The Effect of Rising Fuel Costs on Goods Movement Mode Choice and Infrastructure Needs




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This White Paper is one in a series developed as part of the Tampa Bay Regional Goods Movement Study. The purpose of this series of White Papers is to provide background and information for the freight community in the Tampa Bay Region.

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The freight industry is heavily dependent on energy to move the materials that drive the United States (US) economy. The U.S. employs four modes of transportation for freight movement: train, truck, plane, and ship. Of these four modes, each has its own advantages and disadvantages. Depending on geographic terrain, cost, distance, and time, a business must decide which mode is the most effective way to transport its goods. A large portion of cost comes from fuel prices, which play a major role in mode selection, but to what degree? At what fuel price does moving freight by train become more feasible than by truck? When does air transport become too expensive? As fuel costs remain high, with the potential to rise further, the freight industry must adapt to this change where practicable and where there are benefits to the bottom line. The purpose of this white paper is to determine how goods movement in the Tampa Bay Region will need to adjust to the rising costs of fuel.

THE COST OF FREIGHT IN RELATION TO THE COST OF FUEL

Fuel costs comprise a large portion of the total cost of moving freight. "Diesel price fluctuations, more than any other single factor, trigger the immediacy of motor carrier rate swings."[1] Fuel costs affect the price of each freight mode differently. Some modes are more energy intensive than others and have higher operating costs. The four mode performances are often compared by measuring their effectiveness at moving one ton for one mile (ton-mile). The proportion of the total cost to fuel cost varies from mode to mode. The total cost varies significantly, with air freight being more than four times the cost of trucking. Trucking freight is over 10 times as expensive as rail and over 35 times as expensive as waterborne shipping (**Table 1**).

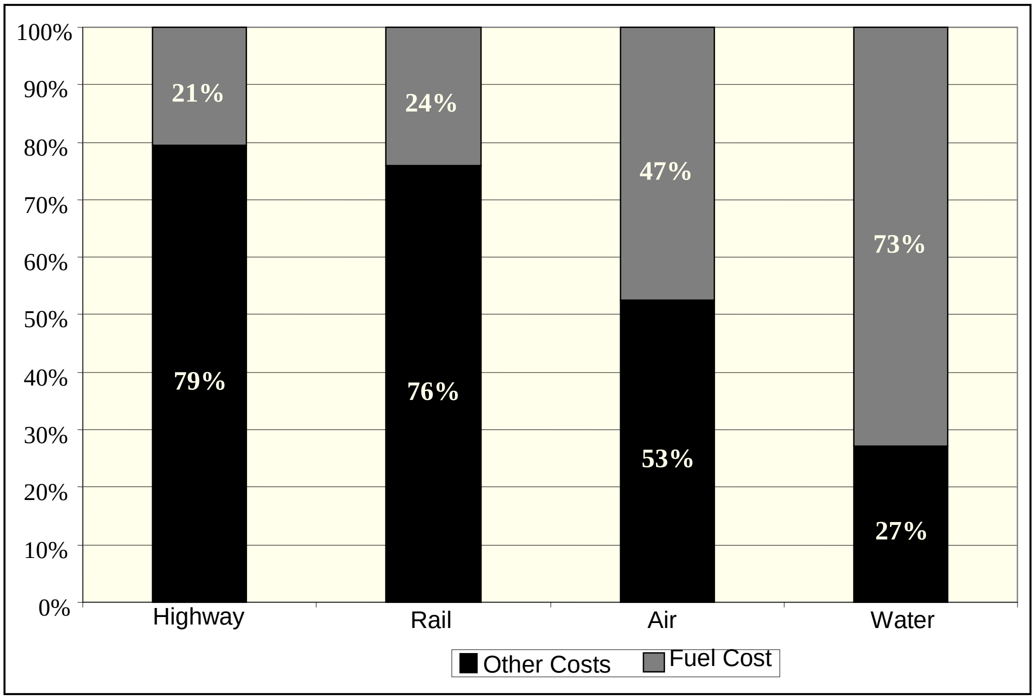
TABLE 1: 2008 US AVERAGE COST OF FREIGHT (CENTS) PER TON-MILE

	Fuel Cost[2]	Other Costs	Total Cost[3]
Air	63.23	70.00	133.23
Highway	8.70	33.68	42.38
Rail	0.89	2.81	3.70
Water	0.84	0.31	1.16

The majority of the total cost to transport goods by ship is fuel (73%). Only 21 percent of the total cost of trucking is determined by fuel costs (**Figure 1**). Based on these proportions, if fuel prices increase, air and water freight pricing will increase at a greater factor than the price of moving freight by truck and rail.

