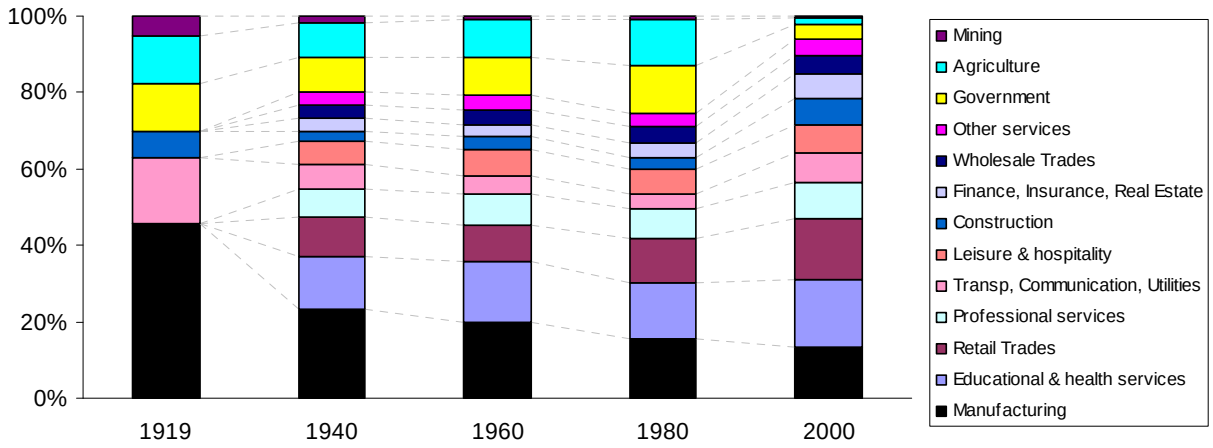
However, companies are beginning to consider the impact of fuel costs in their logistics decisions. When evaluating direct-to-store shipments recently, One US electronics retailer we spoke to analyzed fuel as one of the components of the decision.

5.5 Service economies well-positioned to adapt

Thirty years ago a similar shock to the supply of oil would have been a much worse scenario for the United States. As the economy has shifted from 43% manufacturing in the early 1900s to only 12% in 2006 (see Figure 11 for a time-series breakdown), energy intensive heavy industry represents a much smaller portion of the economy. This means that the US is in a much better position to withstand high energy prices than it was.

However, economies that depend on energy intensive industry for the bulk of their gross domestic product (GDP) will need to react to energy shocks more proactively. Rich Weismann, Associate Professor at Endicott College notes, "[The US is] still pretty cheap compared to other countries."

Figure 11: Manufacturing as a Percentage of US GDP

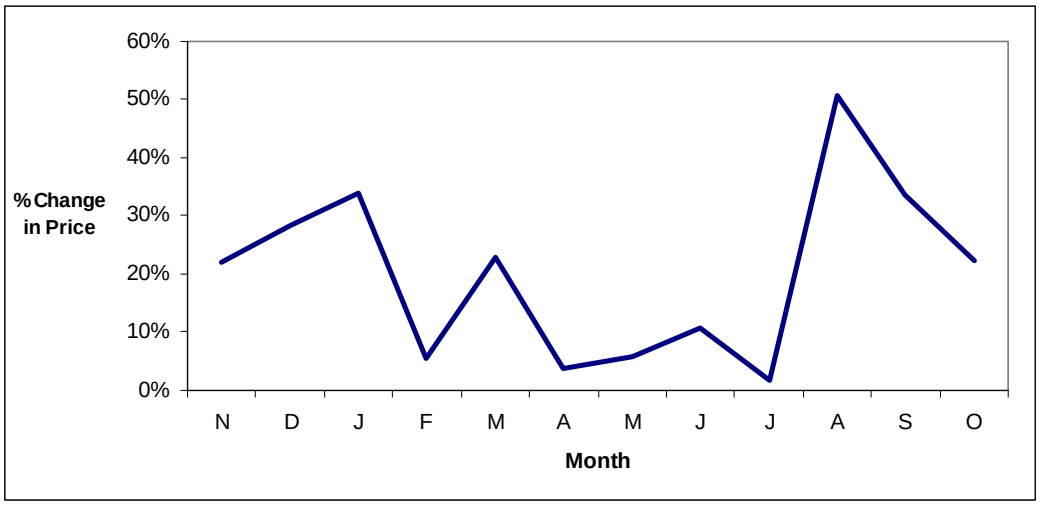


Source: US Bureau of the Census

6 VOLATILITY STILL A CONCERN

Despite the overall ability of supply chains to withstand today's higher energy costs, volatility has hurt companies in the past and continues to be a source of concern. Natural gas has been subject to extraordinary volatility over the past year (see Figure 12)

Figure 12: Natural Gas Volatility November 2005 - October 2006



Source: US Energy Information Administration

Survey respondents expect gas prices to rise by 13.5% in 2007, and oil and coal to rise at about half that rate; however there is wide variance around expectations, given past price volatility.

