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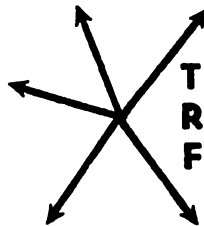
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TRANSPORTATION RESEARCH FORUM

Urban Transportation Planning for Conditions of Limited Petroleum Supply

by William S. Dirker

I. INTRODUCTION

FEDERAL REGULATIONS pertaining to urban transportation planning should include, as a mandatory alternative, a system plan that provides in the planning horizon year for no more vehicle-miles-traveled (VMT) than in the current or base year. This proposition will be supported as follows:

1. It is probable that there will be serious constraints on the supply of petroleum within the planning time frame.

2. The technological achievement of practical energy to substitute for petroleum for individual travel is uncertain.

3. Even if this substitute energy is found, the scale of industrial change required to procure, process, manufacture, transport, store and market this energy and the engines and vehicles that can use it will require capital materials, energy and manpower that is probably well beyond our ability to supply these items, especially if we consider competing demands in the same period for these same resources for the production of other energy, food, shelter, water, etc. When viewed in a worldwide context with growing population and aspirations this factor of industrial scale becomes even more dominant.

4. A federal mandatory requirement is a politically practical mechanism to introduce consideration of probable limits on petroleum and VMT into the technical planning process in view of the general public perception of the situation and the limits this places on directly elected local officials involved in the urban transportation planning process. This is a mixed technical-political process, a condition sometimes overlooked, leading to frustration of technicians and of politicians.

This paper will also touch on the consequences of this proposal. Applying a fixed VMT backward through the network assignment, trip tables, modal split and trip generation models will indicate some important impacts on population and employment distribution, on network capacity and on transport pricing. The consequences of being wrong will also be considered.

Caveat: This brief paper cannot exhaust the documentation available. Other sources will vary from these. However, citations have been selected on a

conservative basis and present a fair representation supporting the major points.

II. PETROLEUM SUPPLY AND DEMAND

This Chart A shows the 1975 total U.S. energy flow pattern. Urban travel by auto consumes 36% or 6.5 of the 18.5 quadrillion BTU's used for all transportation, or 22% of all petroleum and LNG. It is with this non-renewable energy that we are concerned. (Ref. 2, p 32)

Chart B presents the "Pressure on Petroleum Reserves from Automobile Transportation." Note that the chart is semi-log and shows consumption by the automobile alone, U.S. and world wide. (Ref. 1, p C-10)

A future U.S. supply and demand scenario is displayed in the following Chart C. Note the fairly liberal basis regarding imports and domestic supply. These fragile assumptions are subject to major adversity from a range of sources — diplomatic, military, legal, economic, technical and environmental. (Ref 3b, p 2-3)

A linkage between these charts can be established by the factor: 1 quadrillion BTU's/year = 470,000 bbls oil/day. (Ref 1, p 1)

Some assessments suggest that the oil producing nations will optimize benefits to themselves without causing economic ruin to others upon whom they depend for those benefits, and short of inciting the oil dependent nations to war. We can be sure they will not willingly return to milking goats to support our "habit" of inefficient petroleum consumption and its most conspicuous facet, use of the auto in urban transport.

Chart A is from a report published January 12, 1977 by the Secretary of Transportation. Under "Planning Assumptions" it states "The planning efforts assumes, however, that petroleum or substitute liquid fuels would be available, although their costs may be somewhat higher." January 20, 1977 a new administration took office. Secretary of Transportation Adams, testifying in February, 1977 before the House Transportation Subcommittee, stated — "We must look to the ultimate exhaustion