[1] Freight Analysis Framework, http://ops.fhwa.dot.gov/freight/freight analysis/faf/index.htm.
[2] Energy Information Administration & Btu to fuel type conversions.
[3] Bureau of Labor Statistics, Producer Price Index & FHWA 1990 Mode Prices.

FIGURE 1: PROPORTION OF FUEL TO TOTAL COSTS[4]



FUEL COSTS FOR EACH MODE: HOW ENERGY EFFICIENT ARE THEY?

The four freight modes have a large range of energy efficiency. Depending on the mode, the amount of energy expended to move one ton of freight one mile can vary between 360 to 29,000 British thermal units (BTUs[5]) (**Table 2**). In the ten years between 1994 and 2004, the national average fuel efficiency for air freight has improved significantly. Both trucking and rail have had modest gains in fuel efficiency. These improvements are due to improved technologies and logistical practices. However ship transport on average has become much less fuel efficient. This is a result of the industry's focus on increasing speed and decreasing transport time.

TABLE 2: US AVERAGE ENERGY USAGE OF FREIGHT MODES (BTU/TM)[6]

	Rail	Water	Highway	Air
1994	366	369	3,203	28,472
2004	325	511	3,163	21,976

[4] Energy Information Administration June 2008 Gulf Cost Prices, Bureau of Labor Statistics PPI, & Federal Highway Administration.
[5] BTU is used to describe the heat value and power of heating and energy systems.
[6] Energy Information Administration.

In general, the intensity of energy input per ton-mile changes depending on the speed of the mode. Those modes that are faster require more energy per mile than the slower modes. An airplane in 2004 for example used 68 times more fuel on average than a train to move one ton-mile (**Table 3**). Table 3 shows the relative amount of energy for each mode, indexed to the amount of energy used by rail, being set to one.

TABLE 3: STANDARDIZED US TON-MILE AVERAGE ENERGY USAGE OF FREIGHT MODES[7]				
	Rail	**Water**	**Highway**	**Air**
1994	1.0	1.0	8.8	77.8
2004	1.0	1.6	9.7	67.6
Speed	23 mph[8]	8 mph[9]	54 mph[10]	531 mph[11]

As previously shown in Table 1, the four freight modes do not all use the same type of fuel. These fuels have varying prices depending on the market (**Table 4**).

TABLE 4: GULF COAST ENERGY PRICES, JUNE 2008		
Fuel	**$/Gal[12]**	**Modes[13]**
Jet	3.88	Air
Diesel	3.82	Truck, Rail, & Ship
Residual	2.47	Ship

BTUs per ton-mile can be converted into the BTU equivalent of each mode's required fuel type (**Table 2**). This amount can then be applied to current fuel prices (**Table 4**) yielding today's estimated fuel cost per ton-mile (**Table 5**). With these values the relative cost of each mode can accurately be compared among the other three modes to determine which are most and least cost effective at utilizing energy. Based on this analysis, rail is the least expensive, water the second least expensive, trucking is approximately eight times as expensive as either, and air freight is seven times as expensive as trucking. As fuel prices rise, these multiples diverge even further and converge as fuel prices fall. Therefore, these multiples denote how competitive each mode is with the other three and how vulnerable each mode is to the fuel market.

[7] Railroad set as base year.
[8] Great Lakes Central Railroad, Class I Train
[9] http://www.globalsecurity.org.
[10] American Transportation Research Institute.
[11] Martinair, Boeing 767-300ER.
[12] Energy Information Administration.
[13] Energy Information Administration.

TABLE 5: COST OF FUEL 2008				
	Rail	Water	Highway	Air
Gal/TM[14]	0.0023	0.0034	0.0228	0.1631
Cents/TM[15]	0.89	0.84	8.70	63.23

Air freight is by far the most vulnerable to fuel spikes. Truck freight is the next most vulnerable mode. This mode's fuel costs have risen so dramatically in recent months that driver's strikes have sprung up in South Korea and France[16]. Recent rises in fuel prices have already spurred a shift in the freight industry.

