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Foreign Oil Dependence: State-Level Analysis

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This paper discusses the dependence of New York State on foreign sources of petroleum products. The paper defines dependence to include direct product imports and imported crude oil that is domestically refined into such products. By use of a generalized allocation procedure that is applicable to all states, the original foreign sources of petroleum products are traced back from major East Coast and Gulf Coast refineries to the particular countries that supplied the imported crude oil. Known imports of refined products are then added to these estimates to obtain estimates of total dependence. Four products are studied: residual oil, distillate, gasoline, and jet fuel. Results show that, overall in 1976, New York is 72 percent dependent on foreign oil, compared with 43 percent for the United States. For residual oil, New York is 96 percent foreign dependent; major suppliers are Caribbean and South American countries, particularly Venezuela, Virgin Islands, and the Netherlands Antilles. For distillate, gasoline, and jet fuel, New York is between 54 and 58 percent dependent on foreign sources; supplies come mainly from African and Middle Eastern countries, particularly Nigeria, Algeria, and Saudi Arabia. The United States' dependence pattern is similar but less severe and broader in base. Although New York, like many states, gets its oil from many countries, it relies primarily on a relatively small number of suppliers for most of its petroleum products, making it particularly vulnerable to supply curtailments. A number of actions are suggested to broaden New York's base of sources, to cut foreign dependence, and to reduce petroleum use.

The technology and lifestyle of America has been predicated on the availability of cheap, unlimited energy, particularly petroleum. In its various forms, petroleum powers our automobiles and airplanes, heats many of our homes, runs our factories, and generates our electricity. Its presence pervades our society. Recent shortages, however, have demonstrated the finiteness of this resource, its uncertain availability, and its volatile price. The overall problem may vary widely in individual states. New York has no indigenous petroleum supplies and gets all of its petroleum from other states and foreign countries. Refined petroleum products come to New York primarily from three sources (see Figure 1):

Flow	Description
A	Direct from foreign refineries
B	Direct from petroleum administration for defense district (PAD) 1 (U.S. East Coast) refineries
C	Direct from PAD 3 (U.S. Gulf Coast) refineries

Figures for 1975 (New York State energy plan) show that 40 percent of New York's refined petroleum products came from foreign sources (A), and that the remainder came from U.S. refineries (B and C).

However, the entire picture is not so simple, since crude oil flows must also be taken into account. For instance, crude (unrefined) oil is often imported to Gulf Coast (flow D) and to East Coast (flow E) refineries from foreign countries and then is refined into petroleum products and sent to New York. Domestic crude from PAD 3 is also sent to PAD 1, refined there, and sent to New York (flow F). [This assumes that no refined product arrives in New York from PAD 2, which understates by about 1 percent New York's domestic dependence (1).] Thus, the degree of total dependence of New York on foreign sources is likely to be much greater than 40 percent. Since not all countries or states produce all refined products, New York's foreign dependence for certain products (e.g., residual oil) may be greater than for others (e.g., gasoline). Detailed breakdowns by country can show exactly which nations or states New York depends on for what products.

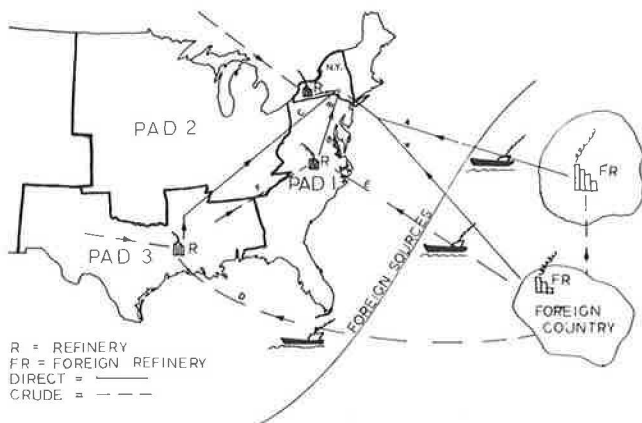
This paper estimates and describes New York's dependence on both domestic and foreign sources for refined petroleum products. The following key questions are addressed:

1. To what extent is New York more or less dependent on foreign petroleum than is the United States?
2. On what countries and states is New York most dependent and for what petroleum products?
3. How is New York's profile of dependence different from that of the United States?
4. What are the implications of such dependence on New York's energy policies?

