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CALIFORNIA'S ENERGY FUTURE

Deane N. Morris

March 1976

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The Rand Corporation
Santa Monica, California 90406

PREFACE

The principal authors of the report from which this summary was derived (R-1793-CSA/RF) are William Ahern, Ronald Doctor, William Harris, Albert Lipson, Deane Morris, and Richard Nehring. This abridgment was prepared with the assistance of Stephen Dole.

The research was sponsored by the California State Assembly with additional support from the Rockefeller Foundation and the Rand Corporation.

The paper was prepared as background material for a presentation to the 1976 Joint National Meeting of the Operations Research Society of American and The Institute of Management Sciences (ORSA/TIMS), held 31 March 1976 at Philadelphia, Pennsylvania.

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I. INTRODUCTION

This paper presents an abridgement of the results of a Rand study on energy policy issues facing California, more fully reported in *Energy Alternatives for California: Paths to the Future*, R-1793-CSA/RF, and summarized in some detail in an Executive Summary, R-1793/1-CSA/RF.

The study was started in September 1973, before the Arab oil embargo and the intensification of the energy crisis. The work was performed, therefore, during a period when perceptions of energy problems were rapidly developing and changing, and when government policy at the federal and state level was extremely fluid.

The study is concerned with the problems of an uncertain future. These problems are extraordinarily complex and interwoven. Under conditions of rapid change, the full consequences of policy actions are difficult to predict and policy objectives are difficult to define. In addition, the relationships between state and federal actions are poorly understood, involving issues of equity among individuals and regions, and issues of environment, health, safety, and land use.

Simple solutions should not be expected in such a policy area. However, a number of recommendations are presented because policy decisions should be made on the basis of the best information available when the political process demands they be made.

The brief summary presented here necessarily omits most of the rationale for our conclusions and recommendations, as well as a number of subsidiary conclusions. The interested reader should consult the full report for these additional details.

II. PRESENT ENERGY PATTERNS IN CALIFORNIA

The nation has arrived at an energy policy crossroads--the result of steadily shrinking production of petroleum and natural gas in the United States and a realization that we can no longer afford to continue our growing dependence on foreign sources of energy. This study has focused on California's part in the energy picture. During the next few years, the state's leaders will have to make many critical choices that bear upon the future of the state's energy system. To assist them, this study has attempted to:

- o Identify the major energy issues
- o Present the relevant information
- o Identify policy alternatives
- o Discuss the implications of alternative choices

Before getting into a discussion of energy problem areas in California, however, let's take a quick look at our present situation--where our energy comes from and how it is used.

ENERGY SOURCES

In 1975, the energy used in California (in terms of the primary energy contained originally in fuels or other energy sources) came from the following:

Energy Source	*Percent of Primary Energy, 1975*
Petroleum	57
Natural Gas	30
Hydroelectric	7
Coal	3
Nuclear	2
Geothermal	1
Total	100

As may be seen, California is now overwhelmingly dependent on oil and gas. Although a large oil and gas producing state, it is far from

self-sufficient in these fuels. Currently, we must obtain almost one half of our oil from outside the state (mainly from Alaska, the other western states, and foreign countries such as Saudi Arabia, Iran, and Indonesia). Similarly, almost three-quarters of our gas comes from outside the state (mainly from the southwest U.S. and from Canada). Our sources of crude oil and natural gas in recent years are shown graphically in Figures 1 and 2.

From the tabulation of sources shown above, it may be seen that the "other" energy sources (those other than oil and gas) are still relatively minor. California is unusually fortunate in having access to natural water supplies from which energy can be extracted to produce hydroelectric power. However, this source provides only 7 percent of the state's energy use, and most of the sites that could be dammed have already been developed for this use. The possibilities for expanding hydroelectric power generation are quite limited. Hardly any coal is burned in California; the designation "coal" represents energy from coal from the Four Corners area (Utah, Colorado, Arizona, New Mexico) that is sent to California in the form of electric power. Electric power production from nuclear and geothermal plants is still small in the state, but both of these sources are expected to become larger contributors as time goes by.

ENERGY CONSUMPTION PATTERNS

In 1975, the consumption of primary energy was distributed as shown in the table on page 5, according to the using sector and the form in which the energy was used (the numbers indicate percentages of the total primary energy used in the state).

It may be seen that the transportation sector in California is the largest user of petroleum products and energy in general; the industrial and residential sectors are the largest users of natural gas, while electricity is used about equally by the commercial, residential and industrial sectors.

To round out the picture, we show in Figure 3 the breakdown by type of energy used for generating California's electricity. It may be seen that the pattern has changed rather radically in the last four

