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Can the Intercity Transportation System Accommodate the Demand During an Energy Shortage?

Gibson W. Fairman

What is an energy shortage? In this paper, it is defined as a short-term emergency interruption of the supply of transportation fuel similar to that created during the 1973-1974 oil embargo by OPEC. Such a short-term shortage is characterized by its suddenness, its severity (percentage of supplies cut off), the curtailment of normal travel, and the likelihood of government intervention (fuel allocation, rationing, etc.), as well as its adverse long-term economic and social impacts.

Individual efforts by private citizens and government-initiated programs to reduce travel would be aimed primarily at the automobile and light-truck user. Together, they account for more than 88 percent of the total person miles of travel in the United States and consume about 63 percent of all petroleum used for transportation, or nearly 33 percent of all petroleum consumed in the United States. (All data in this report are for 1977.) The other forms of passenger transportation consume an additional 6.3 percent of the petroleum used for transportation. Freight movement by truck, rail, water, pipeline, and air accounts for the remaining 3 percent of transportation fuel use. Transportation used 53.7 percent of the total U.S. petroleum consumed (1-3).

Petroleum accounts for approximately 49 percent of the total U.S. energy resource. Nearly 48 percent of the petroleum consumed in the United States is imported. A sudden one-third reduction in oil imports could mean a 16 percent reduction in fuel available for transportation. Similarly, a two-thirds cutoff of imported oil could result in a 32 percent reduction. These percentages are based on the assumption that available oil would be distributed in proportion to past consumption patterns. Undoubtedly, reallocation would deviate from past trends but to what extent is beyond the scope of this paper.

Aside from the uncertainties of emergency shortages, we are also faced with the long-term problem of diminishing world oil supplies. Responses to the long-term problem call for different and more deliberate actions than those we would take in an emergency. Nevertheless, consideration of the long-range implications should be a factor in evaluating potential short-range solutions.

Before attempting to determine the amount of excess capacity that may exist in the public intercity modes, it would be useful to summarize the basic assumptions of this paper. All data are for 1977. Intercity trips by automobile and truck are defined as one-way trips of 100 miles or more and 50 miles or more. Automobile and light-truck travel data are taken from the 1977 U.S. Census of Transportation for one-way trips of more than 100 miles. A light truck is a pickup or van. Additional automobile and truck travel to account for trips of 50 miles or more was determined from output from the California Statewide Travel Model (trip-length frequency distribution). Reductions in available fuel are applied across the board, except for total decreases in intercity travel that are applied to automobile and truck travel only—i.e., the modal shift is from automobile and truck to the three public modes (bus, rail, and air). No change in existing (1977) oil distribution patterns is assumed as a result of reductions, except as noted above. Automobile and truck occupancy for total travel is 2.2

persons/vehicle, while occupancy for intercity travel is 2.4 persons/vehicle. A barrel is considered equivalent to 42 U.S. gallons. The table below on 1977 imports of petroleum used for transportation (2,3) and Table 1 are based on reconciling fuel consumption (gallons) with amount of travel (person miles):

Factor	Gallons (000 000s)
Total U.S. consumption	282 550
Imports	135 002
One-third of imports	45 001
Transportation use	151 729
One-third of imports for transportation	24 169

The petroleum use data indicate 151.729 billion gal for all transportation. Travel data converted to fuel consumption by using energy-intensity factors show an estimate of 145.284 billion gal for all transportation in Table 1 and the table below on freight movement and petroleum consumption:

Mode	Gallons (000 000s)
Truck (excluding pickups)	26 534
Rail	4 115
Water	7 598
Pipeline	4 320
Air and other	1 896
Total	44 463

The small difference could be due to variations in the energy-intensity factors. The lower figure is used for most of the remaining calculations in this paper. [Whenever possible, the energy-intensity factors (person miles per gallon) are synthesized from actual use data published in generally accepted references, keyed to each mode in the tables presented in this paper.] There is considerable potential for improving these factors—and good incentives to do so for reasons of fuel conservation and economics. In fact, the load factors (person miles divided by seat miles) for public modes have increased since 1977, with resulting increases in fuel efficiencies (person miles per gallon). Improved efficiencies have also occurred due to such changes as those in operating procedures, engine modifications, and lighter vehicles.

