HOW A PLANNER LOOKS AT TRANSPORTATION OF U.S. ENERGY

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Today, my portion of this program is to cover the transportation and transmission of energy. I estimate that the transportation portion represents one-quarter to one-half the cost of energy. Today energy in the U.S. costs a little under 10% of the GNP for the nation, consequently, the transportation of energy costs 2.5 to 5% of the GNP, the other costs being production, conversion and distribution. By 1980, I believe we will face an increase to between 15% and 20% of GNP.

It is my intention to break the total energy system down, access the traditional parts of the system, point out possible new parts and hopefully leave you with a number of possible solutions and possibly some thoughts on a "national energy production, transportation and conversion policy." I do not have the solution to the energy problem, only a way of looking at it.

Exhibit 1 shows the energy system as we presently know it. This fits all systems and is very general. The transportation and conversion block can be switched, depending on individual economics. Conversion is made to accommodate the transportation of energy. Other speakers today are addressing the conversion of energy to more transportable modes or more usable form, and I will not address that. It is my intention to stay close to the transportation area, but I will also discuss the other blocks in Exhibit 1, namely source, form and market.

The assessment of these traditional vs. new blocks will evaluate changes in the past and determine if these were evolutionary or revolutionary. Looking at these in historical perspective will surely help in understanding the present energy situation and provide a way of looking at the problem. By evolutionary, I mean it developed naturally, and by revolutionary, I mean there was somewhat of a radical change. You may not evaluate these developments exactly the same as I have. We will be going over each block in the exhibit and the transportation portion.

Exhibit 2 lists the traditional sources of energy consumed in the U.S. They are in the order they reached prominence as a national supply. Coal and hydroelectricity were carry-overs from the old country. Liquid petroleum production was started with Drakes oil well and was somewhat of a revolutionary development.

Natural gas became prominent with the discoveries of huge deposits in Western Kansas, the panhandle of Texas and Oklahoma. It was not in great need at the time, but I classify it revolutionary because it took over other market shares. The Natural Gas Act of 1938 helped in the revolutionary change.

EXHIBIT 1

ENERGY SYSTEM

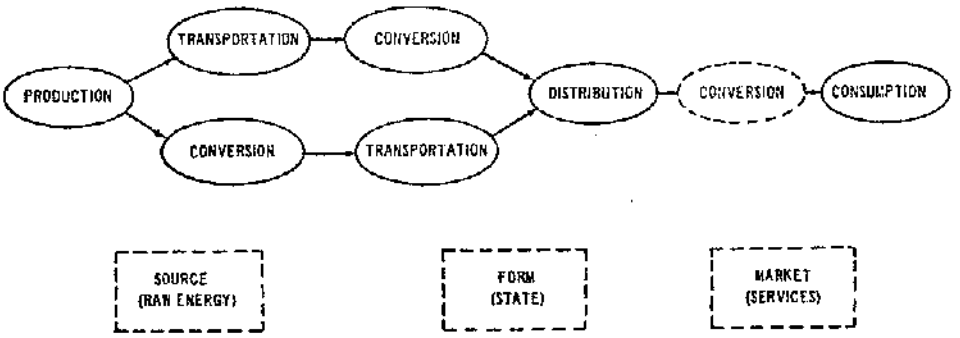


EXHIBIT 2

TRADITIONAL SOURCES

1. Coal
2. Hydroelectric
3. Liquid Petroleum
4. Natural Gas
5. Fission

EXHIBIT 3

NEW SOURCES

1. Offshore Petroleum
2. Foreign Petroleum
3. Solar
4. Geothermal
5. Oil Shale and Tar Sands
6. Fusion

Fission is a byproduct of war research and development and is surely considered revolutionary and gaining prominence. The Atomic Energy Act of 1954 was what the legislature needed to promote the infant source.

Exhibit 3 is what I listed as new sources. First, offshore petroleum has developed within the last 10 years. I consider these evolutionary developments as an extension of on-land production. Establishment of ownership of subsea mineral rights certainly aided in this. Certainly the technical development of offshore drilling equipment had to help develop this source.

My classification of foreign petroleum would put it in the evolutionary development category. There is no clear legislation for assistance presently in effect.