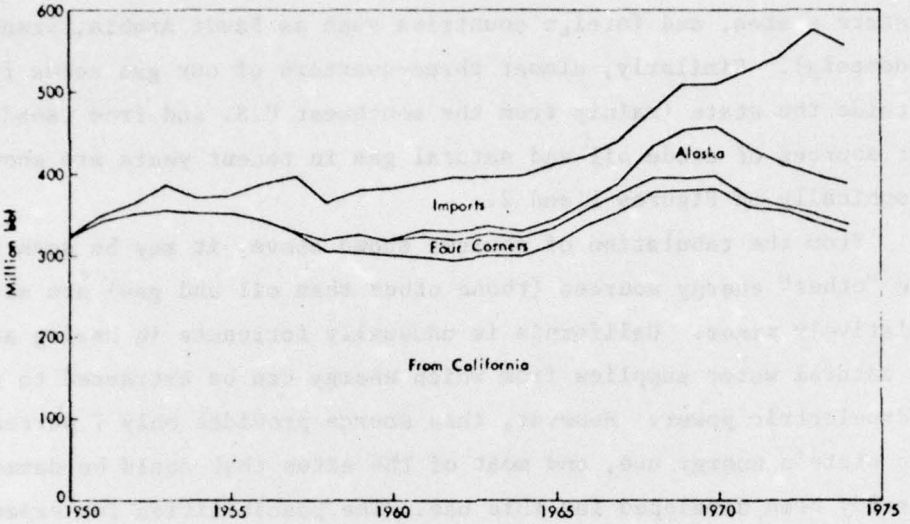

Fig. 1 —Sources of crude oil for California refineries, 1950-1974

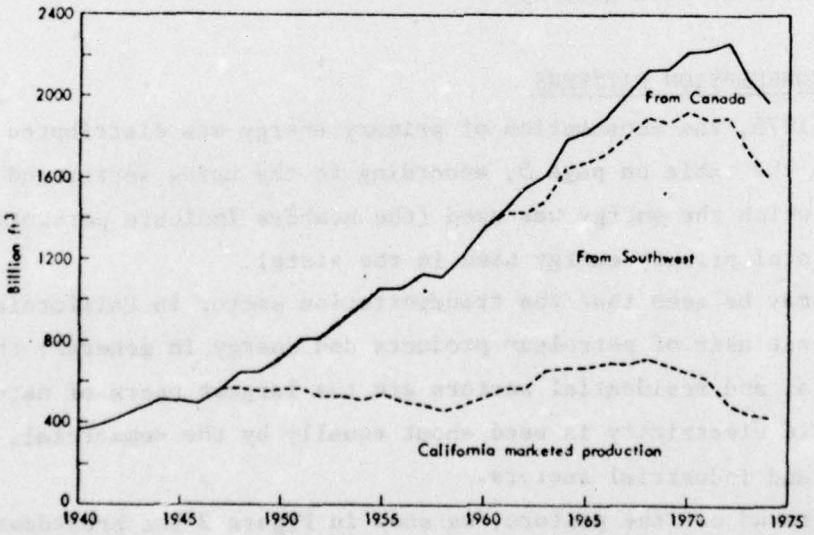

Fig. 2 —Sources of natural gas for California, 1940-1974

Form in Which Energy was Used, 1975 (percent)

Using Sector	Oil	Gas	Electricity	End-use Totals	Electricity Conversion Losses	Totals
Transportation	37	0	0	37 (47)	0	37
Industrial	7	12	3	22 (27)	6	28
Residential	--	10	3	13 (16)	6	19
Commercial	--	4	4	8 (10)	8	16
Totals	44	26	10	80 (100)	20	100

or five years, with natural gas being phased out (because of supply shortages) and replaced by oil as a power plant fuel, and nuclear and out-of-state coal gradually expanding in importance.

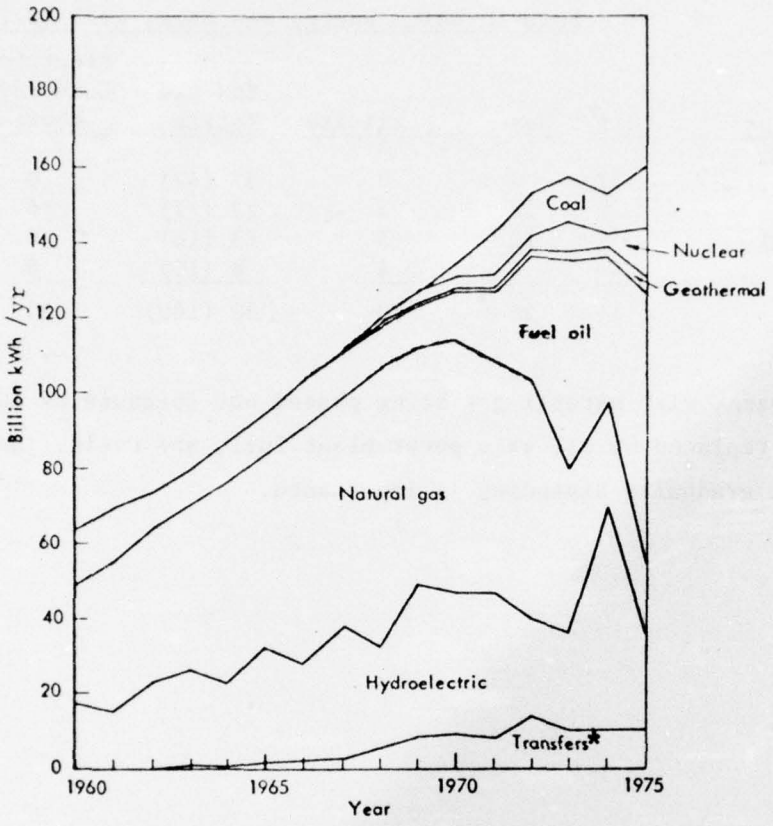

Fig. 3—Electricity produced for use in California by source of energy 1960–1975

*Electric power, mainly of hydroelectric origin, transferred from the Northwest.

