A Blueprint for Cogeneration at State Facilities

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At the June 3, 1980, meeting of the Governor's Cogeneration Task Force, Governor Edmund G. Brown Jr., challenged utilities and industries to develop 6,000 megawatts (MW) of electricity in California during the 1980s through cogeneration. The Governor also announced that the state will take the lead by beginning immediately to develop 400 MW of cogeneration at state facilities.

As a first step, the Governor requested the Department of General Services, the Office of Appropriate Technology, and the Department of Water Resources to prepare a blueprint for developing this capacity. The Governor called for identification of feasible cogeneration projects that can be implemented without delay; establishment of an overall timetable for additional planning, feasibility studies, design and construction; and a discussion of potential sources of funds.

Since the Governor's announcement, the California Energy Commission, the Department of General Services, the Office of Appropriate Technology, the University of California, and the state university and colleges, with the cooperation of the Departments of Developmental Services, Mental Health, Corrections, and Health Services have initiated, continued work on, or completed feasibility studies or engineering design work for state facilities totaling more than 177 MW of cogeneration capacity. The Department of Water Resources has conducted preliminary site investigations at thirteen additional state facilities.

Earlier in 1980, the Department of Water Resources (DWR) hired a consultant to identify state-owned facilities that have potential for using cogeneration systems. The consultant was asked to identify potential projects to provide water heating, space conditioning or process heat for on-site thermal energy requirements, and for electric energy for the state water project.

The study concluded that substantial cogeneration capacity and energy potential exist in state facilities. Overall, 188 state facilities were identified as having sufficient thermal energy requirements to make cogeneration technically feasible and cost effective. DWR estimates that the electric capacity for technically feasible cogenerated power totaled over 700 MW, with an average plant size of approximately 3.6 MW. Of the potential 700 MW identified, 490 MW were considered cost effective to develop.

Near-Term Potential

The study team evaluated cogeneration projects to determine their potential for development in the near-term: those projects that could be designed, under construction, or operating within three years. The projects were evaluated using four criteria:

(1) *Results of Feasibility Studies*—Those projects with draft or completed feasibility studies that showed that cogeneration investments were cost effective were scheduled for immediate development. Projects with limited available data such as Community College sites were not considered to have near-term potential.

(2) *Status of Conservation Program*—Those sites with a history of effective conservation programs were given high priority. Sites where conservation studies have been initiated were also given a high priority. Those sites with limited conservation programs were scheduled for feasibility studies in FY 81-82 to enable conservation studies to be conducted and improvements to take place.

(3) *Estimated Thermal Loads*—Those sites with fairly constant daily and annual thermal loads were given priority because they result in the most cost-effective cogeneration investments.

(4) *Status of Cogeneration Technologies*—The larger cogeneration sites using gas turbines with current air emission controls were given high priority. Also included in the near-term potential were a limited number of sites requiring technologies such as small gas turbine and internal combustion engines with new air emission control devices. New cogeneration technologies were included as a demonstration and development program.