In order to assess the amount of excess capacity in the intercity transportation system, we need to know what the system consists of, how it is being used, what its capacity is under existing (1977) service levels, and what its capacity could be if it were used more intensively. Some of these data appear in Table 2. The first three systems in Table 2 are public, common carriers subject to a wide range of government regulations that affect service levels, fares, schedules, labor management, safety, and so forth. The last two are privately owned and operated. The movement of freight is not within the scope of this paper, except to note the potential for passenger and freight interference (especially for passenger rail service).

ECONOMIC IMPACTS OF REDUCED INTERCITY TRAVEL

A relatively convenient method of estimating the potential economic impact of a period of vehicle fuel shortage is to look back at the impact of the two shortage periods already experienced in 1973-1974 and in 1979. During these two shortages the economic indicators did not reveal any significant change or shift in the level of economic activity for several reasons. First, the shortage period was not long enough to cause any serious economic impacts. After a brief period of shortage, fuel became available—even though at a higher price—and things returned to normal. Second, in spite of the fuel shortage, the public managed to make all essential trips, thus averting many adverse economic impacts. In comparison to the total trips taken, the number of cancelled trips that created some adverse impacts was so insignificant that such trips did not appear in the aggregate statistics. Also, compared to total economic activity, trip-related activities were small enough not to appear in any aggregate data. Whatever impact was detected was highly localized and in specific sectors. However, given a longer and deeper period of shortage, the impacts could become detectable, even though they would still be highly localized in specific sectors.

In case of a fuel shortage, major urban centers are going to be the most resilient and immune to adverse economic impacts. The reasons are that these centers usually have a diversified industrial mix and a larger economic base.

The most vulnerable economies are the nonmetropolitan area economic centers, especially recreation areas and vacation resorts, to and from which the automobile serves as the major travel mode. In many of these areas, resident businesses depend on a short, seasonal peak period for about 80 percent of their annual income. Adverse impacts in these areas would hurt the private sector by a loss of income and the public sector by loss of tax revenues. In large or small communities, when a few major businesses suffer for one reason or another, the whole community suffers. However, there are certain businesses that stand to lose more than others in a period of motor fuel shortage—manufacturers of recreation vehicles and boats; hotels, motels, and their suppliers; restaurants, resorts, and amusement parks; camping and skiing areas; convention centers; vehicle sales and repairs; and service stations.

The potential impacts of a severe cutback in travel on these businesses would take the form of employee layoffs; reduced wages, salaries, and other forms of income (e.g., proprietor's income); business closures; and loss of tax revenue for essential public services. A relatively healthy reaction to the fuel shortage that might take place in many affected areas, where possible, would be the relocation of some of these businesses closer to their clients.

EXISTING USE OF THE SYSTEM AND CALCULATION OF EXCESS CAPACITY

The year 1977 was chosen for this research effort because all the necessary data were available from government and private-industry publications. In 1977, the three public modes of intercity person transportation handled a total of 193.1 billion person miles of travel in the United States. In addition, the two major private modes carried another 260.8 billion person miles of travel. Table 3 summarizes the number of person miles traveled (about 14.9 percent of total travel) and the gallons of fuel consumed (about 10 percent of petroleum used for transportation) for intercity travel in 1977.

Informal inquiries to the air, bus, and rail passenger industries resulted in a set of load factors considered to be the maximum practical under current service levels. These are air carrier, 70 percent; intercity bus, 90 percent; and Amtrak, 80 percent. Attaining these load factors would require extensive managerial effort, intramodal and intermodal coordination, streamlined maintenance, improved operating procedures, and probably some changes in government regulations. For instance, under current deregulation, the airlines are precluded from closer coordination because of antitrust laws. Government's role may be to provide a mechanism for coordination that is workable or to seek regulatory and administrative changes that foster coordination both within and between modes of intercity travel. Data obtained from these travel modes in relation to load factors are summarized briefly below.

Amtrak

These statistics (14,16-18) concern Amtrak's load factor: revenue passenger miles, 4.204 billion; seat miles, 15.680 billion; average load factor, 26.82 percent; revenue passengers (trips), 19.0 million; average passengers per train,

Table 1. Petroleum consumed by person-travel modes.