III. ESTIMATES OF FUTURE ENERGY PATTERNS

The energy policy issues discussed in the next section revolve around questions of (1) future energy supplies for California, (2) the benefits and costs of energy conservation, and (3) tasks that must be undertaken by the state, first to ensure that a desirable mix of energy sources is available in the future, and second to evaluate the impacts of major proposed national energy developments as they affect California.

In view of the many complexities of these issues, we chose to examine them in the framework of forecasts of various levels of future energy sources by type and energy uses by sector, a high, medium, and low level in each case, covering the next twenty-five years out to the year 2000. The objective was to span the probable range of uncertainties about future energy prices, resource availability, government actions, and the responses of energy producers and users. The source and use projections were made independently of one another.

With three estimated levels of future sources of energy and three levels of use, there are nine possible combinations that could be analyzed. But to keep the discussion reasonably straightforward, we here consider only two of these combinations. These are: medium production with medium use (the Base Case), and medium production with low use (the Conservation Case).

SOURCE PROJECTIONS

The key assumptions that we adopted in estimating the future availability of oil and gas were based on possible variations in (1) the prices of these fuels at the wellhead, (2) amounts of domestic oil and gas resources remaining to be discovered, (3) increases in recovery of crude oil, (4) production levels of synthetic natural gas (e.g., from coal), and (5) levels of natural gas imports.

All the projections of oil production assume there is development of frontier areas offshore (the Outer Continental Shelf) and in Alaska. Assuming full development of these areas, domestic production of petroleum will increase in all cases. With the completion of the Alaskan pipeline, the recent decline in domestic production will be reversed

and production will peak in the late 1980s at levels 20 to 70 percent above current levels. In the 1990s, production is expected to decline as available oil resources start to become depleted.

California's gas supplies will undergo major changes in both availability and composition during the next 25 years. The availability of gas, both in California and nationwide, will continue to decline during the late 1970s. It could turn around and increase in the 1980s as new sources of gas--natural gas from Alaska, synthetic gas from coal, and imports of liquified natural gas--are developed extensively. These new sources will be considerably more expensive than current sources of supply. In the 1990s, total availability of gas is expected to decline in all cases.

USE PROJECTIONS

The *medium energy use case* assumes (1) economic and population growth will follow recent forecasts for the state, (2) energy prices will continue to increase more rapidly than prices of goods and services in general, and (3) energy conservation policies already adopted by the state and the federal government will be enforced. Although we consider this case to be a reasonable one for planning purposes, the uncertainties make it necessary to assess policy alternatives against other projections. The *low energy use case* is derived by assuming that a number of state policy actions will be taken to implement energy conservation measures beyond those already planned and those that result from price increases. A *high energy use case* would assume no increases in energy prices and no government actions to induce conservation. Because these last assumptions are viewed as unlikely, this case was used mainly for estimating (by difference) the amount of voluntary energy conservation in which people would engage in response to increased energy prices. It is not discussed further in this summary.

BALANCING SOURCES AND USES

The balancing procedure consisted of a systematic allocation of the available energy sources among the several using sectors. As mentioned before, we have chosen two cases to illustrate the projections

into the future, a Base Case (medium production-medium use), and a Conservation Case (medium production-low use). The salient features of these two cases are summarized as follows.

Base Case. The outstanding feature of the Base Case (Table 1) is the high relative growth of electricity as an energy form within the state.[1] The electrical energy growth, at an average annual rate of 4.7 percent between 1975 and 2000, is much greater than the overall rate of growth of energy use in the state, 2.4 percent. Among the sources of electricity in 2000 the largest by far is nuclear generation. This is consistent with the announced plans of utility companies who prefer nuclear power because of its expected lower costs compared with generation from oil, gas, or coal. Geothermal energy appears as a small but rapidly growing component of electrical power generation. Another feature of the Base Case is the continuing importance of gas as a fuel for industry. Transportation continues to dominate the use of oil in the state, but its growth is substantially slower than in the past.

Conservation Case. Results for the Conservation Case are shown in Table 2. Note that conservation in residential and commercial use of natural gas makes more gas available to industrial and utility users. Assuming that the utilities will be allowed to use this gas, less oil will be needed for electricity generation. Conservation in use of electricity results in a significantly reduced need for nuclear power plant capacity. The nuclear capacity in the Conservation Case at century's end is only 57 percent of that projected in the Base Case. Another difference between the two cases is in the petroleum used for transportation. The Conservation Case shows a slight decline over the period in contrast with the slight rate of growth in the Base Case. Overall, by the year 2000, the total amount of primary energy projected in the Conservation Case is about 76 percent of that in the Base Case.

Both projections indicate that oil will continue to be the number one source of energy for the state and that gas will be reduced in

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[1]Note that the uses of oil and gas by the electric utilities appear in the tables twice, and should not be double counted in determining total energy use.

Table 1

PROJECTED ENERGY USE IN CALIFORNIA, BASE CASE
IN COMMON UNITS (Trillion Btu)

	Year		
Type	1975	1985	2000
Natural gas			
Total use	1700	2080	1910
Residential	570	620	650
Commercial	240	290	460
Industrial fuel	680	800	590
Electric utilities	210	370	210
Electricity generation			
Total end-use	550	880	1710
Conversion losses	1130	1830	3560
Sources			
Hydroelectric	370	380	380
Geothermal	40	320	800
Coal	170	310	310
Nuclear	140	520	3120
Gas	210	370	210
Oil	750	810	450
Oil			
Total use	3230	3300	3790
Transportation	2090	2360	2820
Electric utilities	750	810	450
Residential & commercial	20	20	20
Industrial fuel	370	110	500
Total energy end-use	4520	5080	6750
Total primary energy use	5650	6910	10310

Note: feedstock and other non-energy uses are excluded.