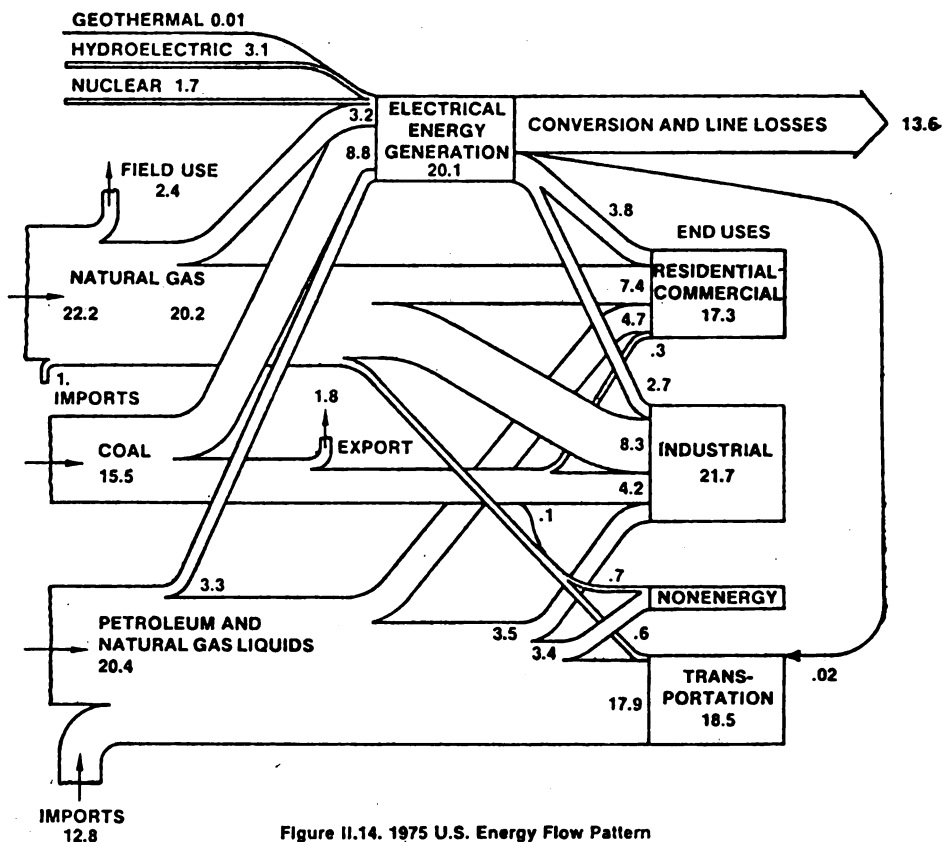


Figure II.14. 1975 U.S. Energy Flow Pattern
(In quadrillions of Btu)

CHART A

of the oil supplies which keep the transportation system running. Ultimately the gas is going to run out."

Thus, there appears to be some reason to seriously consider this possibility, and it is not being done.

Mr. Micawber wandered through Charles Dickens' novel, "David Copperfield" assuring that "Something will turn up." If we can put a man on the moon, we can solve this problem. And well we may. But we may not, at least not in time and not in the scale needed. Micawberism is not a reasonable basis for public policy.

III THE TECHNOLOGICAL FIX

The individual vehicle with which we are familiar and concerned requires a portable energy source, most typically a tank of gas, a flywheel or some version of a battery. Virtually all other energy sources, present or in prospect,

tie the vehicle to an electric wire. If we grant that there may be a limit to petroleum supply, what are the prospects for a substitute portable energy source?

This subject has received various degrees of attention from scientists, industries and governments throughout the world. I am not aware of any development that is regarded as promising.

A thorough review of the matter was published in March, 1976 by the Interagency Task Force on Motor Vehicle Goals Beyond 1980. (Ref 4) I present selected quotations to illustrate the underlying assumptions. **Bold** indicates that the emphasis is theirs.

"Technological development is such that after 1985 synthetic liquids from oil shale, or less likely, coal, could begin to supplement domestic supply and by the mid-90's production could be in the order of 1½ to 2 million bbl/day.