Mode	Person Miles (000 000s)	Person Miles per Gallon	Gallons Consumed (000 000s)
Automobile and taxi (4, 5)	2 461 028	30.67	80 242
Pickup (2, 4)	228 620	20	11 431
Motorcycle (4)	24 823	55	451
Air carrier (6-8)	163 219	25	6 529
General aviation (9, 10)	33 830	34	995
Intercity bus (11)	25 700	140	184
School bus (2, 12)	70 257[a]	175	402
Transit bus (13)	19 730	50	395
Heavy rail transit (13)	9 682	160	60
Commuter rail (13)	5 478	160	34
Amtrak autotrain (14-16)	4 204	43	98
Total	3 046 571		100 821

[a]Estimated figure.

Table 2. Equipment and use data for intercity transportation systems.

System	Item	Use Data
Amtrak (6, 14, 15, 17-19)	System miles	25 811
	Locations served	524
	Number of locomotives	369
	Number of cars	2154
	Average seats per car	60
	Number of trains per day	262
	Average cars per train	7.9
	Average locomotives per train	2.1
	Daily average cars out of service (%)	24.3
	Daily average locomotives out of service (%)	19.5
Intercity bus (6, 11, 17, 20)	System miles	277 000
	Locations served	15 000
	Number of buses	
	Classes 1-3	20 200
	Class 1	8360
	Average seats per bus	43
	Daily average buses out of service (%)	7.0
Domestic air carrier (7, 8, 17)	System miles	
	Total	327 969
	Jet routes	151 848
	Locations served, certificated	
	Total	629
	Air traffic hubs[a]	158
	Airports	2153
	Number of aircraft	2231
	Average seats per aircraft	136.9
	Daily average aircraft out of service (%)	3.0
General aviation (9, 10, 17)	Total system miles	-[b]
	Locations served	15 000
	Airports	14 117
	Number of active aircraft	184 294
	Average seats per aircraft	
	Local	3.5
	Itinerant	5.0
Automobile, truck, and motorcycle (4, 12, 17, 21)	System miles	686 329
	Locations served	All
	Registered vehicles (total U.S.)	
	Passenger automobiles	113 696 100
	Motorcycles	5 014 600
	Single-unit trucks	28 298 400
	Average seats per vehicle	
	Passenger automobiles	4.5
	Motorcycles	1.5
	Single-unit trucks	2.0

[a]These hubs handle 96.8 percent of all enplanements.
[b]Data are not available.

126.63; average trip length, 221.26 miles; and average speed (station-to-station), 46.40 mph. If the load factor for Amtrak were increased to 80 percent, based on existing schedules, it would provide for 12.54 billion total passenger miles—an increase of 8.34 billion or 198.3 percent. In terms of person trips, it would add 37.675 million—assuming an average trip length of 221.26 miles. The number of passengers per train mile would increase to 378.

Table 3. Intercity travel and fuel consumption in the United States, 1977.

Mode	Person Miles (000 000s)	Person Miles per Gallon	Gallons Consumed (000 000s)
Air carrier (7)	163 200	25	6 500
Intercity bus (11, 17)	25 700	140	200
Amtrak (14, 17)	4 200	43	100
Automobile and truck[a] (5)	230 700	33.46	6 900
General aviation[b] (9, 10)	30 100	34	900
Total	453 900		14 600

[a]Data, taken from 1977 Census of Transportation, include person miles of travel from one-way trips of 100 miles or more. If trips of 50-100 miles are included, total intercity travel would increase to 671.3 billion person-miles (22 percent of total) and consume 21.1 billion gal of fuel (14.5 percent of total).
[b]General aviation includes itinerant (city-to-city) person miles only.

An additional increment of capacity could also be added by scheduling the trains to run during as many of the 24 hours in a day as possible. Given the average consist of 7.9 cars and 2.1 locomotives per train, it appears that the availability of locomotives becomes the limiting factor. This assumes that there is no pool of unused locomotives to press into service and that none would be shifted from hauling freight. It is also assumed that there is not a large pool of passenger rail cars suitable for service on short notice.

By running the trains as much as possible, using locomotives as the constraint, and assuming an 80 percent load factor, the total person miles of travel by rail would be 5.165 times the existing figure. This would amount to a total of 21.714 billion person miles, or an increase of 17.510 billion.

It is acknowledged that the use of systemwide averages is no way to run a railroad—nor a bus line, nor an airline. However, such use is probably sufficient to establish the order of magnitude regarding how much excess capacity could be made available if needed.