METHOD

The procedure for estimating New York's oil dependence is described in detail elsewhere (1). Basically, the total volume of petroleum products refined in the United States (e.g., gasoline refined in PAD 1) are allocated

Figure 1. Schematic of petroleum products flow.



backward to country or state of origin, based on the shares that those countries or states have of imported crude oil to the refining site. Then these amounts are added to the refined product from these countries sent directly to New York. [Readers interested in applying the method are urged to contact the authors.]

Following the schematic (Figure 1) and letting RP be a refined product (e.g., gasoline) we have

$$\begin{aligned} &\text{Dependence of New York on Texas} \\ &= \text{total RP directly imported from Texas} \quad (\text{Flow C}) \\ &\quad - \sum \text{indirect sources via Texas} \quad (\text{Flow D}) \\ &\quad + \text{Texas' RP to New York via PAD 1} \quad (\text{Flow F}) \end{aligned}$$

The equation is also applied for Louisiana data.

$$\begin{aligned} &\text{Dependence of New York on foreign source} \\ &= \text{amount RP directly imported from foreign} \\ &\quad \text{source} \quad (\text{Flow A}) \\ &\quad + \text{amount RP indirectly imported via Texas} \\ &\quad \quad \text{and Louisiana} \quad (\text{Flow D}) \\ &\quad - \text{amount RP indirectly imported via} \\ &\quad \quad \text{PAD 1} \quad (\text{Flow E}) \end{aligned}$$

The New York State Energy Office (2) feels that the above procedure tends to overstate foreign dependence by (a) ignoring U.S. oil from PAD 2 and other lesser (but considerable) U.S. sources (e.g., Alaska) and (b) by assuming that the only PAD 3 refining states are Texas and Louisiana. These assumptions were made to speed the analysis and are not likely to influence the overall conclusions of this report.

RESULTS

Data from the New York State Energy Office showing New York's 1976 energy use by fuel source and demand sector are shown in Table 1. Petroleum is a central component of New York State energy, accounting for more than 65 percent of consumption. In contrast, the U.S. (3) relies on petroleum for 47 percent of its consumption; the difference is taken up by heavier reliance on coal and natural gas. As may be observed, different refined products are important for different sectors. Residual oil, for instance, is primarily used in electric-power generation and residential and commercial, but distillate fuel is used almost entirely within the residential and commercial sector, primarily as home heating oil. Gasoline and jet fuel are used exclusively for transportation. These figures imply that foreign

dependence on petroleum products must be considered against the ways that products are used.

The results of this analysis are summarized in Table 2. Most refined products reach New York from the U.S. Gulf Coast (PAD 3) and East Coast (PAD 1) refineries; only a small amount is shipped directly from foreign sources. However, adjustment for the source of crude oil (direct and indirect in Table 2) shows a decrease in the significance of the U.S. Gulf Coast states, and increases in foreign sources. PAD 1 is eliminated as an ultimate source because it produces no crude oil itself. On this adjusted basis, New York appears to be 72.1 percent dependent on foreign oil and the United States, 42.8 percent dependent.

For all products combined (total column in Table 2) New York shows greater dependence than the United States on all sources except Asia and North America. Specific countries important to New York and the United States are shown in Table 3. New York's profile of sources shows greater concentration in fewer major sources than the United States. New York is more dependent than the United States on oil from Venezuela, Saudi Arabia, Nigeria, Virgin Islands, Netherlands Antilles, Algeria, Bahamas, and Iran and less dependent on Canada, Indonesia, and Libya.

Residual Oil

Residual oil is a relatively heavy multipurpose product used primarily for generation of electricity, space heating, and industrial-process heat. It is the single largest fuel source to New York's economy and accounts for 25 percent of New York's energy consumption. New York is 96.1 percent dependent on foreign sources for residual oil; the United States is 71.0 percent dependent. Table 2 shows that Texas and Louisiana account for approximately 42 percent of distillate, gasoline, and jet fuel consumed in New York, but only 3.9 percent of New York's residual supply comes from these domestic sources.