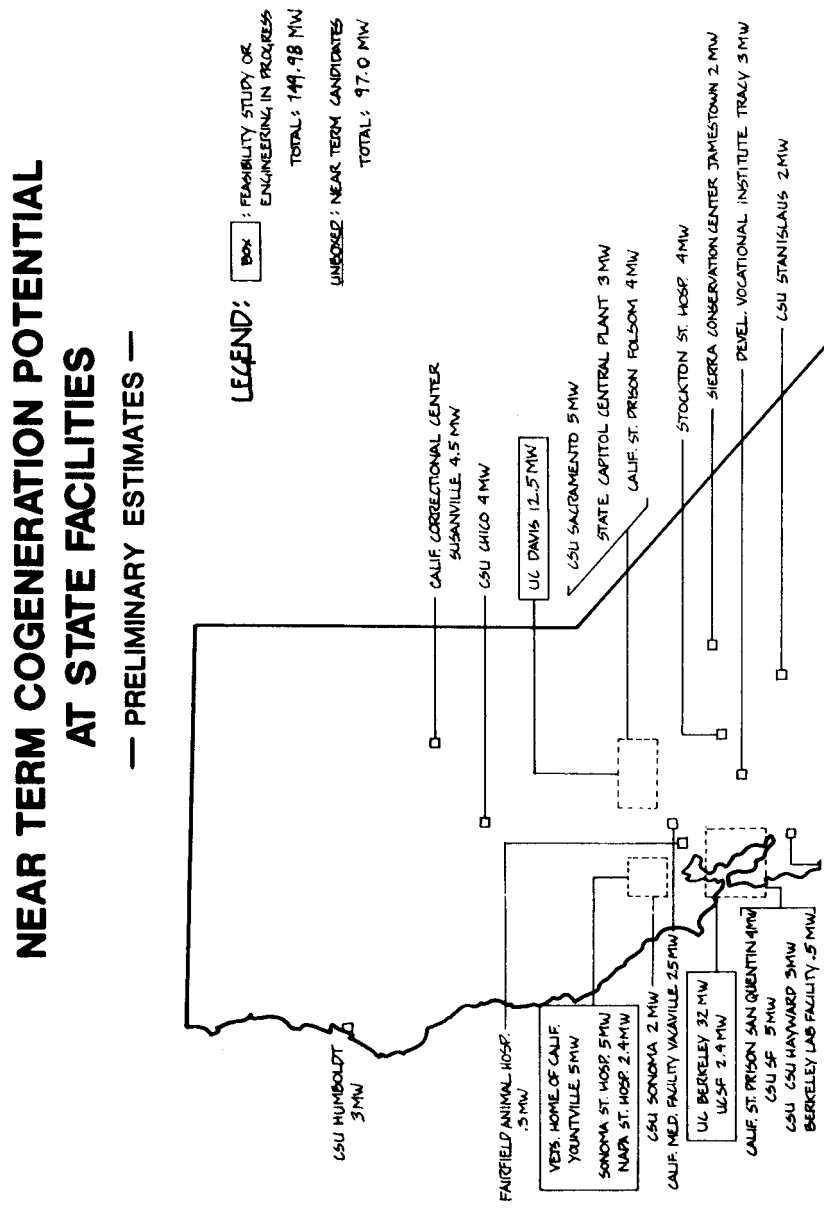
Analysis using the above criteria resulted in a broad grouping of near-term potential by type of facility. The near-term potential consists principally at the campuses of the University of California, the State University and colleges, the state hospitals, and correctional institutions. Additional sites include the state Central Heating and Cooling Plant in Sacramento, the Veterans Home in Yountville, the Berkeley Health Laboratory Facility, and the Fairfield Animal Hospital.