Intercity Bus (Classes 1-3)

The following statistics (11,17,20) concern the load factor for intercity bus systems (classes 1, 2, and 3): revenue passenger miles, 25.700 billion; seat miles, 47.386 billion; average load factor, 54.24 percent; revenue passengers (trips), 332.0 million; average passengers per bus, 23.32; average trip length (one-way), 77.41 miles; and average speed (station-to-station), 39.29 mph. If the load factor for intercity bus were increased to a practical maximum of 90 percent, the total passenger miles carried would be 42.644 billion, or an increase of 16.944 billion (65 percent). This would mean an additional 218.89 million person trips. The average length of such trips would be 77.41 miles.

Combining class 1, 2, and 3 buses shows that, on average, and allowing for 10 percent downtime, each bus is used only 4.23 h/day. By running the buses as much as possible with a 90 percent load factor, the total passenger miles of travel by bus could be 9.42 times the current figure. This would be a total of 242.17 billion passenger miles—an increase of 199.526 billion.

Intercity Bus (Class 1 Only)

It should be understood that 8360 buses of the total intercity bus fleet of 20 200 are engaged in class 1 service (11), which handles the bulk of regular-route intercity service in addition to package express, some charter, and special services. Class 1 buses represent 41 percent of the fleet but account for 66 percent of the passenger miles. These buses are used about 6.9 h/day on average, while class 2 and 3 buses are used only 2 h/day.

If the class 1 buses ran on existing schedules with a 90 percent load factor, they would account for 29.644 billion passenger miles—an increase of 12.714 billion, or 75 percent of the total increase in passenger miles in classes 1, 2, and

3. Since the average trip length on class 1 buses is 135.33 miles, compared to 42.39 miles on class 2 and 3 buses, the increase would account for 93.95 million passenger trips, or 42.92 percent of the additional passenger trips carried by all three classes.

If the class 1 buses were used during as many of the 24 hours in a day as possible at 90 percent load factor, an additional increase of 73.946 billion passenger miles would result, as well as a total increase of 86.66 billion over current passenger miles. This represents 40 percent of total additional capacity in all three classes.

Commercial Air Carrier (Scheduled Domestic)

The statistics concerning the load factor for commercial air carriers (scheduled domestic) include the following (7,8): revenue passenger miles, 156.609 billion; seat miles, 280.619 billion; average load factor, 55.81 percent; revenue passenger enplanement, 222.283 million; passengers per plane, 76.4; average passenger trip length, 704.5 miles; and average airborne speed, 408.1 mph. Discussion with representatives of the commercial air carrier industry revealed these constraints on excess capacity for this mode of travel. The practical maximum load factor was estimated to be 75 percent. This means that many flight legs would be operating at 100 percent, with standbys. There is very little downtime (3-4 percent) to interfere with flight service because most maintenance is performed in nonscheduled hours. The availability of pilots appears to be a limiting factor to increasing capacity. Official air-carrier traffic statistics indicate that the 24 900 pilots employed by the airlines are being used at least 90 percent. Federal regulations and labor contracts are major factors limiting the allowable flight time for pilots. A large number of qualified pilots to be drawn on for greatly expanded service on short notice does not exist. This means that the excess capacity of the air carriers would be based on using pilots (and aircraft) about 10 percent more and on increasing the load factor up to 75 percent.

Revenue passenger miles would be increased from 163.2 billion to 219.3 billion, an increase of 34.38 percent. This would result in 79.77 billion additional passenger enplanements, assuming an average trip length of 704.5 miles.

For purposes of comparison, assume that there are sufficient pilots and airport capacity to operate the air-carrier fleet around the clock. A 10 percent downtime factor is used because aircraft could no longer be maintained during nonscheduled time. Given these assumptions, a total of 753.9 billion passenger miles could be handled, an increase of 362 percent over the existing figure. This would result in an additional 838.5 million passenger trips of 704.5 miles in average length. These figures have little meaning in the real world because it is unlikely that an increase in air travel of 350 percent would be accommodated during a severe energy shortage even if the demand were there and pilots and airport capacity were available.