New York receives 35.4 percent of its residual oil from the Caribbean. This is by far the Caribbean's major contribution as far as petroleum product source is concerned. The same holds true for the U.S. source, where the Caribbean accounts for 21.5 percent of the total. Thus, the Caribbean is a major source of residual oil for both the United States and New York. All of the residual oil that comes to the United States (and New York) from the Caribbean is imported directly [i.e., no crude was shipped from the Caribbean to the United States (Table 2)]. The specific major sources of residual oil are shown in Table 4. New York generally relies on the same nations as does the United States, but its dependence is more concentrated than is that of the United States. Thus, from New York's view, the residual oil source problem is essentially an international one.

Distillate

Distillate oils, a group of relatively light refined products, are used for residential and commercial space heating, industry, and transportation (as diesel fuel). They account for 16.9 percent of New York's total energy consumption.

Domestic production accounts for a greater percentage of both New York's and the United States' supplies for distillate oils. Table 2 shows that only 9.8 percent of New York's distillate arrives in the United States in refined form, but that another 48 percent comes here in crude form. Overall, considering direct and indirect sources, 57.8 percent of New York's supply of distillate and 41.5 percent of the United States' supply is ac-

Table 1. 1976 New York State energy use by source and sector.

Energy Source	New York State					Percent	United States	
	Electric Utility (PJ)	Residential and Commercial (PJ)	Industrial (PJ)	Transportation (PJ)	Total (PJ)		Total (PJ)	Percent
Hydro	321.4				321.4	7.5	3 233	4.1
Nuclear	175.9				175.9	4.0	2 144	2.7
Petrol								
Residual	562.8	363.9	59.5	60.6	1 046.8	65.4	36 860	47.3
Distillate	31.9	583.2	25.9	67.2	708.2			
Gasoline				817.4	817.4			
Jet fuel				181.4	181.4			
Kerosene		35.9	5.2		41.1			
LPG		15.4	5.8	1.5	22.7			
Coal	151.2	5.3	198.2		354.7	8.2	14 505	18.6
Natural gas	5.7	510.3	124.9		640.9	14.9	21 328	27.3
Total	1 253.0	1 514.0	419.6	1 128.1	4 310.5			
Electric	-1 113.6	690.2	296.4	27.0				
Total	135.1	2 204.3	815.9	1 155.1	4 310.5	100.0	78 069	100.0

Note: 1 PJ = 947.8 billion Btu.

Table 2. Sources of New York State petroleum—summary for 1976.

Source	Residual (%)			Distillate (%)			Gasoline (%)			Jet Fuel (%)			Total (%)		
	New York			New York			New York			New York			New York		
	Direct Only ^a	Direct and Indirect ^b	U.S. Total ^b	Direct Only	Direct and Indirect	U.S. Total	Direct Only	Direct and Indirect	U.S. Total	Direct Only	Direct and Indirect	U.S. Total	Direct Only	Direct and Indirect	U.S. Total
United States															
PAD 3	8.1	3.9		61.9	42.2		67.0	42.3		75.5	45.9		43.9	27.9	
PAD 1	11.0	-		28.3	-		31.1	-		14.7	-		20.9	-	
Total	19.1	3.9	28.3	90.2	42.2	58.5	98.1	42.3	63.7	90.2	45.9	55.8	64.8	27.9	56.7
North America	1.5	1.9	3.7	-	1.3	3.2	-	1.5	3.1	0.7	1.8	3.4	0.6	1.6	3.2
Central America-Caribbean	35.3	35.4	21.5	8.2	6.0	3.5	4.3	4.5	1.6	6.9	6.9	3.5	17.3	17.1	6.5
South America	34.2	35.7	23.9	1.4	5.8	3.5	0.3	5.4	2.8	3.6	7.0	4.4	13.7	17.1	7.4
Europe and Soviet Union	6.0	6.1	3.8	-	0.3	0.3	0.1	0.4	0.4	-	0.2	0.4	2.3	2.1	1.1
Middle East	1.1	5.6	6.9	0.2	17.7	13.1	-	20.2	12.1	-	14.5	13.0	0.5	14.0	10.3
Asia	-	0.4	2.1	-	1.3	3.9	-	1.5	3.6	-	1.1	5.1	-	1.0	3.1
Africa	2.3	9.4	9.1	-	20.2	13.8	-	23.4	12.7	-	17.0	13.5	0.8	16.8	11.2
Other	0.5	1.6	0.7	-	3.2	0.2	-	0.8	0	-	5.6	-	-	2.4	-
Total foreign	80.9	96.1	71.7	9.8	57.8	41.5	4.7	57.7	36.3	11.2	54.1	43.3	35.2	72.1	42.8
Total accounted for	100.0	100.0	100.0	100.0	100.0	100.0	102.8 ^c	100.0	100.0	101.4 ^c	100.0	100.0	100.0	100.0	100.0
Organization of Petroleum Exporting Countries (OPEC)		40.7	33.5		42.2	32.2		47.8	29.5		34.3	31.6		42.9	29.0