6.1 Buying strategies

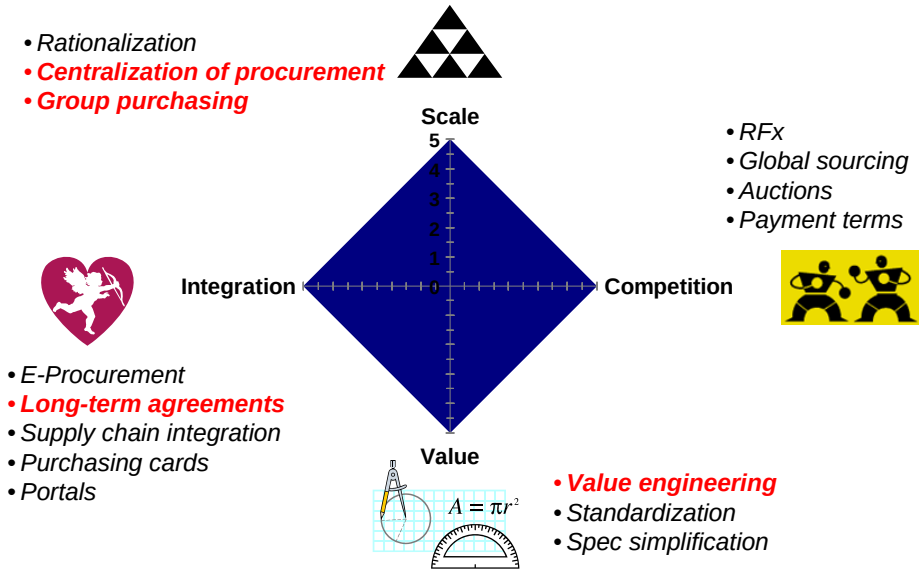
What is a sourcing organization to do?

One airline has staff members dedicated entirely to managing fuel contracts to achieve the lowest price. However, the goal of many buyers, including Hubbell for example, is not to actively manage energy costs, but simply to lock in an acceptable standard rate for the utility spend.

Boston Strategies International's Sourcing Diamond (see Figure 12) shows the four families of sourcing strategies: scale, competition, value, and integration. While large, complex buys generally provide opportunities to deploy multiple cost-savings strategies, energy purchases offer more constrained options. Furthermore, the available options are not as easy to implement. The relevant strategies are:

- Centralized purchasing
- Group purchasing
- Value engineering
- Long-term agreements

Figure 13: Boston Strategies International Sourcing Strategy Diamond



6.2 Centralized purchasing

Given the disparate responsibility for energy consumption, one strategy is to centralize responsibility for the buy. A limited number of companies does this today – usually those that have a large energy expenditure.

Carriers, especially airlines, have energy buying teams since fuel is such a large cost for them. Centralized purchasing saved six percent of acquisition cost, according to Boston Strategies International's second annual State of Strategic Sourcing report, which addressed a wide range of purchased materials and services.

One airline boasts "a special room of 18 people with a bunch of screens focusing on hedging and managing fuel levels in planes for optimal fueling price," according to an executive.

Wizzair, a European discount carrier that flies one to three-hour flights, is adjusting its refueling stops to correspond to the locations where it can buy fuel at the lowest cost. This has saved it eight to nine percent on fuel costs, which is enough to make the difference between a low-cost carrier being profitable or not.

One US grocery chain pools its load for a geographic utility area, and sources from one supplier.

6.3 Group purchasing

Group purchasing, or purchasing consortia, save money on external expenditures, saves companies five to eight percent of acquisition costs, according to Boston Strategies International Group's 2005 "High Impact Sourcing" study. Several companies in the study are participating in purchasing groups to save money on energy expenditures.

The state of Connecticut is establishing a consortium for buying electricity to mitigate the impact of a 30% price increase from utilities that don't own electricity stations, according to Hubbell's Bill Northup.

Latham Plastics uses a shippers' alliance called MESCA to lower its less-than-truckload (LTL) freight costs.

One retailer uses a third party negotiator to execute its electricity contracts with municipalities.

6.4 Value engineering

One way to address rising and volatile energy costs is to reduce consumption or change to less expensive sources of energy.