Tables 4 and 5 list the excess capacities in terms of person miles of travel that would theoretically exist (a) if the three public modes were operated on existing schedules at maximum practical load factors and (b) if the three public modes were operated at the maximum practical load factors with around-the-clock use of equipment and with maintenance downtime. These tables show that Amtrak is underused compared to intercity bus and air carriers. Also, its excess capacity is limited by the availability of locomotives. On the other hand, the excess capacity of air carriers is limited to increasing the load factor to 75 percent. The lack of pilots precludes more-intensive use of aircraft. It is also doubtful that there is a real demand for the excess 56.1 billion person miles of air travel with an average trip length of 704.5 miles. Intercity bus appears to offer the most-readily accessible resource for handling the short- and medium-length trips that characterize the automobile and truck travel shifting to public modes.

Relation of Capacity to Cutoff

How do these excess capacities relate to a one-third, two-thirds, or complete cutoff of imported oil? Assume that a cut in imported oil is distributed across all uses of petroleum in proportion to existing consumption patterns. However, also assume that the reduction in fuel for intercity travel applies only to automobile and truck and that supplies to the three public modes would not be cut.

Table 3, which lists intercity travel and fuel consumption, shows a total of 14.6 billion gal for all intercity travel. A one-third cut in imports would result in a reduction of $1/3 \times 0.4778 \times 14.6 = 2.324$ billion gal. This amount of fuel would be 33.71 percent of automobile and truck fuel--77.77 billion person miles of travel or 32.40 billion automobile and truck vehicle miles. Can the intercity transportation system accommodate this modal-shift demand?

Table 4 shows a potential excess capacity of 81.4 billion person miles. However, 56.1 billion is air carrier person miles, which cannot substitute for most of the automobile and truck person miles. Assuming that the percentage reduction in automobile and truck travel is constant for all trip-length categories (based on the 1977 Census of Transportation) and that trips of 500 miles or more are candidates for shifting from automobile and truck to air, then 23.343 billion person miles of automobile and truck travel could shift to air travel. This would increase the load factor on airplanes to 63.8 percent.

The remaining 54.430 billion person miles, with shorter average trip lengths, could be split between Amtrak and intercity bus. One way to do this would be to use Amtrak to the maximum; this would accommodate 17.510 billion person miles, with the remaining 36.920 billion assigned to intercity bus. The buses would run at a 90 percent load factor for 6.2 h/day instead of 4.2 h. Or, if only class 1 buses were used, they would operate at a 90 percent load factor for 12.5 h/day versus the existing 6.9 h. This example of one way to absorb a one-third cut in oil imports is summarized in Table 6. The additional fuel needed to run Amtrak and buses more frequently would be more than compensated for by automobile and truck trips that would be cancelled, especially those recreational sightseeing trips made by automobiles and trucks carrying camping gear.

If Amtrak merely increased its load factor to 80 percent by using existing schedules, it could handle an increase of 8.336 billion person miles. Intercity buses (classes 1, 2, and 3) would then handle 46.094 billion person miles by operating an average of 7.1 h/day. If only class 1 buses were used, they would operate 14.6 h/day.

If a two-thirds cut in imported oil were treated in similar fashion, air carriers would be operating on existing schedules with a 71.8 percent load factor, Amtrak would be running 24 h/day at an 80 percent load factor, and every intercity bus would be running at a 90 percent load factor for 11.6 h/day. Class 1 buses only would have to operate at a 90 percent load factor 24 h/day.

All of these examples are probably unrealistic, however, because they are based on shifting person travel from automobile and truck to the three public modes. It seems more likely that higher priorities would be placed on energy requirements for agriculture, freight movement, heating and cooling, and industrial uses.

If a complete cutoff of imported oil occurred, all intercity travel by automobile and truck would theoretically cease. The remaining transportation fuel would be sufficient to keep the public modes operating as they do now, except that the load factors could increase. With these increases, the three public modes could handle about 50 percent of intercity travel. This would probably entail prioritizing trips on the basis of necessity, with business and important family matters ranked higher than vacations and sightseeing.

It could be argued that, during a severe energy shortage, air travel should be curtailed because it is the least energy efficient of the intercity modes. On the other

Table 4. 1977 excess annual capacity, by mode and based on existing schedules.