Table 2

PROJECTED ENERGY USE IN CALIFORNIA, CONSERVATION CASE
IN COMMON UNITS (Trillion Btu)

Type	Year 1975	1985	2000
Natural gas			
Total use	1700	2070	1900
Residential	570	510	400
Commercial	240	240	300
Industrial fuel	680	800	800
Electric utilities	210	520	400
Electricity generation			
Total end-use	550	820	1340
Conversion losses	1130	1690	2780
Sources			
Hydroelectric	370	380	380
Geothermal	40	320	800
Coal	170	310	310
Nuclear	140	520	1790
Gas	210	520	400
Oil	750	460	440
Oil			
Total use	3230	2320	2660
Transportation	2090	1730	1900
Electric utilities	750	460	440
Residential & commercial	20	20	20
Industrial fuel	370	110	300
Total energy end-use	4520	4230	5060
Total primary energy use	5650	5920	7840

Note: feedstock and other non-energy uses are excluded.

relative importance. Today about half of our oil comes from outside the state. In the Base Case projection, California offshore production will reduce this dependence to almost zero by the 1990s. In the Conservation Case, the state could become virtually independent of outside oil and a net exporter to other states. In all cases we will have to obtain 60 to 80 percent of our gas from outside the state. Geothermal and nuclear energy will gradually grow in importance as shown in the following breakdown for the year 2000.

	Percent of Primary Energy, 2000	
Energy Source	*Base Case*	*Conservation Case*
Petroleum	37	34
Natural gas	18	24
Hydroelectric	4	5
Coal	3	4
Nuclear	30	23
Geothermal	8	10
	100	100

IV. ENERGY POLICY ISSUES

Using the above projections of energy supply and consumption to give some insight into the future, we identified a number of problem areas which are discussed below. The conclusions arrived at in the study with respect to these problem areas are summarized.

OIL AND GAS SUPPLY ISSUES

West-to-East Movement of Oil. Is it advantageous for California to serve as the western terminus of a new oil pipeline? Oil from Alaska and California will constitute an increasingly large share of the nation's petroleum production over the remainder of this century. Thus, there could be substantial surpluses of oil to be shipped eastward. The amounts available for shipment will depend mainly on the magnitude of future oil production in Alaska, offshore California and the Elk Hills Naval Petroleum Reserve, on the level of energy conservation in California, and on the continuation of low-sulphur oil imports to the West Coast. A surplus is likely to exist by 1980. By 1990 it could amount to 2 to 4 million barrels a day.

Two basic routes for the West-East pipeline are under consideration (Figure 4): (1) a northern route beginning in the Puget Sound area and terminating in the Midwest, and (2) a southern route beginning in southern California, traversing the southwest to west Texas. If southern California were to become the western terminus of such a pipeline, there would be both benefits and adverse effects for the state. The benefits include some additional jobs, substantial port revenues, and potentially lower crude oil costs. The possible adverse effects include a much increased risk of oil spills in California waters with their attendant cleanup costs, and the loss of gas pipeline capacity if existing gas pipelines are converted to oil transport.

There are three interrelated policy questions for California: (1) Should it accept or oppose the choice of California as the western terminus? (2) If the state accepts, what conditions should it require to protect its interests? (3) How shall the state acquire the leverage it needs to protect its interests? It is apparent that a focal point in