Notes: Total residual energy = 1 046.7 PJ (992.2 trillion Btu); total distillate energy = 708 PJ (671.3 trillion Btu); total gasoline energy = 817.4 PJ (774.8 trillion Btu); total jet fuel energy = 181.4 PJ (172 trillion Btu); Total energy = 2 753.9 PJ (2 610.3 trillion Btu).

^aShipment of refined products.^bTrue dependence.^cSome of New York's supply is shipped to PAD 1.

counted for by foreign sources. Africa and the Middle East are the major foreign sources of distillate, supplying 20.2 percent and 17.7 percent of New York's total, and 13.9 percent and 13.1 percent of the U.S. total; virtually all of this oil arrives indirectly (i.e., it is shipped to the United States in crude form). Major countries that provide New York and the United States with distillate are shown in Table 5.

Middle East and African dependence dominates both profiles, but, as with residual oil, New York's dependence is concentrated in fewer nations. New York depends more on Saudi Arabia, Nigeria, the Virgin Islands, Algeria, Venezuela, and Iran than does the United States and less on Indonesia, Libya, and Canada.

Gasoline

Gasoline is used exclusively for transportation purposes. It accounts for 19.5 percent of New York's energy consumption. Considering both direct and indirect sources, foreign sources of gasoline account for 57.7 percent of New York's supply and 36.3 percent of the U.S. supply. Both the Middle East and Africa supply a greater percentage of gasoline than they do distillate to New York—20.2 and 23.4 percent, respectively; however, all of

this comes to the United States in crude form. OPEC nations provide New York with 47.8 percent of its gasoline (5.5 percent more than do domestic sources); OPEC provides the country as a whole with 29.5 percent of its gasoline. This is the largest difference for a refined product between OPEC oil supplied to New York and that supplied to the United States. Primary sources of New York and U.S. gasoline are shown in Table 6.

Saudi Arabia, Nigeria, and Algeria head both profiles, and New York's dependence is more heavily concentrated. Beyond that, New York depends more on Venezuela, Iran, and the Virgin Islands than does the United States and less on Canada and Indonesia.

Jet Fuel

Jet fuel is used exclusively in air transportation and accounts for 4.3 percent of New York's energy consumption. Only 9.8 percent of jet fuel is imported directly (in refined state); but an additional 44.3 percent is imported in crude form. Thus, foreign production accounts for 54.1 percent of the jet fuel consumed in New York. In contrast, foreign production accounts for 43.3 percent of U.S. consumption.

Again, the Middle East and Africa are the largest

Table 3. Overall petroleum dependence—major sources.

New York State		United States	
Source	Percent	Source	Percent
United States		United States	56.7
Texas	18.1	Saudi Arabia	6.9
Louisiana	9.8	Nigeria	5.7
Total	27.9	Venezuela	4.7
Venezuela	12.4	Indonesia	3.2
Saudi Arabia	9.7	Virgin Islands	3.0
Nigeria	9.1	Canada	2.7
Virgin Islands	8.2	Libya	2.6
Netherlands Antilles	5.6	Algeria	2.5
Algeria	4.2	Netherlands Antilles	2.0
Trinidad	4.1	Trinidad	1.8
Libya	2.4	Iran	1.7
Bahamas	2.3		
Iran	2.2		

Table 4. Major sources of residual oil.