Mode	Existing Person Miles of Travel (000 000s)	Existing Load Factor (%)	Maximum Load Factor (%)	Person Miles per Gallon	Potential Person Miles of Travel (000 000s)	Excess Person Miles (000 000s)
Amtrak	4 204	26.82	80	128	12 540	8 336
Bus						
Classes 1, 2, and 3	25 700	54.24	90	232	42 644	16 944
Class 1	16 930[a]	51.39	90	245	29 644[a]	12 714[a]
Air carrier	163 219	55.81	75	34	219 341	56 122
Total	193 123				274 525	81 402

[a]Not included in total.

Table 5. 1977 excess annual capacity, by mode, if equipment is used 24 h/day.

Mode	Existing Person Miles of Travel (000 000s)	Existing Load Factor (%)	Maximum Load Factor (%)	Potential Person Miles of Travel (000 000s)	Excess Person Miles (000 000s)
Amtrak	4 204	2.98	1.73	21 714	17 510
Bus					
Classes 1, 2, and 3	25 700	1.66	5.68	242 170	216 470
Class 1	16 930[a]	1.75	3.49	103 590[a]	86 660[a]
Air carrier	163 219	1.34	3.44	753 909	590 690
Total	193 123			1 017 793	824 670

[a]Not included in total.

Table 6. Potential for shift from automobile and truck to three public modes to absorb a one-third cut in oil imports.

Mode	Existing Load Factor (%)	New Load Factor (%)	Existing Use per Day[a] (h)	New Use per Day[a] (h)	Excess Person Miles of Capacity (000 000s)
Amtrak	26.82	80	13.86	24.00	17 510
Bus					
Classes 1, 2, and 3	54.24	90	4.23	6.20	36 920
Class 1	51.39	90	6.87	12.48	36 920[b]
Air carrier	55.81	63.79	6.28	6.28	23 343
Total					77 773

[a]With allowance for equipment downtime. [b]Not included in total.

hand, the 1977 U.S. Census of Transportation shows that probably one-half of all air travel could be classified as necessary because it involved business or important family affairs requiring prompt personal attention at great distances. It could also be argued that a large amount of pleasure travel or discretionary travel between cities would simply not occur.

For instance, in California—where automobile use is the most extensive in the United States—motorists have voluntarily reduced their driving so that 1979 showed a net annual decrease in vehicle miles of travel of 0.9 percent. Normally, travel on the state highway system would have increased 5 percent/year. The point is that a one-third cut in oil imports, which theoretically translates to a 33.71 percent reduction in automobile and truck person miles of travel, may in fact turn out to be much less of a drop. The most significant problems would undoubtedly occur within urban areas where trip making is generally less energy efficient.

ROLE OF THE INTERCITY TRANSPORTATION SYSTEM IN MEETING A FUEL SHORTAGE CONTINGENCY

Intercity travel in the United States accounts for approximately 14.9 percent of the total 3 trillion person miles of travel. Because intercity travel is more energy efficient than intraurban travel due to higher vehicle occupancy and better operating conditions, it probably consumes no more than 10 percent of the total energy for transportation. In the example of a one-third cut in imported oil, intercity travel would accommodate a saving of about 1.6 percent of the total energy used for transportation.

Given that intercity travel's role in the total transportation picture and its important economic and social values are known, curtailment of travel brought on by a sudden fuel shortage should be handled as equitably as possible with some sense of priorities. These priorities should be based on necessity and the extent that other transportation modes and nontravel forms of communication can be substitutes for automobile travel.

The 1977 U.S. Census of Transportation provides some insights into the nature of intercity travel that may be useful. The reader is cautioned, however, to be aware that the data presented here on the three public modes from this census will differ from the summary figures given previously because the 1977 census reported only on one-way trips of 100 miles or more. Data from automobile and truck travel will agree because they were taken from the 1977 census. This is illustrated in the following table, which compares average trip lengths:

Mode	Average Trip Length, Including Trips < 100 Miles	1977 Census Average Trip Length in Miles
Amtrak	221	473
Bus	77	298
Air	704	961
Automobile and truck	-	261

By using 500 miles as a breakpoint, the 1977 census shows that 45 percent of total person miles resulted from trips under 500 miles. Automobile and truck modes accounted for 90 percent of that travel. Air carriers accounted for 60 percent of the person miles of travel for trips of more than 500 miles. Automobile and truck modes accounted for 35 percent of travel for trips of more than 500 miles.

In terms of person trips, 83 percent was less than 500 miles in length. Three-quarters of these trips were by automobile and truck. For trips greater than 500 miles in

Table 7. Percentage of person miles of travel, by mode and purpose, based on 1977 U.S. Census of Transportation.