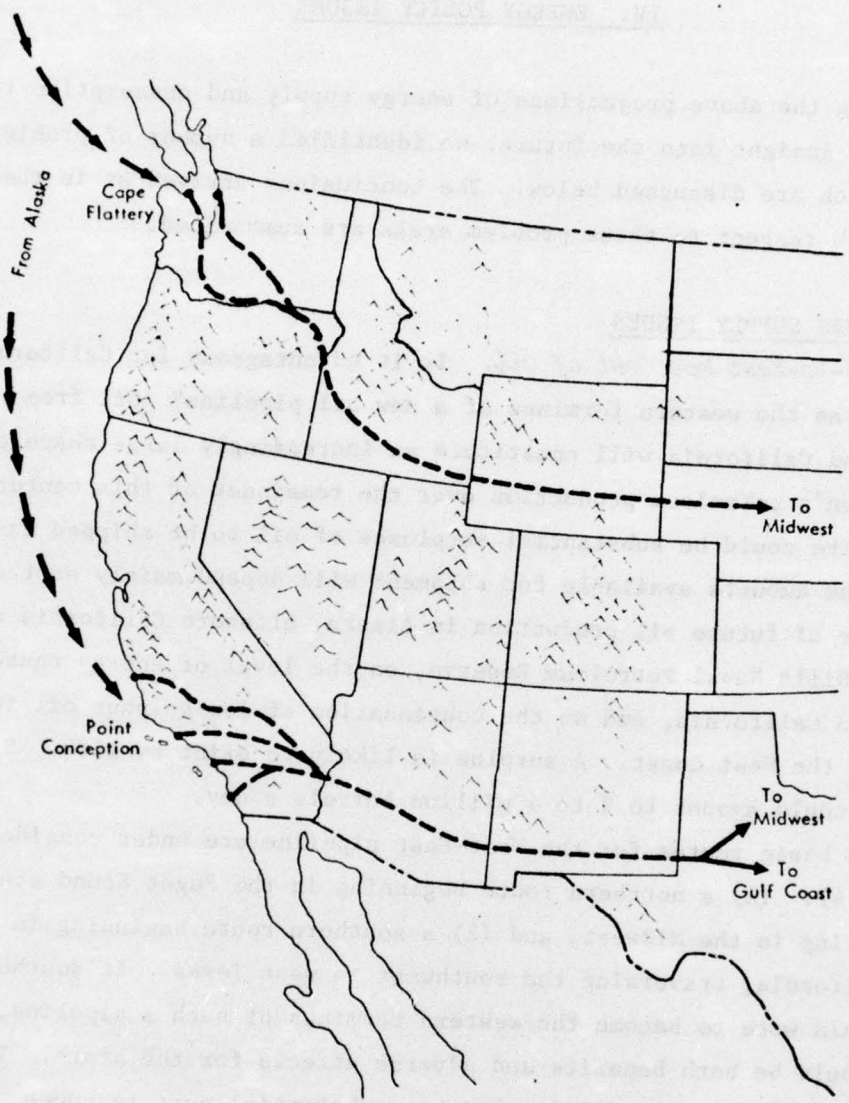

Fig. 4 —Possible West-East pipeline routes for Alaskan oil

state government will be needed to formulate a firm policy position and to represent the state interests to federal agencies involved in selecting the route and regulating oil transport.

The conclusions of the study in this area are summarized as follows:

- Because the choice of route for a West-East oil pipeline will have a major effect on the future distribution of domestic oil production, California should seek an evaluation by the federal government of alternative routes before commitments are made to any one route. This evaluation should include an examination of West-East oil movement in the context of long-run energy development in the Pacific Coast states.
- Since preliminary indications are that the preferred route would begin in California, a lead state agency should be given the responsibility (1) to evaluate corridor, right-of-way, and terminal alternatives concurrently with any federal study; (2) to coordinate planning for a West-East oil pipeline with other energy facilities; (3) to represent before the appropriate federal bodies California's interests in obtaining necessary safeguards, particularly for tanker construction and operation; and (4) to make appropriate recommendations to the governor and the legislature.
- California should oppose conversion of present interstate gas pipelines for use in West-East oil movement until it can be shown that such conversions would not reduce natural gas or synthetic gas shipments to California. Preliminary data indicate that at least one of five El Paso gas pipelines may be converted without loss of future gas supplies.
- If it can be shown that a route beginning in California is in the national interest, and if appropriate measures

that minimize the costs to California of West-East oil movement are implemented, opposition by the state to a West-East pipeline does not appear warranted.

Offshore Oil and Gas Development. Questions of developing state offshore lands (within three miles from shore) and the OCS (Outer Continental Shelf, under federal control) for oil and gas production involve numerous policy issues for California. While the state has direct control over leasing and development of state offshore lands, it can only influence decisions on the OCS, primarily through its permit-granting authority over pipelines and onshore facilities. Again, there are potential benefits and adverse effects of development, both involving uncertainties. Offshore development promises to provide most of the oil for the future California market and possibly 15 to 20 percent of California's gas needs. It would also reduce oil imports and provide jobs. However, it would bring an increased risk of oil spills, create adverse effects on recreational and property values in coastal areas, and require the construction of some unsightly structures in the coastal zone.

The basic alternatives for the state are: (1) to use its permit authority to delay or prevent further leasing and development; (2) to approve proposals as submitted; or (3) to establish conditions for development and seek state participation in key aspects of OCS leasing and development. It appears that a well regulated offshore development would be beneficial to the state.

The conclusions reached in the study were as follows:

- California should seek a joint federal/state planning effort for OCS leasing and development: (1) to determine leasing areas to the mutual satisfaction of both parties; (2) to promote consolidation and coordination of onshore facilities associated with offshore developments; (3) to encourage the use of technology that minimizes the onshore visual effect of offshore facilities;

and (4) to evaluate and upgrade, as necessary, safety regulations and oil spill contingency plans and capabilities. The governor should designate a lead agency to participate in this effort.

- Environmentally sensitive areas should be excluded from the first lease sale.
- California should support federal compensation for onshore areas adversely affected by offshore development and should also support a comprehensive federal oil spill liability fund.

Northern California Deepwater Port. Will California need a deepwater port to serve San Francisco Bay Area refineries in the future? Whether it will or not depends on a variety of uncertainties: the quantity of oil that is produced offshore; whether the Elk Hills Naval Petroleum Reserve is allowed to be tapped for domestic use; and future imbalances (northern California versus southern California) in oil production, refinery capacity and input, and consumption. If shipments from Alaska and foreign countries to San Francisco Bay Area refineries approach or exceed about 600,000 barrels per day (assuming no production from Elk Hills), a deepwater port serving these refineries may be desirable. Because they can accomodate larger tankers, deepwater ports permit reduction in the transport cost of oil and less tanker traffic for a given amount of oil shipped (and thus a reduced risk of collisions). But with the use of larger tankers, the size of the largest possible spill is increased. Such a facility would not be necessary, however, if tanker shipments of oil for northern California refineries remain well below the level of 600,000 barrels per day.