New York State		United States	
Source	Percent	Source	Percent
United States	3.9	United States	28.3
Venezuela	26.4	Venezuela	16.1
Virgin Islands	14.7	Virgin Islands	8.9
Netherlands Antilles	13.8	Netherlands Antilles	8.4
Saudi Arabia	4.0	Trinidad	5.2
Nigeria	4.0	Saudi Arabia	4.5
Algeria	2.7	Nigeria	4.1
		Bahamas	3.6
		Algeria	2.2
		Libya	2.0
		Indonesia	2.0

Table 5. Major sources of distillate.

New York State		United States	
Source	Percent	Source	Percent
United States		United States	58.2
Texas	28.6	Saudi Arabia	8.5
Louisiana	13.6	Nigeria	7.1
Total	42.2	Indonesia	3.8
Saudi Arabia	12.6	Libya	3.1
Nigeria	11.4	Algeria	2.8
Virgin Islands	5.9	Virgin Islands	2.7
Algeria	4.9	Canada	2.6
Venezuela	4.2	Iran	2.1
Iran	2.8	Venezuela	2.1
Libya	2.8	United Arab Emirates	1.8

exporters. The Middle East accounts for 14.5 percent of New York's total and 13.0 percent of the United States' total, all in the form of crude oil. Africa accounts for 17.0 percent of New York's total and 13.5 percent of the United States' total. Not surprisingly, Saudi Arabia and Nigeria are the countries with the largest amount of exports to both the United States and New York. Saudi Arabia provides 10.3 percent of New York's total and 8.4 percent of the United States' total. Nigeria provides 10.2 percent of New York's total and 7.0 percent of the United States' total. Other important suppliers are shown in Table 7. New York depends more on Trinidad, Algeria, Netherlands Antilles, and Virgin Islands and less on Indonesia, Libya, Canada, and United Arab Emirates than does the United States.

SUMMARY AND POLICY ACTIONS

The above analysis shows the following key findings:

1. New York's dependence on foreign oil is much greater than that of the United States: 72 percent versus 43 percent in 1976. Of this foreign petroleum, however, 35 percent is directly imported, and another 37 percent is imported in crude form and refined in the United States.

Table 6. Major sources of gasoline.

New York State		United States	
Source	Percent	Source	Percent
United States		United States	63.7
Texas	26.2	Saudi Arabia	7.9
Louisiana	16.1	Nigeria	6.6
Total	42.2	Indonesia	3.5
Saudi Arabia	14.5	Libya	2.9
Nigeria	13.3	Algeria	2.6
Algeria	5.5	Canada	2.5
Venezuela	3.8	Iran	1.9
Libya	3.3	United Arab Emirates	1.7
Iran	3.2	Venezuela	1.6
Virgin Islands	3.0		
United Arab Emirates	2.0		

Table 7. Major sources of jet fuel.

New York State		United States	
Source	Percent	Source	Percent
United States		United States	55.8
Texas	22.8	Saudi Arabia	8.4
Louisiana	23.1	Nigeria	7.0
Total	45.9	Indonesia	3.7
Saudi Arabia	10.3	Libya	3.1
Nigeria	10.2	Algeria	2.8
Trinidad	4.3	Canada	2.8
Algeria	3.6	Iran	2.1
Netherlands Antilles	3.4	Venezuela	1.9
Virgin Islands	2.7	Netherlands Antilles	1.8
Venezuela	2.4	United Arab Emirates	1.8
Libya	2.4		
Iran	1.9		

2. This dependence varies by petroleum product. For residual oil, New York is 96.1 percent foreign dependent; for other products (distillate, gasoline, and jet fuel), New York is between 57.8 and 54.1 percent dependent.

3. For residual oil, New York depends heavily on the Caribbean and South American countries. For distillate, gasoline, and jet fuel, New York depends first on Texas and Louisiana, next on Middle Eastern and African countries.

4. For residual oil, both the United States and New York are dependent on three major sources (Venezuela, Virgin Islands, and Netherlands Antilles). For distillate, gasoline, and jet fuel, both the United States and New York are dependent on three major sources (Saudi Arabia, Nigeria, and Algeria). The United States also relies on Canada and Indonesia, but New York has few imports from these nations.