Trip Purpose	Automobile and Truck Without Camping Gear	Automobile and Truck with Camping Gear	Bus	Train	Air	Other	Use of Different Mode Going and Coming	Total
Visit to relatives or friends	23.59	1.42	0.69	0.49	9.13	0.09	1.25	36.66
Business	6.76	0.23	0.11	0.25	11.75	0.19	0.44	19.66
Convention	0.99	0.09	0.10	0.02	1.83	–	–	3.11
Outdoor recreation	5.80	1.85	0.23	0.04	1.22	0.07	0.11	9.32
Entertainment	4.03	0.64	0.33	0.05	2.74	0.11	0.24	7.98
Sightseeing	3.43	1.06	0.34	0.05	2.29	–	–	7.31
Personal, family, medical reasons	7.17	0.34	0.20	0.11	2.87	0.07	0.79	11.35
Shopping	0.24	0.01	0.01	0.00	0.00	–	–	0.26
Other	2.38	0.28	0.33	0.01	1.15	–	–	4.35
Total	54.39	5.92	2.34	1.02	32.98	0.46	2.83	

Table 8. Percentage of person trips, by mode and purpose, based on 1977 U.S. Census of Transportation.

Trip Purpose	Automobile and Truck without Camping Gear	Automobile and Truck with Camping Gear	Bus	Train	Air	Other	Use of Different Mode Going and Coming	Total
Visit to relatives or friends	30.79	1.16	0.66	0.29	3.07	0.11	0.73	36.80
Business	11.35	0.24	0.13	0.25	5.19	0.20	0.28	17.58
Convention	1.21	0.06	0.10	0.02	0.53	–	–	1.97
Outdoor recreation	9.54	2.62	0.30	0.02	0.41	0.12	0.09	13.09
Entertainment	5.67	0.51	0.50	0.05	0.85	0.17	0.11	7.75
Sightseeing	3.37	0.57	0.39	0.05	0.74	–	–	5.24
Personal, family, medical reasons	10.53	0.32	0.20	0.08	0.95	0.10	0.43	12.45
Shopping	0.63	0.01	0.02	0.00	0.01	–	–	0.68
Other	3.12	0.27	0.47	0.01	0.42	–	–	4.44
Total	76.21	5.76	2.77	0.77	12.17	0.69	1.64	

length, automobile and truck modes, along with air carriers, accounted for 51 and 46 percent of these trips, respectively. Only 13 percent of the bus trips and 29 percent of train trips were more than 500 miles in length. The average number of persons per trip by mode was automobile and truck, 2.5; Amtrak, 1.6; bus, 1.5; and air carrier, 1.5.

Tables 7 and 8 give the percentage breakdown of intercity person miles of travel and trips by purpose and mode of travel. Automobile and truck modes dominate for all trip purposes, except for business and convention travel, where air is the preferred mode. For person trips, automobile and truck dominate for all trip purposes.

The 1977 census also reported intercity travel as vacation or nonvacation travel and weekend or nonweekend travel. Person miles of travel were about evenly split between vacation and nonvacation. Automobile and truck modes accounted for 60 percent and air carriers for 33 percent of vacation and nonvacation travel. About 37 percent of the person trips was for vacation; automobile and truck modes carried about 80 percent and air carriers, 13.5 percent. The share of nonvacation travel by automobile and truck and air carriers was 83 percent and 11.5 percent, respectively.

Person miles for weekend and nonweekend travel split 26 percent and 74 percent, respectively. Automobile and truck carried 53 percent, while air carriers handled 40 percent.

Person trips split 41 and 59 percent between weekend and nonweekend travel. Automobile and truck carried 92 percent of the weekend trips and 75 percent of the nonweekend trips. Comparable percentages for air carriers were 4 percent and 18 percent.

In prioritizing intercity travel, one can surmise from Tables 6 and 7 that business, personal family affairs, or medical reasons are the trip purposes most likely to be considered as high priority on a scale of necessity. Such purposes account for about one-third of the person miles of travel and of person trips. Because a 100 percent cutoff of foreign oil would result in a 50 percent reduction in intercity travel, we can conclude that all necessary trips would continue to be made unless fuel for the public modes of intercity travel was also preempted for higher-priority purposes.