It was concluded that:

- If a proposal for a northern California deepwater port is made in the future, the legislature should establish standards for its construction and operation.
- A process should be developed to coordinate the port facility with other energy developments, particularly

the development of oil production in Alaska and the Santa Barbara OCS.

Gas Transportation from the North Slope of Alaska. Two routes for transporting natural gas from Alaska's North Slope to U.S. consumers in the "lower 48" are now being considered by the Federal Power Commission. These are shown in Figure 5. One, the Arctic Gas system, is an all-pipeline route across Alaska, Canada, and the United States. The other, the El Paso system, consists of a gas pipeline across Alaska in combination with the transport of liquified gas by tanker to California and the Southwest. The choice between these two proposed systems could have a profound influence on California's gas supply from 1980 into the 21st century. Although the decision is a federal one, California as an intervenor could influence that decision.

In comparing the two routes on the bases of costs, reliability, timeliness, safety, and environmental effects, the Arctic Gas system appeared to have a slight edge. However, because actions by the Canadian government could alter the apparent superiority of the Arctic Gas system, the study concluded that:

- The state should not make an immediate commitment to either of the two proposals.
- A task force of the involved commissions and agencies should determine, and communicate to the Department of State, an acceptable range of conditions for the terms of a potential agreement between the United States and Canada governing the Arctic Gas system. Of particular importance here are conditions regarding (1) equitable sharing of pipeline construction and operating costs, (2) future expansion of the line, (3) reliability of deliveries, and (4) nondiscriminatory taxation by provincial and federal governments in Canada.
- If there are reasonable assurances that these conditions will be met, California should support the Arctic Gas proposal.

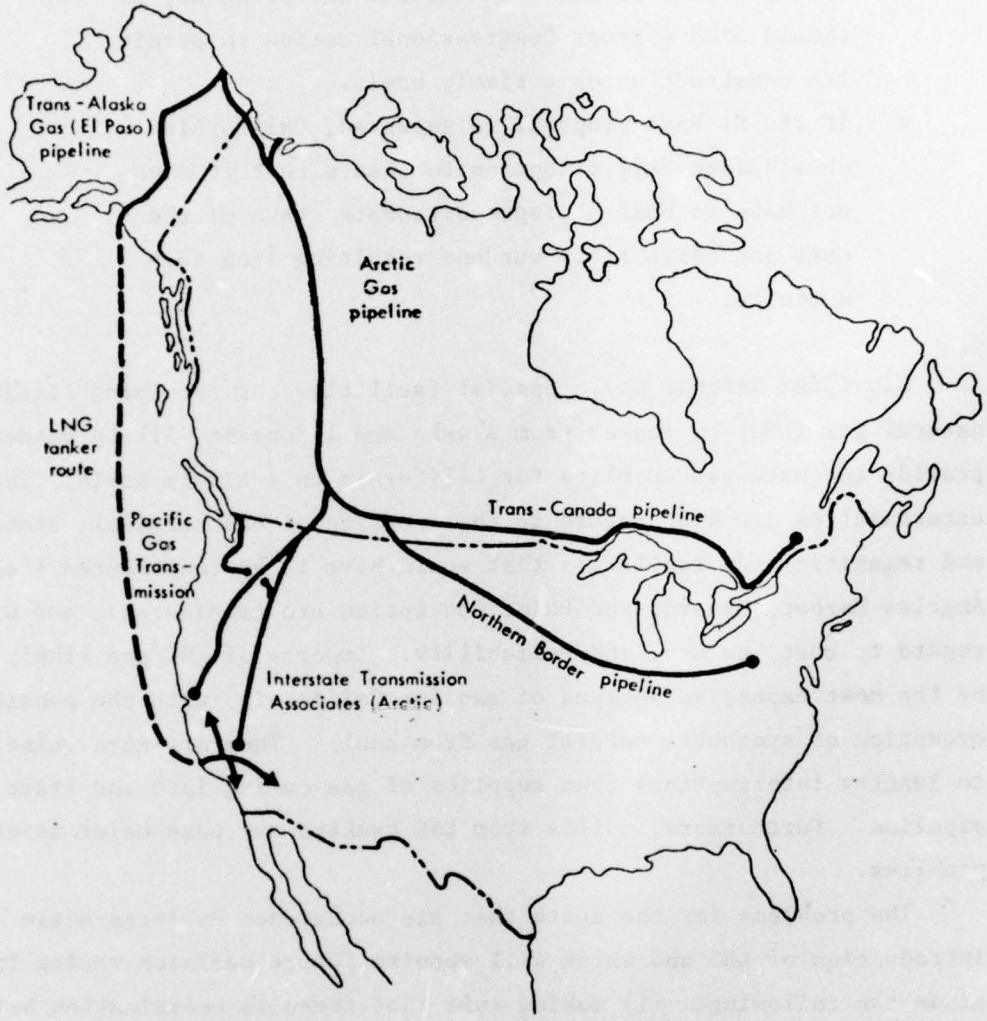

Fig. 5—Proposed North Slope natural gas transportation systems

- o If California supports the Arctic Gas proposal, it should also support Congressional action to permit its construction on a timely basis.
- o If the El Paso proposal is selected, California should seek federal action to ensure that it does not have to bear a disproportionate share of the cost and reliability burdens resulting from such a choice.