Here are some ways that companies in our study are doing this:

- Some airlines and airports are implementing propane-electric conversion for ground handling equipment. Sixty percent of one airline's ground handling equipment now runs on liquid propane gas (LPG). The airline's fuel costs for LPG equipment have risen only 22%, while fuel for comparable gasoline-powered equipment soared 49%. Some locations are run completely on gas and electric.
- A major paper products manufacturer is re-emphasizing intermodal transportation over truckload transport because of intermodal's greater fuel-efficiency. This company is also working with its large customers to reduce empty backhauls.
- A large data storage company and a retailer are shifting their energy usage to off-peak hours.
- Groom Energy, an energy services company, helps reduce its clients' energy bills by reducing their lighting load, improving their heating, ventilating, and air conditioning (HVAC) systems, and employing renewable energy sources such as solar and wind power.
- One retailer says it has reduced its electricity consumption by 10-20% by using sensors to activate lights.

6.5 Long-term agreements

The most prevalent approach to managing energy price risk in companies that participated in the study is to sign long-term contracts: 71% of survey respondents said they use long-term contracts as their preferred buying strategy.

One airline mentioned that it has "locked in most of its contracts long-term as a corporate initiative to control all costs." An executive also said that the airline had found 18-month contracts for jet fuel to be inefficient, now favoring two-month agreements.

Some companies are successfully implementing longer term agreements. One manufacturer recently negotiated eight to 10-year agreements with its rail carriers. Latham Plastics has five to seven year agreements for electric power.

6.6 Buying futures contracts

A US grocery chain conducted an analysis of 25%, 50%, 75%, and 100% splits of locking in rates using futures contracts. Based on their analyses, they decided that there is no benefit of locking in early. "If the market goes down, you get hurt just as much as if the market goes up," explains one executive, who is responsible for purchasing indirect materials and services. Many are unwilling to pay the premium for futures contracts. More fundamentally, some do not trust that futures prices accurately predict the market.

6.7 Other approaches

Other approaches to managing the energy spend include passing price increases on to customers and speculative (timed) buying.

Price increases can be passed on either in the form of a surcharge that floats up and down, or in the form of a permanent price increase that embeds the higher cost of energy. For example, while parcel express companies have implemented surcharges, some railroads have rebased their rates to embed the higher fuel cost. "Railroads are using [increased fuel costs] as a profit center," says one large rail shipper.

Speculative buying is buying before an anticipated price increase. The precise timing of a speculative purchase depends on the buyer's judgment regarding prevailing market conditions and current and future price levels.

6.8 Simulation comparison of results using eight approaches

Are long-term contracts the best strategy? Boston Strategies International modeled six buying strategies that buyers might have used during the period October 2005 to October 2006 to mitigate the impact of high prices and volatility. Each strategy was compared to the baseline of buying on the spot market and pay the prevailing price. The strategies were:

1. Pass price increases on to customers and embed the cost in the product price even after the energy prices go back down
2. Pass price increases on to customers as a surcharge that fluctuates with actual energy prices
3. Sign 6-month or one-year energy contracts at the prevailing average forecast
4. Buy in advance at the current price ("speculative buying")
5. Buy options and exercise them only when the actual price exceeds the strike price of the option
6. Centralize purchasing within the company
7. Join a purchasing consortium
8. Reduce energy consumption through value engineering

We simulated the results that a heavy manufacturer and a retailer would have had using each strategy for oil and also for natural gas. We used actual energy cost and forecast data and took into account the financial and inventory carrying cost of advance energy purchases. We also factored in the lost sales that companies sustain by passing on price increases, and the increase in sales they would realize from reducing prices. In the Options scenarios, we calculated the historical price volatility and used the Black-Scholes options valuation formula. The savings potential of centralized purchasing, joining a purchasing consortium, and reducing energy consumption was based on previous studies.

Figure 14 summarizes the percent change that the financial and pricing strategies would have had relative to the baseline energy costs (the costs at the beginning of the period) as well as the rank order of success for each strategy (in parentheses).

Figure 14: Energy Costs Under Six Financial and Pricing Strategies

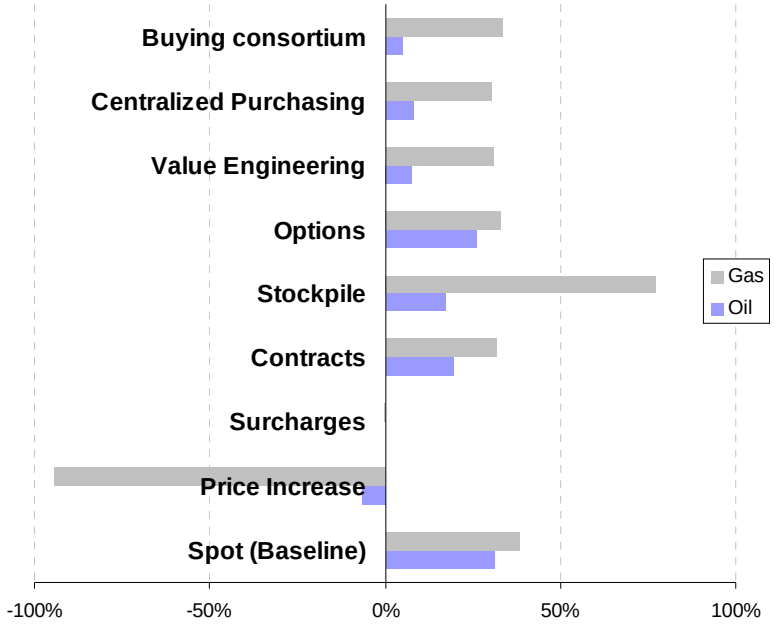
Percent Change from Baseline and Rank Performance (in parentheses)