5. New York's pattern of dependence is generally similar to that of the United States; however, it is also different in the following ways: (a) dependence is concentrated in fewer sources rather than spread among many sources and (b) it is generally more dependent than the United States on Venezuela, Virgin Islands, Netherlands Antilles, Saudi Arabia, Nigeria, Algeria, and Trinidad and less dependent on Canada and Indonesia.

Overall, New York appears to be in a significantly tighter position than the United States generally with respect to petroleum dependence. Its dependence on all products is higher, and its pattern of dependence, although similar to that of the United States, is generally more concentrated.

New York appears particularly vulnerable with respect to residual and gasoline because of (a) the extremely high foreign dependence of residual, (b) the large spread (18.3 percent) between New York's and the United States' gasoline dependence, and (c) its exclusive use in the transportation sector.

Such a finding has profound implications, for it reflects the sensitivity of New York's transportation energy supply to an embargo. It would necessarily mean that New York would be affected to a greater degree than would the rest of the country in the event of such an embargo. Such an embargo would also affect New York's supplies of other refined products greater in relation to the rest of the country, but the greatest rift would be in gasoline supplies.

It would be easy to say that New York should cut down on its imports from OPEC nations, but the situation is not so simple. Most petroleum products from OPEC nations arrive in New York indirectly (i.e., they are refined in Texas, Louisiana, or PAD 1 refineries). Thus, as far as the state's policy goes, it would have to rely on these refineries to import less OPEC crude. Such a move implies that the crude oil would have to come from different sources, unless, of course, conservation efforts permit an absolute drop in foreign oil imports.

Based on the above, we suggest the following policies for consideration as ways by which New York State can cut its overly high foreign-oil dependence.

Foreign oil supplies could be shifted from one source to another; however, total foreign dependence cannot be reduced unless (a) the U.S. demand for petroleum is reduced through conservation and (b) present U.S. reserves are used and expanded to a greater extent. Generally, supply policies are outside the realm of any one state to influence significantly, but each state can take unilateral or joint actions to reduce demand.

1. Concentrate energy-conservation actions in the residential-commercial and transportation sectors. These two sectors use the greatest percentage of residual oil and use all gasoline, the two most vulnerable products. Conservation efforts in New York's industrial sector, although important, would impact primarily coal and natural gas use, and may slow the state's economic recovery. Such actions would be most effective if coordinated among states, since present federal policies (e.g., allocation plans) unfairly burden states that are already relatively energy efficient, such as New York.

2. Substitute flexible-source fuels for inflexible-source fuels where possible, to reduce pressure on less flexible sectors, such as transportation. Encourage national actions to achieve these ends. Examples of such conversions would be residual oil to coal or additional small hydro plants for the generation to electricity and substitution of renewable fuels, such as wood or plant-based alcohols, where feasible. Coal gasification or liquefaction, although expensive and in an infant industry state, could also provide significant amounts of liquid or gaseous fuels in the intermediate future.

3. Encourage the conversion of existing residential and commercial structures to non-oil-based heat and

the construction of new structures with attendant heat sources. Such a move would accelerate the introduction of these new energy sources into New York's economy.

4. Encourage consumers, through incentives, to purchase automobiles that meet the energy-conservation standards of the federal government. If the efficiency of New York's motor vehicle fleet reaches 11.7 km/L (27.5 miles/gal) average by 1990, about 18 percent of the gasoline could be saved (4). This is the single most effective action to conserve gasoline that New Yorkers can take.

5. Support actions to increase aircraft load factors, thereby reducing the jet fuel required to serve a given number of air passenger kilometers. Jet fuel use is a small percentage of the present energy use, but its use is increasing rapidly and its use should be conserved.

Generally, New York is limited to acting in concert with other similarly positioned states and the United States in influencing energy supplies. Such actions are intended to reduce the overall energy dependence of New York on foreign countries and to make maximum use of its own resources. Such actions alone cannot solve the energy crisis or make it energy independent: Only by acting with other states, by maximizing use of new technology, and by reducing demand can progress be made toward these goals. Although we cannot yet control our energy future, we can influence it in certain ways. The thrust of this paper is that such actions as we can take are wisely viewed against New York's unique energy supply picture.

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