Liquified Natural Gas. Special facilities for receiving liquified natural gas (LNG) by tanker from Alaska and Indonesia will be needed to provide adequate gas supplies for California on a timely basis. The uncertainties are with regard to the location of the terminal, storage, and regasification facilities that would have to be constructed (Los Angeles Harbor, Oxnard, and Point Conception are candidates), and with regard to cost, safety, and reliability. Imports of LNG are likely to be the most expensive sources of gas for California (with the possible exception of synthetic natural gas from coal). They are more vulnerable to lengthy interruptions than supplies of gas coming into the state by pipeline. Furthermore, spills from LNG tankers may pose major safety problems.

The problems for the state that are occasioned by large-scale introduction of LNG and which will require future decision making include the following: (1) making sure that there is coordination between LNG proposals and other gas supply issues; (2) ensuring coordination of LNG facility siting with other energy facility siting; (3) making provisions for handling the consequences of possible interruptions in LNG shipments and potential LNG accidents; (4) choosing terminal sites. It is suggested that it would be advantageous to designate a single state agency for coordinating LNG terminal siting decisions. LNG can be a useful addition to California's gas supplies if other less costly and more reliable sources fail to become available on a timely basis. Development of other sources of gas should be encouraged, however, to avoid too heavy a dependence on LNG.

The conclusions of the study were that:

- The Interagency Natural Gas Task Force and other relevant state institutions should encourage the timely development of other sources of gas supply--selecting among the options of (1) developing gas supplies from the federal OCS off California, (2) supporting federal legislation permitting increases in new contract prices for interstate gas supplies, and (3) urging federal approval, under appropriate safeguards, of the Arctic Gas proposal for transport of North Slope gas to U.S. markets.
- The California legislature should establish a process for LNG terminal siting coordinated by a single state agency. Because shipments of LNG from south Alaska and Indonesia could provide timely additions to California's gas supply, one LNG terminal should be approved soon. Los Angeles Harbor should not be the initial site unless the uncertainties with respect to LNG safety can be demonstrated to be insignificant.
- Siting of LNG terminals should also be coordinated with other energy developments, particularly West-East oil movement and offshore development.
- Appropriate state agencies, working with federal agencies, should establish safeguards to minimize the effects of potential disruptions in LNG shipments.
- The legislature should consider establishing a hazardous gas liability and compensation fund for damage resulting from any LNG accident that may occur.

Natural Gas Regulation. The question of governmental regulation of natural gas prices and production is a particularly knotty one. Some of its elements include: (1) the lack of competition in the corporate ownership of Alaskan gas reserves and in the ownership of gas pipelines serving California markets; (2) uncertainties about the effects on gas supplies that would result from removing federal price controls; (3) uncertainties about the future availability of Canadian

gas to California consumers; (4) uncertainties about future legislation that would prohibit electric utilities from using gas as a boiler fuel except in air-quality emergencies.

Because the subject of gas regulation is so complex, we will not go into these issues here but present the major conclusions in this area that were reached in the study. These are as follows:

- California should support deregulation of new onshore gas supplies sold in the interstate market.
- California should seek common carrier status for *interstate* gas pipelines.
- The California legislature and the California Public Utilities Commission (CPUC) should postpone imposing common carrier status on gas utility pipelines *inside* the state until there is federal gas price deregulation and until there are reasonable guarantees that this would not result in additional curtailments of gas to utility customers.
- California should take the initiative in working with other states and the U.S. government to limit major curtailments of Canadian gas exports to the U.S.
- The CPUC should adopt an end-use curtailment system for natural gas allocation to minimize further curtailment of interstate gas supplies.

OTHER SUPPLY ISSUES

Electricity Generation. A survey and comparison of possible future mixes of electricity generation facilities was made during the course of the study. Estimates of future capacity were derived primarily from electric utility projections and other published information. The power generation facilities considered included natural gas and petroleum fueled steam plants, coal-fired power plants in the southwestern states, nuclear power plants, hydroelectric power, and geothermal resources.

Two important policy recommendations emerged from this brief survey:

- o Permission should be sought from the Federal Power Commission for the use of natural gas for electricity generation in critical air basins, at least during periods of high levels of pollution.
- o Contingency plans should be developed by the state for alternative actions in the event the Nuclear Safeguards Initiative becomes law.

Geothermal Development. As shown in the table on page 13, geothermal energy is projected to provide some 8 to 10 percent of the state's energy supply in the year 2000. Certain problem areas will have to be dealt with by governmental agencies, however, to encourage the development of this energy resource. The problem areas we identify include: (1) uncertainties about the legal definition of the resource, (2) uncertainties concerning property tax status, (3) lack of clarity in leasing procedures, (4) lack of development of private leaseholds.

The recommendations of the study in this area were for joint federal/state action on the following:

- o Removal of regulatory impediments that may unnecessarily slow development. Steps in this direction would be (1) consolidation of ownership of KGRAs (known geothermal resource areas) by federal and state governments, (2) development of common regulations, and (3) consolidation of reporting on environmental effects when possible.
- o Requiring performance by those who hold geothermal leases (e.g., for exploration and development) within a reasonable time after leases are purchased.
- o Continued support of research and development to resolve remaining environmental, technical, and other problems associated with development.

Solar Energy. Although solar energy does not appear in the tabulated projections shown here, it could replace a significant

fraction of the electric energy used for space and water heating in the residential sector, particularly if positive action were taken by state or federal agencies to encourage its development and use.