RISING FUEL COST AND THE FUTURE OF FREIGHT IN FDOT DISTRICT 7

Time Cost Trade-off

Cost is only one factor in deciding which freight mode to use. As mentioned earlier, time and more specifically speed also plays a major factor in mode choice. Some modes carry time sensitive items such as food and agricultural products. Others carry less time sensitive items such as chemicals, minerals, and raw materials. Ultimately, the business manager must decide which mode to use to transport the materials a business needs to operate and deliver the products it produces. They must decide between speed and cost advantages and disadvantages and select the mode with the greatest benefit to their purpose. To illustrate this tradeoff in today's prices, **Table 6** compares the cost to move 20 tons of freight (equal to one full truckload) a distance of 1,000 miles to the approximate time it would take using the various other modes to travel this distance. The total dollars per ton-mile from **Table 1** were used along with travel speeds from **Table 3** for these calculations.

TABLE 6: COST AND TIME TO MOVE THE EQUIVALENT OF ONE TRUCKLOAD* 1000 MILES BY MODE				
Mode	$/TM	$/TM x 1000 mi	Cost to Move 1 Equivalent Truckload($)	Approximate Travel Time**
Water	0.012	12	240	5 days
Rail	0.037	37	740	2 days
Truck	0.42	420	8,400	1 day
Air	1.33	1330	26,600	2 hrs

*Assumes a truck carries 20 tons of cargo. ** Does not include pickup or delivery time

[14] Converted from 2004 Energy Intensity, Energy Information Administration.
[15] 2008 June U.S. Energy Information Administration Gulf Coast Price.
[16] China Post June 24, 2008.

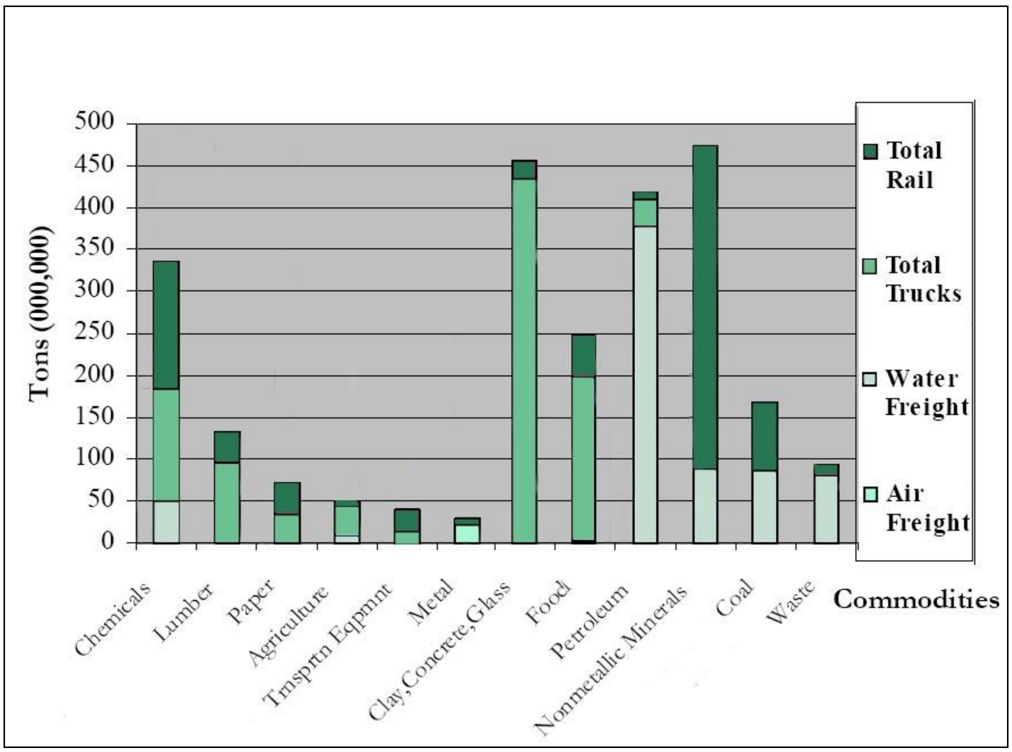
The table includes the cost of fuel along the gulf coast for each freight mode to move one ton-mile of freight in July 2008. Among the four modes, the cost to operate at higher speeds increases almost exponentially. Water and rail are among the slowest and cheapest. Truck is much faster and more expensive. Air freight is fastest, but far more expensive. This is the trade-off that a business manager must consider in deciding which mode to choose.

FDOT District 7 Context

Florida and the Tampa Bay Region

Time and fuel cost are not the only factors that determine which mode to use. A 2003 study conducted by the Center for Urban Transportation Research (CUTR), for the FDOT Rail Planning and Safety Division, attempted to capture the market preference of freight modes and identify opportunities for mode shift[17]. This study focused primarily on rail and truck. The results identified 12 of the top 20 commodities traded in Florida as having some capacity to change modes. These commodities are identified in **Figure 2** in order of greatest and least possibility for mode shift. Although this data is over ten years old and its geographic focus is the entire state, this data provides an idea of the existing mode split of freight within Florida Department of Transportation, District 7.