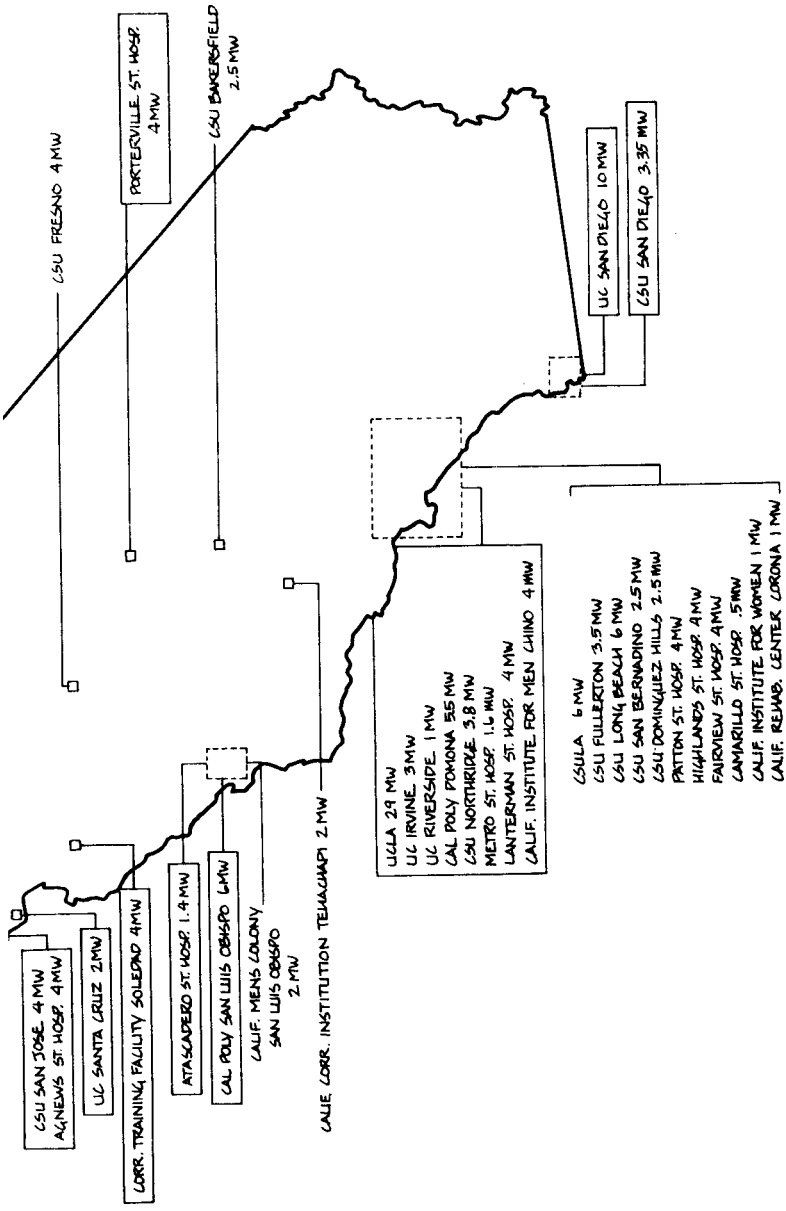
- The magnitude of cogeneration potential varies greatly depending on the type of facility. The *University of California* system offers the largest individual sites for cogeneration, averaging 11 MW. The UC Berkeley campus offers the largest potential cogeneration capacity of 32 MW.
- Every *state university and college* analyzed demonstrates significant cogeneration potential. Estimated capacity ranges from 2 MW to 6 MW per campus, averaging 3 MW.
- *State correctional facilities* offer good opportunities because of their steady demand for heating. The facilities average about 3 MW and range in capacity from 1 MW to 4.5 MW.
- Many *state hospitals* have similar heat loads. This demand is large enough to support cogeneration plants sized between 1.4 MW and 5 MW.

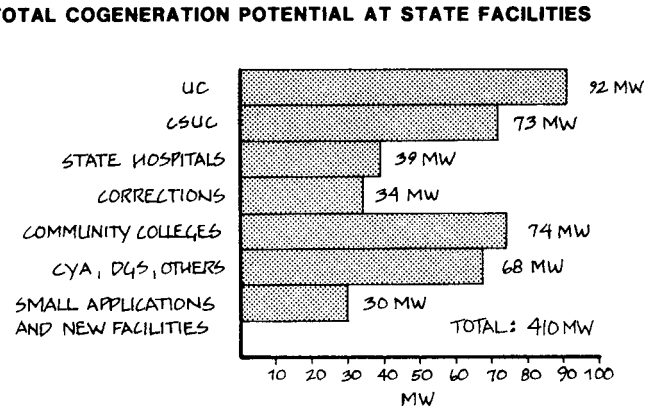
The evaluation showed that 150 MW at 24 sites could be designed, under construction or in operation in FY 1981-82. An additional 97 MW at 31 sites could be developed in FY 1982-83, totaling 247 MW at 55 sites (see map). *It should be clearly understood that these are preliminary estimates of cost-effective cogeneration capacity*. Further engineering analysis may result in increased or decreased capacities. For example, the feasibility study for Metropolitan State Hospital indicated a capacity of 1.6 MW. Currently, detailed engineering analysis has shown that 3.2 MW can be developed for the same cost as the 1.6 MW system.

Total Cogeneration Potential

Based on our review of specific facilities, total cogeneration potential in state facilities is in excess of 400 MW. Some of this additional potential may require new technologies, such as small, modular cogeneration systems. The following chart shows where this total cogeneration potential lies.