FIGURE C-8
PRESSURE ON PETROLEUM RESERVES
FROM AUTOMOTIVE TRANSPORTATION

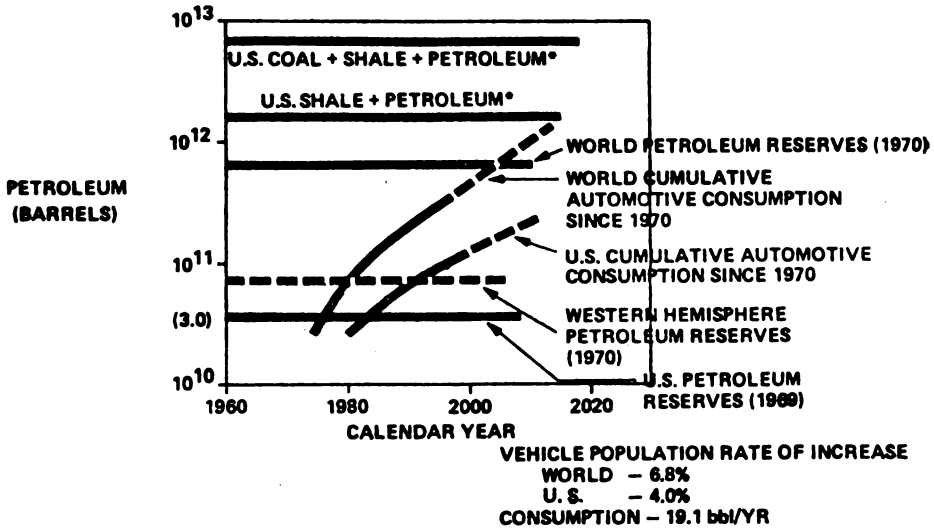


CHART B

Availability of synthetic liquids in that quantity is dependent upon development of a synthetic liquids industry; availability within the time frame indicated is wholly dependent upon immediate (1976) resolution of policy questions and implementation of first steps toward accelerated development." (Ref 4, p ES-1)

"In the analysis for this study there was a primary assumption that petroleum imports will be available as required." (Ref 4, p ES-2)

"... from the standpoint of automotive technology, methanol is a fully possible fuel alternative. Use of methanol produced from organic waste could become significant to local or to area economics but its use on a national scale will develop only if methanol is found to be an energy-efficient and cost-effective coal conversion liquid. Results in the extensive R and D on coal conversion as yet provide little basis for forecasting the preferred, more energy-efficient, synthetic liquid fuel form." (Ref 4, p ES-3)

"The Panel has considered its charge in that light and recognizing a dominant influence of unpredictables has declined any attempt to forecast availability in an absolute

sense. The unpredictables that preclude useful forecasting take forms of legislated action, economic trends (particularly as they affect capital availability) and political and cartel developments external to the U.S." (Ref 4, p 7)

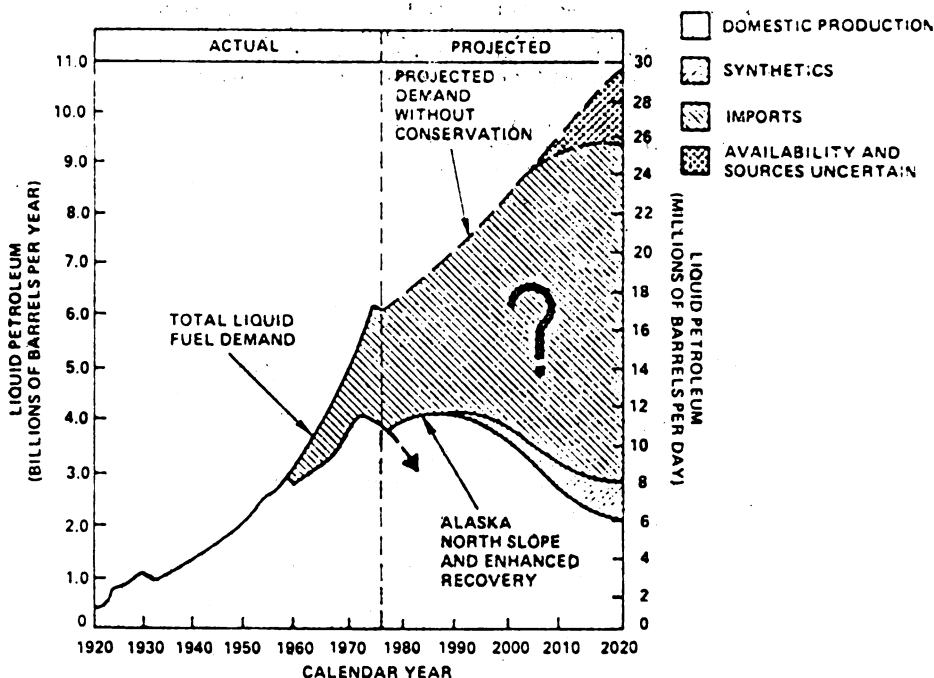
"Furthermore, it appears that hydrogen will not be available in large quantities at competitive prices until low-cost energy is available for use in the extraction of hydrogen from water." (Ref 4, p 16)