		Oil		Gas		Overall	
		Manufacturer	Retailer	Manufacturer	Retailer	Oil	Gas
	Buy on Spot Market (Baseline)	31% (7)	31% (7)	38% (6)	38% (5)	31% (7)	38% (6)
a	Pass on to Customers and Embed Cost	-7% (1)	-6% (1)	-94% (1)	-94% (1)	-6% (1)	-94% (1)
b	Pass on to Customers Up and Down Adjustments	0% (2)	0% (2)	1% (2)	1% (2)	0% (2)	1% (2)
c	6-Month Contracts	20% (5)	20% (5)	30% (4)	26% (3)	20% (5)	29% (3)
d	1-Year Contracts	19% (4)	19% (4)	34% (5)	34.2% (4)	19% (4)	34% (5)
e	Speculative Buying	17% (3)	17% (3)	77% (7)	77% (7)	17% (3)	77% (7)
f	Options	25% (6)	25% (6)	29% (3)	44.2% (6)	25% (6)	32% (4)

Source: Boston Strategies International

Figure 15 summarizes the cost of each strategy over the 12-month period studied, including the savings that can be realized on supply chain and sourcing strategies such as joining a buying consortium, centralizing purchasing, and value engineering.

Figure 15: Energy Costs Under All Buying Strategies



6.9 The benefits of a hybrid approach

Managing the energy buy is worth the effort. Except for stockpiling natural gas, any buying strategy other than buying on the spot market would have averted at least 15% of the cost increases. Some coordinated purchasing and pricing strategies actually netted positive gains (negative cost increases).

Pricing and some financial strategies effectively mitigated the cost increases. The most effective strategy for mitigating the impact of oil cost increases was to pass through price increases to customers. Contracts proved to be of some value.

- There are two ways to pass through the price increases – through surcharges or by embedding them in the base sales price.
    - Adding an energy surcharge resulted, in a basically cost-neutral position. Cost increases were passed through when they occurred, and retracted when they went away.
    - Embedding the cost increase in the base price proved to create a lucrative profit center, a strategy that was acknowledged by many interviewees. It not only shielded buyers from price increases but resulted in windfall gains as energy prices subsequently declined but those increases were structurally embedded in the sales price.
- The second most effective strategy was buying early at the first major downswing in price and stockpiling. In our simulations, stockpiling beat contracts. However, the savings from stockpiling depend on future price movements that are impossible to predict, and could have resulted in losses in other periods.

- The third most cost-effective strategy was short-term contracts. The overall falling prices over the period made it advantageous to renegotiate the contract mid-year. Short-term contracts also limit downside risk in that they can usually be renegotiated before major price increases occur.
- Options turned out to be a relatively costly strategy over this time horizon, since recent extreme price volatility bid up the option premiums substantially. However, if re-evaluated frequently, options are a flexible strategy that is close to cost-neutral in the long-run.

Curiously, the percent savings from such as centralized purchasing, buying groups, and value engineering was relatively small compared to the overall increase in energy prices. However, these proven supply chain strategies can result in consistent and dependable savings whether prices are increasing *or* decreasing, while financial and pricing strategies may work well in a given period and fail in the next. Therefore, a hybrid program that involves supply chain strategies as well as financial and pricing strategies, is the most prudent approach for the long run.