NEAR TERM COGENERATION POTENTIAL
AT STATE FACILITIES
— PRELIMINARY ESTIMATES —
LEGEND:
BOX : FEASIBILITY STUDY OR ENGINEERING IN PROGRESS
TOTAL: 149.98 MW
UNBOXED: NEAR TERM CANDIDATES
TOTAL: 97.0 MW
CSU HUMBOLDT 3 MW
FAIRFIELD ANIMAL HOSP. .5 MW
VETS. HOME OF CALIF. YOUNTVILLE 5 MW
SONOMA ST. HOSP. 5 MW
NAPA ST. HOSP. 2.4 MW
CSU SONOMA 2 MW
CALIF. MED. FACILITY VACAVILLE 2.5 MW
UC BERKELEY 32 MW
UCSF 2.4 MW
CALIF. ST. PRISON SAN QUENTIN 4 MW
CSU SF 5 MW
CSU CSU HAYWARD 3 MW
BERKELEY LAB FACILITY .5 MW
CALIF. CORRECTIONAL CENTER SUSANVILLE 4.5 MW
CSU CHICO 4 MW
UC DAVIS 12.5 MW
CSU SACRAMENTO 5 MW
STATE CAPITOL CENTRAL PLANT 3 MW
CALIF. ST. PRISON FOLSOM 4 MW
STOCKTON ST. HOSP. 4 MW
SIERRA CONSERVATION CENTER JAMESTOWN 2 MW
DEVEL. VOCATIONAL INSTITUTE TRACY 3 MW
CSU STANISLAUS 2 MW


CSU SAN JOSE 4 MW
A.NEWS ST. HOSP. 4 MW
UC SANTA CRUZ 2 MW
CORR. TRAINING FACILITY SOLEDAD 4 MW
ATASCADERO ST. HOSP. 1.4 MW
CAL POLY SAN LUIS OBISPO 6 MW
CALIF. MENS COLONY
SAN LUIS OBISPO
2 MW
CALIF. CORR. INSTITUTION TEHACHAPI 2 MW
CSU FRESNO 4 MW
PORTERVILLE ST. HOSP.
4 MW
CSU BAKERSFIELD
2.5 MW
UCLA 29 MW
UC IRVINE 3 MW
UC RIVERSIDE 1 MW
CAL POLY POMONA 5.5 MW
CSU NORTHRIDGE 3.8 MW
METRO ST. HOSP. 1.4 MW
LANTERMAN ST. HOSP. 4 MW
CALIF. INSTITUTE FOR MEN CHINO 4 MW
CSULA 6 MW
CSU FULLERTON 3.5 MW
CSU LONG BEACH 6 MW
CSU SAN BERNADINO 2.5 MW
CSU DOMINGUEZ HILLS 2.5 MW
PATTON ST. HOSP. 4 MW
HIGHLANDS ST. HOSP. 4 MW
FAIRVIEW ST. HOSP. 4 MW
CAMARILLO ST. HOSP. .5 MW
CALIF. INSTITUTE FOR WOMEN 1 MW
CALIF. REHAB. CENTER, CORONA 1 MW
UC SAN DIEGO 10 MW
CSU SAN DIEGO 3.35 MW



The Role of Conservation and Renewable Resources

In developing cogeneration at state facilities, the following must be considered in this order:

- Energy Demand: The state must minimize its demand for energy by curtailing all unnecessary uses.
- Energy Conversion: The state must maximize energy efficiency by improving the methods of energy conversion, i.e., cogeneration.
- Energy Supply: The state must evaluate renewable resources as an energy supply option before considering the use of high-cost conventional energy sources.

Cogeneration is a very efficient method of providing electricity and heat. **In evaluating a facility, cost-effective conservation measures must take place first. Then cogeneration must be evaluated along with the potential for renewable resource use.** For example, the California Correctional Center at Susanville appears to be a cost-effective cogeneration investment. However, the Department of General Services and the California Energy Commission are studying the use of known geothermal hot water resources for heating the facility. The geothermal project may, at the conclusion of the study, support the cogeneration investment or lower its cost effectiveness. In either case, the most appropriate and cost-effective solution will be selected.