Two other quotations from the Task Force on Motor Vehicle Goals are pertinent. (Ref 3a p 17)

"The prospect that a revolutionary new engine technology development that could make a substantial impact on fuel efficiency within the 1980's is remote."

"The prospects for a highly efficient electric car, in the next ten years at least, appears to be slim."

I do not dismiss the possibility that there are dramatic technical inventions out there just waiting to come into their own. There may be. I've read recently a credible news release announcing a practical zinc-chlorine battery for auto propulsion and also an external combustion auto engine burning coal dust. But neither do I dismiss the practical prob-



SOURCES: Historic Data:
 1920 to 1963 Energy Facts,
 1964 to 1973 Annual Statistical Review, Petroleum Industry Statistics
 1973 to 1975 FEA, Monthly Energy Review
 Projected Data:
 Synfuel Interagency Task Force, Vol. II (Nov 1975), pH 67,
 Figure 4-111-10, "High SynFuels Cost" case adjusted to include
 2 million barrels per day

Figure 2-4. U.S. Petroleum Consumption and Sources Over Time

CHART C

lems of bringing these into use on a national or world scale. The probability that we face a seriously constrained energy supply appears real.

IV. INDUSTRIAL LIMITATIONS

There is a host of ideas and developments to replace, supplement or stretch out the portable energy that powers autos today. Many of these have substantial merit. All of them face the incredible problem of scale and of the short time before petroleum constraints appear.

There are over 100 million passenger cars in the U.S. today and about that many more in the rest of the world.

The capital investment required to make a significant change in our petroleum dependent transportation system in the time available is enormous. The sheer ability of U.S. industry to undertake such a change is very questionable.

"America faces a 'capital crisis' during 1977-1980, when capital needs of non-financial corporations will average about \$285 billion annually," Alva O. Way, Vice President and Chief Financial Officer of the General Electric Company, told the 1976 Stanford Business Conference.

"The \$285 billion estimate includes working capital and plant and equipment expenditures during

1977-1980, he said. It assumes federal tax policy will remain essentially unchanged with respect to rate structure, rate base, and depreciation allowances.

Way estimated \$108 billion annually in capital will be provided through depreciation allowances, with an additional \$37 billion coming through retained earnings. This leaves \$140 billion to be funded through debt and equity issues, he said. But experience indicates we can expect no more than \$10 billion a year in new equity. That leaves an unthinkable \$130 billion a year in new debt." (Ref 5, p 7)

A 5% shift of urban automotive city-center commuting to bus would require 9,200 additional buses. Bus purchases from 1960 to 1971 averaged about 2,500 per year. The transit industry now operates 49,000 buses. (Ref 6, p 6)

A bus transit system for Los Angeles to carry 20% of the person trips must have 9,500 buses. They now have 2,500 and carry 3% of the trips. (Ref 7, p iv, 28)