It seems fair to say that there is enough potential excess capacity within the intercity transportation system to absorb a one-third shift from automobile and truck to the three public modes. A two-thirds shift would require almost maximum use of the three public modes. Only intercity bus would have much excess capacity remaining. With a complete cutoff of foreign oil, the three public modes would be able to meet about 50 percent of the intercity travel demand. These statements are based on the foregoing analysis, which rests, admittedly, on fairly simplified assumptions. For instance, the use of nationwide annual averages implies that travel is evenly distributed in time and space. Nothing could be further from the truth.

Travel demand comes in bunches and spreads out along major population corridors. There are peak hours, peak days of the week, peak months of the year, special holiday peaks, and special-event peaks. During many of these periods, various intercity modes are operating at full capacity or are unable to handle all who wish to travel. Moreover, much intercity travel flows along congested corridors where one worries about airspace, ground-side capacity, passenger train-freight train conflicts, overcrowded highways, and teeming terminals. Any meaningful planning for a fuel-shortage contingency must be conducted at the corridor level for intercity travel and at an even finer level for intraurban travel.

Marshaling the potential excess capacities to handle a sudden increase in demand caused by a fuel shortage could present major logistic problems. Examples include government rules and regulations, labor contracts, service area disputes, maintenance, modal interface, and the

average person's desire to travel during daylight hours. There are personal phobias and biases to overcome in any major shift from the automobile.

CONCLUSION

In summary, we can say that considerable excess capacity is available, but it may be difficult to use unless we can focus sufficient managerial and logistic talent in the transportation area to develop plans to use that capacity. Also, in recent months, evidence that we can handle these problems has increased, as U.S. citizens responded to a realistic awareness of diminishing fuel supplies, to the prodding of rapidly rising fuel prices, and to their desires to reduce U.S. dependence on foreign energy.

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Energy and the Airline Industry

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The most critical problem facing the airline industry today concerns fuel--its availability, price, and supply. This report (a) presents background information on jet fuel availability and prices, (b) discusses fuel efficiency and conservation, and (c) describes the impact of the 1973-1974 fuel shortage and possible future actions resulting from shortages.

FUEL AVAILABILITY

Adequate fuel supplies are necessary to ensure the reliability and availability of air transportation. The following are a few basic facts about jet fuel.

1. Scheduled air carriers use kerosene-based jet fuel (kerojet). It is a middle-distillate product, and only about 10 percent of the crude oil barrel can be used to produce jet fuel. Currently, however, only about 4.5 percent is processed and sold as kerosene-based jet fuel.
2. In addition to its use by scheduled airlines, kerojet is used by the military, general aviation (including business aircraft and commuters), and electric utilities that rely on kerojet as an alternative fuel.
3. Kerojet, as a middle distillate, can be diverted into other comparable products, such as heating oil. In winter months, however, such diversion has an adverse potential for kerojet supplies.
4. Kerojet is sold directly by refiners to air carriers in the United States. Middlemen are seldom involved in its distribution.

U.S. airlines supported the removal of price and allocation controls from kerosene-based jet fuel, which occurred in February 1979. But, since March 1979 and the upheaval in Iran, suppliers that have contracts with carriers have allocated jet fuel supplies. Most of these allocations, which refer to different base volumes, are tied to corresponding 1978 monthly increases and do not reflect current levels of carrier operations or the continuing surge in air transportation.

The difference between the allocated volumes and the volumes needed to maintain adequate service has been made up with purchases in the spot market, contracts with new suppliers, and, to some very limited extent over the past year or so, cancelled flights.

FUEL PRICE

The recent sharp increases in the price of jet fuel began in the early months of 1979. By December 1979, the average price of jet fuel was $0.75/gal, compared to $0.40/gal in 1978 and $0.12/gal prior to the OPEC embargo in 1973.

Currently, the average price is more than $0.80/gal. The December 1980 price may well reach $1.10/gal based on trends over the past year. Every increase of $0.01/gal adds more than $110 million annually to the operating costs of U.S. airlines.

The airline industry's total 1980 fuel bill is estimated at $10.6 billion, with $4.1 billion added in 1980 due to price increases alone. At this level, fuel accounts for more than 30 percent of total operating expenses. By comparison, fuel accounted for 25 percent of operating expenses in 1979, based on a total fuel bill of $6.5 billion, and about 12