Balancing Electrical Supply and Demand

The state uses a significant amount of both electricity and fossil fuels. In FY 1979-80, state facilities used more than 2.7 billion kWh of

electricity and over 20 trillion Btus of natural gas, fuel oil, and other fossil fuels.

In January, 1980, the Governor requested that energy use in state facilities be reduced 20 percent over the next three years. Reaching this goal will mean that the state's overall use of electricity will be less than 2.2 billion kWh annually.

The 400 MW of cogeneration will produce 2.4 billion kWh at state facilities annually. This will be greater than the state's total electric energy use after the 20% reduction in energy use.

INVESTMENT SCHEDULES

Budget packages for studying, designing, or constructing 150 MW of cogeneration are being prepared for inclusion in the FY 1981-82 Governor's budget. The funding required is approximately $10 million in FY 1980-81.

Two implementation schedules for the 400 MW of cogeneration capacity were developed for this blueprint. *Investment Strategy A* was developed by first ranking the near-term potential of the sites according to the criteria previously discussed. Projects were then spread over ten years so that the program pays for itself by the fifth year. "Paying for itself" means that the program's capital costs are approximately the same or less than the operating savings.

- *Investment Strategy A* has 111 MW under study or engineering design and 93 MW under construction or operating in FY 1982-83 and 105 MW and 253 MW, respectively in FY 1985-86. Strategy A results in the state producing as much electricity as it uses—2.4 billion kWh—by 1990.

- *Investment Strategy B* is a "fast-track" approach to cogeneration development. Projects were scheduled according to design development times only, not according to available funds.

According to *Strategy B*, 109 MW will be under study or engineering design and 241.6 MW under construction or on-line in FY 1982-83, and 49 MW and 380 MW respectively in FY 1985-86. *Strategy B* results in the state producing as much electricity as it uses by 1988.

INVESTMENT ANALYSIS

Capital Costs—Costs for installation of cogeneration systems range from $300 to $1,500 per kW. Each site must be evaluated individually to determine costs. For example, the most cost-effective investment at San Diego State University included absorption chilling equipment that produces cooling for air conditioning from the cogeneration system's waste heat. This additional equipment leveled the annual heat demand, making cogeneration practical and economical. On the other hand, Metropolitan State Hospital has a consistent annual heat load that can be met using cogeneration without the addition of similar cooling equipment. However, the hospital had to replace the existing boiler and add standby power equipment to meet federal licensing requirements. Rather than build a new boiler plant and install standby power, the Office of Appropriate Technology and the Department of General Services proposed a cogeneration system that met federal requirements and costs less than the boiler plant and standby power. These projects are currently undergoing engineering design.

Savings—Cogeneration projects in state facilities funded in the Governor's FY 1980-81 Budget had estimated annual savings ranging from $200,000 to $600,000 per MW (1980 dollars). Analysis of the savings used a 10% discount rate for capital cost, 1980 energy prices, and assumed 0.2 to 0.5 cents per kWh for operating and maintenance expenses. Special lower gas rates for cogeneration ordered by the California Public Utilities Commission were not included in the analysis.

Operating savings vary considerably from site to site. Some sites may actually yield revenues to the state from the sale of electricity over the cost of purchasing natural gas. Other sites may only lower their annual utility bills.

Cash Flow—In the following graphs, the annual capital costs required for Investment *Strategies A* and *B* are compared to the savings from the projects generating power in that year.

Investment Strategy A—Subtracting the capital requirements from the estimated operating savings each year showed that Strategy A would require $43 million in FY 1983-84, break even in 1985, have a net savings to the state of $56 million in FY 1986-87, and increase in annual savings each year thereafter (see graph). The total savings through 1990 would be approximately $735 million.