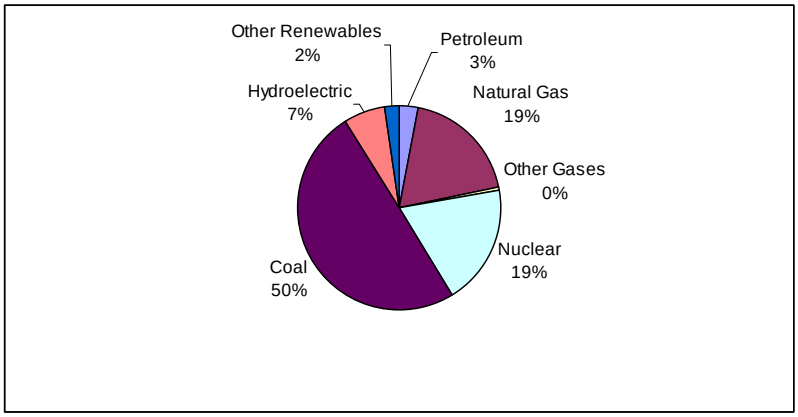
7 Policy Needs to Consider the Prospect of Continued Escalation

Much attention has been given to the potential of green energy generation and alternative fuels in the recent past, and talk of a coming "Hydrogen Economy" has waxed and waned. Our research indicates that, while advances may be made in these areas, their effects on the costs to supply chains will be minimal.

7.1 New fuel and vehicle technologies will begin to compete with oil

Figure 16 shows that fully half of all power produced for electrical production comes from coal.

Figure 16: The Dominant Role of Coal Electricity Generation



Source: US Energy Information Administration

Wind is an increasingly cost effective method of generating electricity, the only green method demonstrated to have a lower cost than coal or gas-fired plants. Although generation levels depend on wind speeds, companies in Colorado, Minnesota, and Montana have been able to generate electricity at lower cost than conventional methods. However, due to the fledgling state of the industry and current inability to store electricity produced by wind farms, wind is not likely to capture enough market share to exert much widespread downward pressure on the market for electricity.

Some theorists claim that combination hybrid-alternative fuel vehicles will become mainstream within ten years, with some uncertainty as to the best alternative fuel to use. However, these vehicles represent less than a half of one percent of the US vehicle market today, (see Figure 16).

Figure 17: Alternative Fuel Vehicles in 2004

Fuel	Number	Percent of Total Vehicles
Liquefied Petroleum Gas	194,389	0.084%
Compressed Natural Gas	143,142	0.062%
Ethanol	146,195	0.063%
Electricity	55,852	0.024%
Total	**539,578**	**0.233%**

Sources: US Department of Transportation, US Energy Information Administration

Hybrid electric vehicles and vehicles running on gasohol (a blend of gas and ethanol) may exert an impact, albeit minor, on the current dependence on oil for transportation. Lance Grenzeback at Cambridge Systematics, anticipates that hybrid automobiles will

gain in popularity and that ethanol will become popular as automotive fuel in rural areas. Freightliner and Eaton Corporations have partnered with FedEx to put 75 hybrid delivery vehicles on the road in 2006 and are perfecting a prototype hybrid medium-duty vehicle. Volvo is also promising a commercially viable heavy duty hybrid truck in 2009.

Ethanol made from corn feedstocks is currently the dominant ethanol product in the U.S., and sugar cane ethanol is mass-produced in Brazil. Raising crops for ethanol, while a boon to the agriculture industry, requires a heavy level of subsidization, and cellulosic ethanol (producing ethanol from excess biomass such as switchgrass) is potentially much cheaper. The technology for large scale cellulosic ethanol is not ready for mass-production yet, however, and even if it were, the equivalent cost per gallon would be approximately $2.94 and uneconomical until gasoline consistently exceeds that price.

7.2 CAFE standards can be met with existing fuel technology

Unreformed Corporate Average Fuel Economy (CAFE) standards for 2008-2010 were 22.5, 23.1, and 23.5 mpg respectively. 2007 standards have been increased from 20.7 miles per gallon to 22.2, a change which can easily be met using existing fuel and vehicle technologies. The US government's CAFE standards have been revised for model year's 2008-2011 so that they are based on a vehicle's "footprint," its wheelbase multiplied by its track width, requiring increasing levels of average fuel economy for each model every year. By incorporating a vehicle's footprint into the CAFE regulations, the program aims to make trucks safer by reducing the incentive to make trucks lighter at the expense of safety.

Figure 18: CAFE, Standards vs. Actual

	Miles per Gallon Standard		Miles per Gallon Actual	
Year	**Cars**	**Light Trucks**	**Cars**	**Light Trucks**
2000	27.5	20.7	28.5	21.3
2001	27.5	20.7	28.8	20.9
2002	27.5	20.7	29.0	21.4
2003	27.5	20.7	29.5	21.8
2004	27.5	21.0	29.1	21.5
2005	27.5	21.6	30.0	21.8

Source: US National Highway Traffic Safety Administration (NHTSA)

7.3 Alternative fuel policy should not override infrastructure funding needs

In the past, as consumers receive tax breaks for buying ethanol-fueled vehicles, less revenue accrued to the Federal Highway Trust Fund for each gallon of gasohol currently sold. According to Cambridge Systematics' 2003 Federal Highway Trust Alternative Fuels report, foregone tax revenue from the sale of gasohol resulted in $1 billion less revenue to the Federal Highway Trust Fund. As shown in Figure 19, the report estimates that nearly $4 billion dollars per year could have been precluded from the Highway revenue stream by 2010.