Solar, geothermal, oil shale and tar sands, and fussion are not given a ranking because I don't know which will become prominent first. Each has a potential several magnitudes larger than traditional sources, other than coal. However, each is only receiving small assistance in research and development dollars and legislation.

Exhibit 4 is the traditional form for distribution and consumption. If the cost were comparable, I would judge the desirability to rank as follows: 1. electric AC, 2. gas, 3. liquid, and 4. solids.

EXHIBIT 4

TRADITIONAL FORMS

1. Electric-A.C.
2. Gas
3. Liquids
4. Solids

Exhibit 5 lists new proposals for forms. These are modifications of the old forms but are being proposed to allow microeconomics to work. Generally, this is for the benefit of transportation.

EXHIBIT 5

NEW PROPOSALS FOR FORMS

LNG
D. C. Electricity
Slurry
Methanol
Hydrogen
Char

Exhibit 6 lists the traditional markets, which are probably the most stable of all the parts of the energy system. However, if new forms are used for transportation, then some of these markets could adjust to accommodate them. Some markets are changing, such as electricity for space heating and gaseous fuels for transportation.

EXHIBIT 6

TRADITIONAL MARKETS

Residential
Industrial
Commercial
Transportation
Raw Material

Exhibit 7 shows traditional transportation modes: trucks, waterways and railroads were already in existence and it was an evolutionary step to utilize them for

EXHIBIT 7

TRADITIONAL TRANSPORTATION MODES

Trucks

Ships and Barges

Railroads

Pipelines

Electric-A. C.

EXHIBIT 8

NEW PROPOSALS FOR TRANSPORTATION MODES

Offshore Pipelines

Slurry Pipeline

Aircraft

Electric-D.C., Underground

Cryogenic Tankers

Super Tankers

EXHIBIT 9

TRADITIONAL TRANSPORTATION COSTS

¢/MMBtu/100 Miles

Truck	9. - 18.
Ship and Barge	1.2 - 1.7
Railroads - Coal	4. - 6.
Railroads - Unit Train	2.5
Pipelines - Gas	1.5 - 2.
Pipelines - Oil	.3 - .8
Electricity-A.C.	7. - 14.

EXHIBIT 10

NEW PROPOSED TRANSPORTATION COSTS

¢/MMBtu/100 Miles

Offshore Pipelines - Gas	6. - 10.
Slurry Pipeline	1.3 - 1.8
Aircraft	1.07
Electric-D. C.	6. - 12.
Electric - Underground	10X
Cryogenic Tankers	1.0 - 2.0
Super Tankers	.5 - .8

the transport of energy.

Pipelines were evolutionary with liquid petroleum transportation but I consider them revolutionary to gaseous fuels, because of the development of high tensile steel and the arc welder.

Electric transmission of energy is very expensive and is primarily an answer to dependability and moving load peaks across time zones. I consider this evolutionary.

Exhibit 8 lists new proposals for the transportation of energy. Slurry pipelines now carry 1/2% of our coal. I consider this new but holds a very great potential and could be revolutionary.

There is a proposal to bring petroleum out of the Arctic via air, which is certainly revolutionary. It has some advantages, however, as it allows start-up on a small investment. Underground electric transmission is a modification of present means. D.C. electric transmissions might be evolutionary. Cryogenic transportation of gas is revolutionary as it is in a completely different state. It reduces the volume by a factor of 10 from the normal high pressure lines. Super tankers are evolutionary from present tankers.

Exhibits 9 and 10 are transportation costs and illustrate the cost of various transportation modes.

These are extractions from the literature and are not meant to be exact, only representative. The new are not significantly lower, which we would hope for.

When a national energy policy is developed, transportation cost will be one of the major deciding factors.

Considering the eleven sources mentioned, the ten forms, the five markets and the 10 transportation modes, each of you can visualize your own individual way of solving the energy problem. But before you select your source of energy, your form, and your market, I want you to add a number of limitations and considerations. These include (Exhibit 11): EPA, OSHA, national security, land use, regulation of price, DOT, mine safety, balance of payments and financing.

In summary, for which I have built my case, I am going to mention two examples of how a national policy on energy evolved in the past. Some may not believe the U.S. has had an energy policy. These two examples may illustrate that we have had an energy policy.