A shift to much more abundant coal as the source of fuel for autos is enticing. An engine powered by coal dust has been offered. Conversion of coal to petroleum and methane is possible. But . . . the supply of coal is not quickly elastic. Mining engineers and miners are a limited resource. Safety and environmental problems must be solved and these require time and money, both in short supply. Moving the coal or its products from where it is to where it is used in the vastly increased quantities required is a problem that makes even enthusiasts very uneasy. Most coal hauling railroads are bankrupt and their track and rolling stock deteriorated. The number of freight cars owned by Class I railroads dropped from 1,488,385 in 1964 to 1,339,223 in 1974. (Ref 8, p 30) A major increase in the use of coal as energy for autos transported to where the energy is used, on top of expected large increases in the use of coal for electricity generation, space heating and industrial power will tax the transportation equipment manufacturing industry and the capital markets beyond any reasonable expectancy. The Railroad Revitalization and Regulatory Reform Act of 1976 (the 4R Act) is a serious public effort to bail out and sustain our present national rail system but in no way provides massive new resources for a greatly enlarged energy transportation role. Converting coal to synthetic liquid fuels and/or transporting coal slurry or liquid products in pipelines requires vast quantities of water, and coal gen-

erally is where water is not. One must be brought to the other, somehow. Massive national reliance on coal for an automotive energy source runs into two very serious barriers—lack of capital and net energy, i.e., it may require more BTU's to mine, convert and transport the energy into an automobile than it yields. This is a formula for bankruptcy both in terms of money and of energy.

V. TIME

No credible source forecasts world petroleum supplies to last more than 100 years. A consensus seems to cluster at 50 years or less. An analogy of our situation might be found in the occupants of a lifeboat, adrift at sea, determining how to use their 5 gallons of water for an indeterminate time. Certainly the individual auto in urban transportation has got to be a prominent candidate for change. But what change and how long does it take? The vice president for engine manufacturing of a major auto company estimated it will take 13 years output of the American machine tool industry to make a major shift from today's Otto cycle engine. In any case the time required for change on the scale required is substantial. The planning proposal as this paper suggests is, at least, a practical beginning.

VI. THE POLITICAL PROCESS

Urban transportation planning is conducted, in accordance with federal regulations, by Metropolitan Planning Organizations (MPO) designated by the Governor. (23USC 134(a); 23USC 104(f)) These are usually Councils of Governments (COGs), associations of local general and special purpose governmental units for a given urbanized area. The governing body is made up mainly of elected local officials from the member units. Thus the political vitality of urban transportation planning, within the framework of federal certification and funding requirements, is drawn from the local electorate. Political figures are, at different times and in varying degrees, both leaders and followers of their constituency. The political art is to know how much of each role to play and survive. Those who fail become ineffective and unelected. It is unrealistic to expect a local official to exert strong and sustained leadership in the matter of petroleum limitations and its impact on America's "love affair with the auto" that is well ahead of his constituents perception of the problem, especially a problem that is national and worldwide in scope. With some ex-

ceptions I think it's a valid assessment that the general public is unaware or highly skeptical of petroleum limits, especially in this post-Watergate period. Note the steadily increasing consumption on Chart A above.

A more successful response to this condition can come from a remote governmental agency. The Constitution provides for a representative national government and the intent was to enable it to function from a national perspective relatively free of local pressures. The federal bureaucracy can take action on a national basis. Precedent is found in the Clean Air Act of 1970 and various civil rights regulations. The Council of Environmental Quality requires Environmental Impact Statements that consider alternates to proposed projects including a "no build" alternate. (42USC 4332) It is proposed here that the Federal Highway Administration and the Urban Mass Transit Administration issue joint regulations requiring, as one alternate, an urban transportation system plan that provides for no more Vehicle Miles Traveled (VMT) than the current or base year. This could be included as an additional technical activity (h) under Par. 12 a(8) of Federal-Aid Highway Program Manual, Vol. 4, Chap. 4, Sect. 2.

VII. IMPACT OF LIMITED VMT ON SYSTEM PLAN

I'll illustrate the consequences of this requirement by the example of the city with which I am familiar, Portland, Oregon. Although a moderate density western urban area of about 1 million people, I believe it is sufficiently representative to make a valid illustration for all but perhaps the 4 largest metropolitan areas of the U.S.

The urban transportation planning process has not changed fundamentally since its first large scale application in the Chicago Area Transportation Study (CATS) beginning about 1955. It is well described in "Urban Transportation Planning" by Creighton (Ref 9). Defects and limitations of the models have also been noted but without much emphasis. (Ref 11) Variations and refinements have occurred but the fundamental process has been quite stable. Elements of the process are as follows:

1. Land use, population and employment, present and future.
2. Trip Productions and Attractions by analysis zone.
3. Person trips by purpose.
4. Vehicle trips using various occupancy rates.
5. A combined interzonal trip table.