Figure 19: Trust Fund Revenues from Selected Fuels

Fuel Type	Gross Revenues 2000 ($ Billions)	Gross Revenues 2010 ($ Billions)	Gross Revenues 2020 ($ Billions)	Change 2000-2010 ($ Billions)	Change 2000-2020 ($ Billions)
Gasoline	$22.0	$26.2	$30.0	$4.2	$8.0
Diesel	7.0	10.7	13.1	3.7	6.1
LPG	0.06	0.12	0.13	0.06	0.07
Ethanol (using adjusted estimates)	-1.1	-3.9	-3.9	-2.8	-2.8
Methanol	0.01	0.04	0.04	0.03	0.03
Hydrogen	0.00	0.00	0.00	0.00	0.00
Totals	**$28.0**	**$33.2**	**$39.4**	**$5.2**	**$11.4**

Source: Cambridge Systematics Alternate Fuels Report

Congress acted to remove ethanol subsidies from the Highway Trust fund last year, but the issue of exactly how to fund alternative fuel subsidies remains on the policy agenda.

7.4 Other policy ideas

Interviewees offered other policy suggestion as well. Ron Dintemann, Vice President of Operations for Key Essentials, a US-based flavor development group, says the US and oil companies need to invest more in domestic refining capacity.

8 CONCLUSION: SHORT AND LONG-TERM STRATEGIES

Energy represents five to six percent of sales for most companies in mature, service-driven economies. At this level, even large spikes in energy costs will not cause most companies to restructure their supply chains until the price of oil reaches far above its current level. Therefore, companies should forge ahead with lean manufacturing and lean distribution programs.

Nonetheless, high and volatile energy cost increases threaten to disrupt budgets and have been problematic for supply chain managers in transportation, procurement, manufacturing, and materials management. And "those who do the best at sourcing energy will win because they will have a cost advantage," in the words of Ron Dintemann, Vice President of Operations at US flavor manufacturer Key Essentials.

Many companies' response to recent energy price trends has been to sign long-term energy contracts. However, the scenarios we tested show that long-term contracts do not have the same benefits for energy as for other less commodity-focused expenditures. In fact, long-term contracts may actually cost more if volatility is high enough to place a risk premium above the current spot market price. The most profitable short-term strategy has been to embed cost increases in price, which serves to guarantee extra revenues for the company when costs slip back down. The next most profitable strategy has been to negotiate a series of short-term contracts.

8.1 Recommendations

Shippers, carriers, and policy makers can and should take action regarding energy price trends, to gain a competitive edge and to build a competency that could serve as an eventual long-term compounding of price increases. We recommend the following actions:

Shippers should establish a program to manage energy spend. Any strategy for managing energy spend is preferable to none, with savings ranging from ten to more than one hundred percent of price increases. As part of that program, they should re-assess transportation mode and frequency quarterly. And when making offshoring decisions, consider whether a doubling of oil prices would change the decision. Dual sourcing may become necessary at higher oil prices.

Carriers should not rush to develop alternative fuel vehicles. Most of the relevant technologies are in their infancies and many companies cannot justify investing in them at present. However, they should actively manage their fuel spend because carriers that do so save substantially, and they should reduce their dependence on petroleum by using ground handling equipment operating on liquid propane gas, ethanol, or electricity.

Finally, they should assess their routes and services for profitability regularly and consider fuel costs in the decisions about which routes to serve.

Policy makers should consider the supply chain costs and benefits when setting policy for emerging alternate fuel technology. They should also consider the possible long-run substitution effects of fuel-efficient modes compared to less efficient modes. Also, they should not jeopardize infrastructure programs to fund alternative fuels because doing so would leave the US's looming capacity bottlenecks unaddressed.

9 APPENDIX: HISTORICAL EVOLUTION OF ENERGY TECHNOLOGIES IN THE US, 1880-2006

9.1 Pre-Industrial Revolution: energy for transportation

Coal began to be a major fuel source in the 1850s, and in 1885 it overtook wood as America's primary fuel source. Coal was burned in furnaces to heat buildings, in steam engines to propel trains and ships, and in plants to produce electricity. Coal was the major fuel of the industrial revolution. It continued as the nation's main fuel until it was transplanted by petroleum in 1951, and then by natural gas shortly thereafter.