Investment Strategy B—The capital cost requirements for Strategy

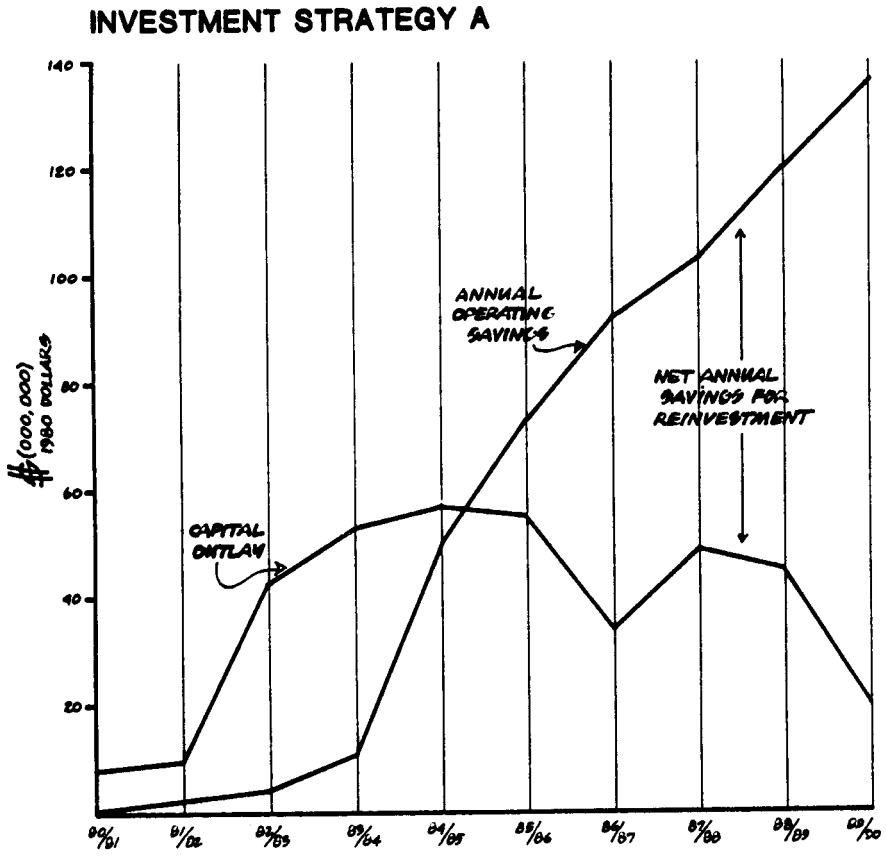
B are significant in the early years of the program. In FY 1982-83 and FY 1983-84, over $93 million and $107 million would be required. From FY 1983-84 on the savings are, however, also significant. Net savings to the state begins in FY 1984-85 with a savings of $51 million and $71 million in FY 1986-87. Total savings from Strategy B through 1990 would be approximately $893 million.

Methods to Reduce Costs and Time—The Department of General Services is investigating a number of actions which could reduce costs and expedite implementation of projects. Included in these actions are:

- State purchasing equipment, installation by contractor,
- Standardizing budget proposals,
- Packaging cogeneration units,
- Packaging cogeneration site studies and construction contracts,
- Developing master power exchange contracts,
- Centralizing state aid for contract negotiations and permit processing, and
- Testifying at PUC and federal rulemakings relating to cogeneration to support favorable funding and rates for State projects.

Comparison of Annual Investments with Annual Savings (in dollars)