6. Modal split using travel time and cost factors.

7. Travel demand assigned to the network.

8. Calibrated for capacity, cost and time constraints and reassigned for optimization.

A product of this process is total VMT. The following rounded data from the Portland area is illustrative. (Ref 10, p 27, 28)

	1970	1990
Population	928,000	1,257,000
Employment	340,000	578,000
Person trips, daily	2,523,000	3,550,000
Modal split (% transit)	2.3%	10.5%
Transit trips, daily	60,000	402,000
Vehicle trips, daily	1,896,000	2,664,000
Average Vehicle trip length, miles	6.22	7.38
VMT, daily	11,795,000	19,657,000

The significant changes from 1970 to 1990 are VMT, 12 million to 20 million, and transit trips 60,000 to 400,000.

The mandatory alternate proposed here would be a new constraint that would force changes all the way back through the calculations to population, employment and land use. Modal split, vehicle occupancy, trip length, auto person trips by purpose, etc. could all be altered and considered in a system plan. Thus, once you have established the probability or even possibility of limited VMT, you can bring compelling impetus to the consideration of other changes to respond to the consequences. The response would likely be some changes in all of the contributing elements but I suspect a principal result will be to stress the desirability or necessity of a very high capacity transit system. For example, in the Portland case above, if no other factors changed (an unrealistic assumption) except VMT, Daily Transit Trips would be 1,630,000, a 46% modal split and a 27-fold increase from 1970! Even with major adjustments in the other factors the resulting demand will still be a radical increase, far beyond any current planning. Portland has doubled transit ridership from 1970 to 1977 to 3% of person trips and is stretching the limits of available resources.

The time and money required to put such a transit system on the ground and operate it, one that can accommodate the required volumes, will bring our real urban transportation problems into focus.

Another consequence may be pricing. User charges to cover full costs of transit may become possible if transit demand reaches a large scale. If the choice is ride transit, walk or don't go, value is added to the transit trip.

VIII. WHAT IF WE ARE WRONG?

Current planning assumes there will be energy to power the auto as demanded. The variable is cost, not absolute supply. If we embark on the planning effort proposed here, and the current assumptions come true, we will have wasted some planning money. To the degree that localities believe this alternate plan and begin to invest in capital works, such as right-of-way, these investments may be underutilized.

If we continue to plan on our current assumptions and, however, serious auto energy limits do appear without planning or preparation, the consequences for our cities seem very dire and are probably best described by talented novelists.

Probabilities are an element of life. We all make assessments of them every day. They are used in public life. For example, building codes require expensive structural protection against earthquake damage on the probability that there may be an earthquake. The public understands and accepts this. There is, at least, probable cause to consider the limitation of portable auto energy. There are other ways of addressing this prospect but the planning proposal suggested here is direct, prompt, achievable, not very costly and may well approximate the future.

The joint technical-political characteristic of urban transportation is illustrated by the major changes that have occurred. After World War II there was pent up demand, a surge of automobile sales and use, and the great Interstate freeway program. The public's perception of the problem was the need for personal mobility. Government and industry responded. Beginning in the late 1960's and in the 1970's the perception of the problem became, to an increasing degree, that it was excessive use of the auto and its impact on air pollution, urban sprawl and the quality of life in the cities and neighborhoods. This was translated through the political process into freeway revolts, environmental legislation, public subsidy for mass transit, the Federal Highway Act of 1973 that permitted an exchange of freeways for alternate transportation, etc. The Transportation System Management program (TSM) is aimed essentially at getting more transporta-

tion production from existing investments. Goals have been mixed but most transportation planning now addresses these problems.

Planning is for the future. I suggest that current planning is addressing the wrong problems, important though they are today. The proposition recommended here is concerned with the most probable future problem.

An analogy of our failure to plan as proposed might be of a VLCC super-tanker sailing into the North Atlantic without even turning on its radar.

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