9.1.1 Land transportation

Until 1870, shortly after the Transcontinental railroad was completed, most horsepower came from real horses and other draft animals as transportation of goods took place in carts, wagons, on pack-animals, in wind-powered ships, or barges. Later, steam power in the form of locomotives or steamboats took hold and began to revolutionize transportation. Rail, powered largely by coal, continued to be the dominant form of transportation until commercial trucks began to gain traction in the 1920s. Diesel became the fuel of choice for locomotives, supplanting coal and eliminating the need to haul a coal car and a water tank with each locomotive car.

9.1.2 Water transportation

Barges transported large amounts of freight via canals in the early stages of industrial development. However, the high costs of canal infrastructure made intra-continental marine transport increasingly less cost effective as rail and truck transport grew in volume and efficiency. Clipper ships (powered by wind) were the most efficient method of ocean transport until 1860, when steamships, capitalizing on more efficient composite steel construction and improved, helical propulsion systems began to make ocean freight truly economical. The introduction of freight containers by Malcolm McLean in the 1950s revolutionized ocean transport and led to modern intermodal transportation.

9.1.3 Aviation

Ocean passenger traffic was eclipsed by aviation in 1958, with the commercialization of the Boeing 707. The 747 made air freight a significant mode of commercial transportation starting in 1969. Supersonic air freight was hailed as a major breakthrough in 1976, but proved uneconomical and no new commercial supersonic planes have been constructed since the 1970s.

9.2 Energy for industry: the era of oil and gas

Energy demand soared throughout the 1900s as electricity entered the scene, steam engines rose to prominence and disappeared, and personal appliances and automobiles became commonplace. Until 1950, most of this increase was mostly supplied by coal. The steel industry in particular, with its heavy use of coke and coal for smelting, contributed to the consumption of coal, but for much of this century, it was the only known fuel and the existing energy generation methods were geared toward its use.

9.2.1 Oil

OPEC, the Organization of Petroleum Exporting Countries, was formed in 1960 by Venezuela, Iran, Iraq, Kuwait, and Saudi Arabia. OPEC solidified its infrastructure and gain extensive control over the global price of oil over the next two decades. The 1973 oil embargo demonstrated the muscle of OPEC's Arab members (OAPEC), and sparked energy awareness globally. As oil prices spiked in the 1973 and 1979 oil crises, manufacturers became more energy conscious and government regulated energy usage. A Strategic Petroleum Reserve was established and gas rationing was considered while rules were implemented to allow only people with license plates ending in an odd number to purchase gasoline on odd numbered days and vice versa. The government instituted Corporate Average Fuel Economy (CAFÉ) standards in 1975. Larger cars declined significantly and average miles per gallon rose.

9.2.2 Natural gas

Natural gas was historically seen mostly as a nuisance. It was burned or "flared" off at the wellhead very frequently. Used in lighting until the end of the 19th century, it was replaced by electricity, only to emerge as a fuel for electricity generation after 1925 and is now a dominant industrial fuel. Easier to harvest and transport than coal, natural gas leapfrogged coal production in the mid-1950s and peaked in 1973. However, natural gas won market share from coal in the industrial sector and in the generation of electricity as it is more energy efficient, burns more cleanly, and can be piped continuously to its destination rather than having to be shipped in batches. This was especially true with the construction of all welded pipelines – the first one built in 1925 was over 200 miles long. Though more expensive per unit of input, natural gas became more attractive, with the added benefit of having fewer harmful emissions than coal and lower fixed costs for generation. U.S. natural gas production peaked in 1971 at 435 cubic feet per well every day, then began to decline as oil harvesting operations declined.

9.2.3 Nuclear power

Nuclear generation of electricity began in the 1950s and was predicted to make energy, "too cheap to meter." This did not happen due to the enormous cost of constructing plants and the largely unanticipated safety and regulation costs, particularly after the 1979 Three Mile Island accident. While nuclear power plant efficiencies have gone steadily

upward since the late fifties, the number of operable plants in the U.S. peaked in 1990 at 112, and has declined to approximately 100. Ordered capacity boomed in the 1970s, but by the early 1980s more than half of the planned generating capacity had been canceled or flat out shutdown due to design flaws. As the most expensive electricity generation method, nuclear power's share of the electricity market has seen slow erosion since then.

9.2.4 Hydroelectric power (the beginning)

The first hydroelectric power plant came into operation 1882 and, with the help of government mandates, hydroelectricity grew to supply 40% of the nations electricity in 1940. Capacity tripled over the next 40 years, although the share of total electricity fell as a percentage of total consumption.

9.3 The information age: new energy technologies

Industrial uses of energy declined sharply in the early 1980s and did not recover for approximately a decade. The decline in U.S. manufacturing especially cut the demand for natural gas Industrial energy has therefore become more expensive relative to past prices and other options. Energy intensive industries, such as steel production and other heavy manufacturing, moved to China and India.