FIGURE 2: 1999 STATE OF FLORIDA COMMODITIES BY MODES[18]



[17] Center for Urban Transportation Research, April 2003.
[18] Reebie Associates, 2002.

There are several other factors involved in freight choice besides fuel cost. This section will attempt to identify which major commodities transported in District 7 are likely to shift independent of other freight factors if fuel prices continue to rise. Increases in fuel prices will change the structure of the fuel industry. To what degree it impacts District 7 is dependent on the commodity flow.

There is sparse available data on the modal freight usage within District 7. However, District 7 is home to the Port of Tampa, a major international trading gateway, and it can be assumed that a substantial portion of freight trips within District 7 either begin or end at the Port. The Tampa Port Authority maintains an annual log of freight tonnage for each commodity shipped through the Port (**Table 7**). These data can be used to speculate on the volume of freight that could shift depending on fuel prices.

TABLE 7: POTENTIAL MODE SHIFT TO RAIL FOR COMMODITIES SHIPPED THROUGHT THE PORT OF TAMPA (2007)

Commodity	Commodity Tonnage Shipped[1]	Truck Equivalent[2]	Rail Car Equivalent[3]	Primary Mode	Potential Mode Shift to Rail
Petroleum Products	19,473,191	649,106	209,389	Truck	No
Phosphate Rock/Chemical	8,414,762	280,492	74,964	Rail	No
Coal	4,658,932	155,298	41,505	Rail	Yes
Sulphur, Liquid	3,265,999	108,867	35,118	Truck	Yes
Other Dry Bulk Commodities	2,303,927	76,798	20,525	Truck	Yes
Ammonia, Anhydrous	1,807,937	90,397	19,440	Pipe	No
Limestone	1,778,039	59,268	15,840	Truck	Yes
Cement, Bulk	969,813	32,327	8,640	Truck	No
Granite Rock, Bulk	604,411	20,147	5,385	Rail	Yes
Scrap Metal	577,100	19,237	5,470	Truck	Yes
Steel Products	338,099	11,270	3,205	Truck	Yes
Citrus Pellets	330,746	16,537	2,947	Rail	No
Containerized	297,457	42,494	3,510	Truck	No
Other Liquid Bulk Commodities	134,766	6,738	1,449	Rail	No
Sulphuric Acid	108,229	5,411	1,164	Rail	No
General Cargo	84,327	4,216	796	Truck	Yes
Citrus Concentrate, Bulk	64,827	2,161	697	Rail	No
Vehicles *(in tons)*	61,255	3,063	1,094	Truck	No
Reefer Cargo	16,564	828	156	Truck	No
Forest Products	3,124	156	28	Truck	Yes
Total Trucks or Railcars		**1,584,811**	**451,322**		

[1] FY 2007. Includes both Tampa Port Authority and private port shippers.
[2] Assumes each truck can transport 30 tons of bulk or 20 tons of other commodities. Note: Truck weight limited by highway weight limits.
[3] Rail car capacity varies depending on car type. Max capacity used for calculation of railcar equivalent. Source of Car Type and capacity, *Guide To Railcars*

As noted in **Table 7**, several commodities can be identified that may have a high enough potential for mode shift due to higher fuel prices. These Commodities include: Phosphatic Chemical Bulk, Granite, Scrap Metal, Other Dry Bulk, and Coal. Assuming fuel prices continue to rise and the appropriate alternative modal facilities are in place, between destinations in the supply-chain, and sufficient capacity exists, there could be a shift of several million tons of freight off of District 7 trucking routes. The vast majority of tons of freight that enter the port are from petroleum. It should be noted the CUTR study identified petroleum as a small potential for freight shift because it is transported to Tampa by tanker barge and distributed to gas stations throughout southwest Florida by truck.

As the price of fuel continues to rise, air cargo has become less and less feasible as a means of shipping for businesses. “In the United States, ground transport is now competitive with airfreight up to 1,000 miles. Shippers are increasingly optimizing supply chains to rely on cheaper ground and ocean shipments supplemented by occasional air express shipments.”[19] Only those goods that are extremely time sensitive will continue to be shipped by air. Others will be diverted to truck, rail, and water transport depending on time sensitivity.