The case of natural gas which I consider very successful.

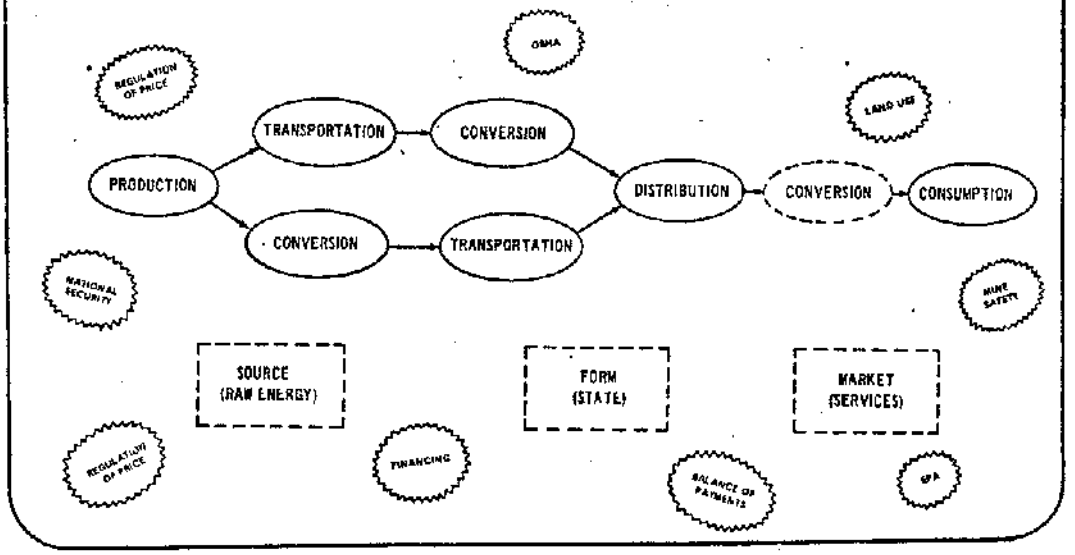
1. The source was unique as it would self-produce in most cases, also, it was a sizeable quantity.

2. Legislation was enacted by the Natural Gas Act of 1938 which allowed the industry markets and favorable growth opportunity.

3. Technology was developed, at the right

EXHIBIT 11

ENERGY SYSTEM



time, in the form of high tensile steel for large diameter pipe and arc welding. Conversion technology was not needed as the fuel was in a superior form.

4. It was a non-polluting fuel and was easily acceptable and substitutable, consequently, it captured 33% of the market within 40 years. It was marketed at a very competitive price.

The case of nuclear energy, which I consider not as successful.

1. The source was unique as it would almost self-produce (if you consider the breeder).

2. Legislation was enacted (Atomic Energy Act of 1954) which not only allowed this industry to grow, but it even did its research and promotion.

3. War technology was transferred to industrial but not quite as successful as proponents hoped.

4. Nuclear electricty is now only reaching economic justification for limited applications, consequently, after 18 years, it only supplies 1/2% of the market.

In conclusion, I believe that an energy which can meet the following criteria will play a major role in the national energy crisis. This is how I look at the National Energy Crisis. We are in need of a new energy source that can supply 20 to 30 quadrillion BTU by 1985. Exhibit 12 is an outline of what I'm looking for as a solution.

1. A source of energy that has significant size and is producible (any of the 6 new sources meets this).

2. Legislation that promotes and does not hinder. (Everyone is looking for a total energy policy that probably is not the answer but something like the Atomic Energy Act or Natural Gas Act).

3. Technology that is fully developed for transportation and conversion. (Here, I would look at the things that were evolutionary rather than revolutionary).

4. Relatively more economic than present supplies, i.e., may be as much as 10 to 20% underpriced so that within 15 years it can account for over 25% of the total supply. (This will be difficult because no one knows where other energies will eventually level).

Maybe I got away from transportation a little, but I feel certain that any solution will be very heavily dependent on the transportation of energy.

EXHIBIT 12

A solution to energy crisis must

- be a source of significant size
- have favorable legislation enacted
- have technology that is fully developed
- have an economic advantage of 10% to 20%