The study recommended consideration of:

- State subsidies to support research and development directed toward reducing manufacturing and installation costs, job training, and tax credits for a solar industry.
- Financial incentives for builders and homeowners, such as property tax exemptions, state guaranteed loans, low-interest loans, and income tax credits.
- Establishment of state building code, construction and performance standards to encourage use of solar energy.
- CPUC encouragement of solar system installation by lease purchase arrangements allowing utility customers to pay for such systems as part of their monthly bills.
- Development by appropriate state agencies of legal guidelines bearing on individual rights to sunlight.
- State support of the development of organic waste conversion systems, and a demonstration program for production of energy crops and associated conversion facilities.

ENERGY CONSERVATION ISSUES

The projected differences in energy use between the Base Case and the Conservation Case (Tables 1 and 2) result from hypothetical government actions of various kinds that would be taken to promote energy conservation. These might include providing information to consumers, taxing undesired energy uses, subsidizing energy-conserving practices, imposing mandatory minimum energy standards on buildings and energy-consuming appliances, or prohibiting certain uses of energy.

Like other government actions, energy conservation programs would produce both benefits and costs. The benefits would be those arising

from the reduced energy use. These include reduced reliance on imports of oil, avoidance of spillover effects of energy production and use on the environment (such as air pollution), more time to resolve uncertainties about future energy supplies, and reductions in outlays for energy.

The costs include, of course, the costs of administering the government program. They also include reductions in the services provided by the energy use in question, and the value to energy users of the consumption opportunities that would be lost because of government actions. They may include increases in costs of energy-using equipment and economic dislocations.

In evaluating various actions the government might take to foster conservation, the study focused on actions having the largest potentials for reducing the state's energy usage in future years. It was not possible, however, to conduct a thoroughgoing assessment of all of the relative social costs and benefits of alternative programs. The most promising targets for conservation among the many that were studied appeared to be the following: (1) gasoline-burning vehicles (automobiles and trucks) where energy consumption could be reduced by requiring new models to have better fuel economy and by reducing the number of vehicle miles travelled through increased taxation of gasoline, (2) the energy used in the heating and cooling of both commercial and residential buildings, where energy consumption could be reduced through improved operating practices and improved standards of construction, and (3) the fossil fuels used by industry for process heat and steam generation, where efficiencies could be improved.

Relative to automobile gasoline consumption, the study concluded that:

- The state should evaluate means, preferably in conjunction with the federal government, to increase the fuel efficiency of automobiles and the conservation of gasoline. The evaluation should consider the various proposals that have been made to encourage such results, including excise taxes on new cars graduated by fuel efficiency, mandated fuel efficiency standards, and higher gasoline prices.

- o There should be increased support for state informational, educational, and other services to encourage carpooling. Recent experience indicates that these efforts are cost-effective and can result in gasoline savings, especially in a climate of rising gasoline prices.

In connection with the heating and cooling of buildings, the study recommended that the state:

- o Monitor carefully the effectiveness and costs of recently adopted insulation standards for new construction and consider the desirability of adopting more stringent standards as soon as possible.
- o Evaluate standards and incentives (e.g., tax reductions, low-interest loans or partial subsidies) for the improvement of the thermal integrity of existing stocks of buildings (e.g., added insulation, caulking, and weatherstripping and electrical ignition of furnaces). Such improvements could, for example, be required at the time of property resale.
- o Provide incentives for maintaining and reconditioning heating and cooling systems.

With regard to industrial energy use, the study recommended that the state take an active part in the exchange of information on progress in more efficient use of energy for process heat and raising steam. State agencies could, for example:

- o Serve as focal points for monitoring, collecting, and disseminating the results of energy conserving actions by individual industrial plants.
- o Sponsor periodic conferences among industrial groups on techniques for more efficient use of energy.

INSTITUTIONAL ISSUES

At the present time at least 20 governmental agencies at the state level are concerned with energy problems. These include the newly created Energy Resources Conservation and Development Commission, the CPUC, and the Coastal Zone Conservation Commission, among others. Consequently, there is some degree of overlapping and fragmentation of responsibility, and there are certain conflicts between energy development and environmental protection which tend to interfere with the state's capability for producing a coordinated energy policy.

The study considered a number of institutional arrangements that might improve the state's capability to analyze, develop, and implement energy policy but concluded that a major reorganization of state energy activities at this time would be premature for the following reasons: (1) an important new agency, the Energy Commission, has only recently begun to function; (2) major reorganization could well disrupt the operation of existing state agencies at a time when they must respond to the critical emerging problems we have identified; and (3) important land-use policy issues associated with major reorganization proposals are unlikely to be resolved quickly. Longer term institutional changes should be developed as land-use issues are debated and more experience is gained with the operation of the Energy Commission.

To deal with more immediate problems, the study made the following recommendations:

- A lead agency or task force should be designated to review, in a coordinated manner, proposed plans for facility construction associated with West-East oil movement, offshore oil and gas development, transportation of North Slope gas to California, and use of LNG.
- Since OCS planning will be continuous and involve interaction with federal agencies over a long time period, a specific agency should be designated to coordinate OCS-related state activities. Such an agency should represent broad state energy and environmental policy interests.

- A lead agency or agencies should be delegated responsibility to review major gas regulatory problems and policy alternatives, to develop a coherent state position, and to represent California before the FPC and other federal agencies on major issues affecting gas availability.