Trucks will continue to have a major role in the freight industry as all other modes are often dependent on trucks to complete the first and last mile from their origin and to their destination. Trucking will also absorb the majority of commodities shifted from air. Rail will continue to receive a larger share of the commodities previously shipped by truck. As roads and rails become congested, short-sea shipping may become more feasible for domestic trips than in the past. Rising fuel costs will create new demand on rail, roads, and ports.

Capacity and Competition with Passenger Travel

Fuel cost is just one part of the cost of freight transportation. Congestion also increases costs. If prices continue to rise and rail becomes a more attractive shipping mode there will be a greater demand put on rail lines. Demand will also grow for passenger trains. In District 7, the Tampa Bay Area Regional Transportation Authority (TBARTA) is already considering various options to use existing freight rail lines to run passenger transit between regional activity centers.

Increased freight rail usage shifted from highways will create strong competition for rail facilities that could be detrimental to the freight industry. “The Class I railroads experienced several well-publicized service ‘meltdowns’ recently because of unexpected increases in the demand for freight movement by rail. This creates problems for shippers and short lines waiting for pickups and equipment to be returned. The situation has improved, but this illustrates the lack of capacity in the network.”[20] If rails become too congested and capacity improvements are not feasible, domestic freight shipments could shift to short-sea shipping along the coast and inter-coastal waterway system. “Having 1,300 miles of coastline, Florida has available to it an untapped alternative transportation resource that could be utilized to mitigate ever growing landside congestion and transportation inefficiencies.”[21]

[19] Mercer Management Consulting whitepaper 2006.
[20] 2004 FL Freight Rail Component-FDOT.
[21] FDOT Seaport, 2003.

Fuel Price Impacts on Global Market and Meaning for District 7

The global economy has become increasingly connected. For this reason, it is important to consider the potential impacts that rising fuel prices will have on the global market. These impacts may directly affect freight traffic in District 7. As fuel prices increase and transport costs rise, many manufacturers will reconsider the locations of production facilities to sites closer to markets. Cheap and efficient transport systems drive globalization. The new relationships between transportation and energy will restructure the global production and distribution system, placing greater emphasis on locational efficiencies within the transport supply chain.

The current manufacturing trend in the automobile manufacturing industry is to locate assembly facilities in Mexico. This trend will likely spread and other manufactures serving the US market may locate new facilities in North America and South America as the cost of shipping to and from China becomes less competitive. In June 2008, "shipping a standard 40-foot steel container from Shanghai to the US eastern seaboard costs over $8,000. Just eight years ago, when oil prices were around $20 per barrel, it cost only $3,000 to ship the same container. If oil were to soar to $200 per barrel, it could soon cost nearly $15,000."[22]

Another global change with potential to impact the freight industry that may occur as a result of rising fuel prices is the increased value of the euro in relation to the dollar. Oil is traded in dollars and as the price per barrel increases the buying power of euro increases and the dollar decreases. This decline in the dollar in relation to the euro could make the US high tech manufacturing market more competitive than the "East Asian Tigers" such as China, Korea, and Japan.[23] Recently, the US has gone from a trade deficit to a trade surplus with its Free Trade Agreement (FTA) partner nations. "In the first five months of 2008, the trade imbalance in manufactured goods rose to a $2.7 billion surplus with our FTA partners from a $12.3 billion deficit during the same period last year."[24]

The Panama Canal Expansion is expected to be completed in 2015. The expansion will be a global event that will have a major impact on the freight industry in District 7. With higher fuel prices, the canal route will be very competitive compared to multimodal shipping through major west coast ports, for trips between Chinese ports and the US East Coast. The Panama Canal Authority and the Port of Tampa recently renewed a strategic alliance agreement.[25] The result could be a significant increase in containerized cargo through the Port of Tampa.

Other major events that could potentially occur near Florida coasts that would have an impact on freight movement in District 7 are increased trade with nearby Cuba and off-shore oil drilling. With economic pressure to find other sources of energy, off-shore drilling in Florida is becoming a more viable possibility. However, the issue of off-shore drilling ebbs and flows with the political climate in the State. As such, it is unknown at this time how off-shore oil drilling could impact District 7 freight movement. With the resignation of Fidel Castro, and the leadership of his brother, there has been some improvement in relations with Cuba. If those relations continue to become normalized, there could be an enormous increase in trade with Cuba.

[22] The Edge of Singapore, June 2, 2008.
[23] US International Trade Administration, July 31, 2008.
[24] US International Trade Administration, July 17, 2008.
[25] Panama Canal Authority July 14, 2008.