In 2002, the US Government adopted a much more aggressive plan to reduce greenhouse gas emissions (18% by 2012) through public-private partnerships, direct funding, and international cooperation.

9.3.1 Wind power

US wind power generation saw a great deal of optimism during the late 80s and early 90s, especially in the State of California. The industry has recently been able to achieve costs per kilowatt hour less than or equal to new fossil fuel plants. Coupled with the Production Tax Credit, this has led to an explosion of United States wind power. Wind generation in the US grew more than 100% in the decade between 1990 and 2000, and grew by 2500 MW for a rate of 37% in 2005 alone, with another 3000 MW to be completed before the end of 2006. World generating capacity stands at 60,000 MW and is growing at approximately 28% per year. While currently only responsible for 1,260 MW of wind power per year, the Chinese government has been actively encouraging their domestic wind industry by requiring that wind farms use at least 70% of their components made by Chinese manufacturers. This, combined with a 2006 renewable energy law, has many large generation sites planned.

9.3.2 Hydroelectric power today

Hydroelectric power generation provides 10% of US generating capacity. However despite the vast number of available sites (there are almost 5,700 sites that could be

developed for hydroelectricity in the US compared to 2,200 currently developed), the generation capacity of those projects is small (it is estimated at only 30 GW, as compared to the 80 GW currently generated). Most of the sites which are optimal for producing hydroelectricity in areas which are considering such projects have already been developed, with a few notable exceptions. The Three Gorges Dam in China will become fully operational in 2009 and will be the largest hydroelectric dam in existence, five times the size of the Hoover dam. The Dam will generate 18.2 gigawatts (GW) and account for just over 3% of China's electricity needs. Construction on the Ilisu Dam in Turkey began August 2006 and is projected to provide 1.3 GW of electricity as part of the 21-dam Southeastern Anatolia Project of Turkey. Four and a half GW of generating capacity is currently completed for this project and the Ilisu dam will constitute most of the remainder.

9.3.3 Low-sulfur coal

Coal emits almost twice as much CO2 per kilowatt hour (KWH) as any other energy resource, and expensive cleanup systems that prevent the chemical byproducts of its combustion from reaching the atmosphere affect its economics significantly. However, due to cleaner coal from the Powder River Basin and easier harvesting methods developed in the past decades, coal has regained much of its lost ground from natural gas, catching up in 1985. Coal is still the industrial fuel of choice for developing economies, indeed most of the increase in coal use is expected to come from non-OECD countries. The U.S. is currently a net exporter of coal and its abundant supplies account for much of coal's comeback. In 2000 the price of coal was approx $0.80 per million BTU. According to estimates, the world has proven coal reserves enough to last anywhere between 155 to 300 more years.

9.3.4 Biomass

Biomass refers to any use of organic matter to produce energy and is considered a renewable resource. Today the main categories include ethanol and vegetable oils. They are typically considered as largely competing with gasoline and diesel to power vehicles. Of these, ethanol is by far the more economically viable source of fuel. Currently there are about five million vehicles in the US capable of running on E85, fuel comprised of 85% ethanol and 15% gasoline. Most of these have been manufactured to meet CAFE regulations and are currently in corporate fleets. These engines can run on pure gasoline and most often do, as few filling stations offer E85, which provides lower fuel economy as well. More common today is E15, which does not require any engine modification and only hurts fuel economy slightly. Corn ethanol is the most common form today, although cellulosic ethanol using feedstocks such as range grass and hydrid trees like poplars have the most potential. Cellulosic ethanol today however, would have a gasoline equivalent cost of approximately $2.95 per gallon.

9.3.5 Solar power

While solar power remains the source of much optimism, and the state of California has aggressive goals to increase solar power to almost 3,200 MW over the next 10 years (currently 155 MW) with $2.9B of funding, currently the predominant use of solar collectors is the heating of swimming pools. Few experts predict that photovoltaic generation will have a great deal of influence on energy costs in the foreseeable future.

9.3.6 Hydrogen power

Despite optimistic statements from automakers such as GM and predictions of the advent of a "Hydrogen Economy," the benefits likely to be realized from hydrogen technologies in the medium term are minimal. One of the main drawbacks of hydrogen is that it takes a great deal of energy to convert hydrogen to a fuel source, which is expensive and eliminates most of the environmental benefits of using hydrogen in the first place. Iceland, however, which generates virtually all of its electricity from geothermal heat and has abundant excess generating capacity, has plans to eliminate its oil dependency by manufacturing hydrogen fuel cells with this excess capacity and promoting hydrogen vehicles. In addition, some experts have hopes that hydrogen batteries can be used to store energy derived from solar or wind generation project to smooth out the cyclical or unpredictable nature of the energy sources.

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