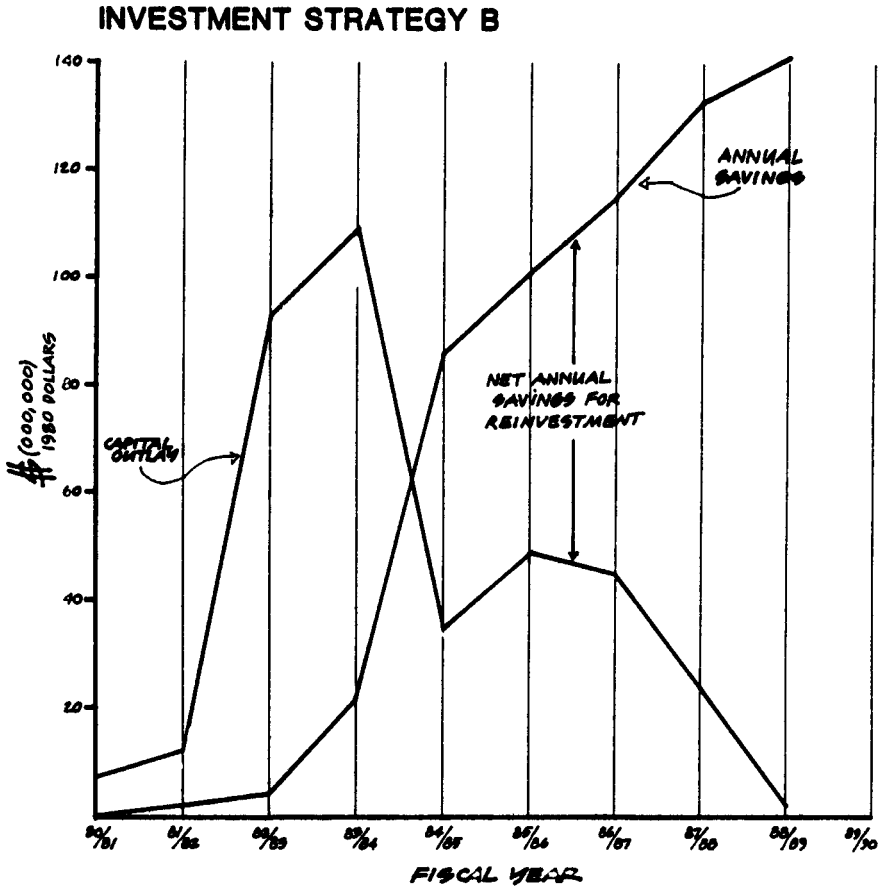
Fiscal Year	*Investment Strategy A*		*Investment Strategy B*	
	Capital Outlay	Savings	Capital Outlay	Savings
81/82	9,590,000	2,075,000	12,380,000	2,075,000
82/83	42,780,000	4,298,000	93,120,000	4,298,000
83/84	52,900,000	11,123,000	107,000,000	21,728,000
84/85	57,050,000	49,378,000	35,200,000	86,443,000
85/86	55,100,000	73,318,000	48,500,000	101,143,000
86/87	36,200,000	92,043,000	45,200,000	116,543,000
87/88	48,500,000	103,943,000	22,200,000	132,993,000
88/89	45,000,000	119,343,000	2,000,000	141,393,000
89/90	20,000,000	135,793,000	-0-	142,793,000



Investment Analysis

FINANCING STATE COGENERATION PROJECTS

There are various options to finance development of 400 MW at state facilities. Use of capital outlay funds is recommended because they offer the greatest benefits to the state provided the projects are developed in a timely basis. However, the competition for these funds is great and will increase each year as the budget surplus is used up. Because the major portion of the funds required are for projects at the University of California, State University and colleges, and the community colleges, the Capital Outlay Fund for Public Higher Education (COFPHE) could be an important funding source. Funding for program requirements should



Investment Analysis

not, however, compete with funding for the cogeneration projects. The development of a state energy reinvestment fund from savings attributable to cogeneration should be established to assure successful completion of the program. The estimates of funds available starts at $4 million in FY 1982-83 and goes to $140 million in FY 1989-90.

Because there are over $35 million unencumbered in the FY 1980-81 budget from tideland oil revenues, it is recommended that a special bill be introduced to secure these funds to initiate the cogeneration projects.

Grants from the state and federal governments and the utilities may co-fund a number of feasibility studies and some design; however, few construction dollars are expected from these sources. It is estimated

that $50,000 to $150,000 annually might be available to the state through grants for the next few years.

Third-party cogeneration agreements appear to be a practical way to expedite project development and relieve some of the funding burden from the state budget. Arrangements with the Department of Water Resources offer the greatest possibilities and should be initiated immediately upon adoption of the blueprint. Utilities have shown little interest in developing the projects themselves. Private investors offer promise but it is a new field and only a few are currently making such arrangements. Third-party cogenerators could develop enough cogeneration projects to relieve the state funding requirements by between $15 and $150 million, but these funds are highly speculative and would reduce the state's overall financial benefits. However, the energy and operating benefits would be available sooner. Funds from bond measures could cover all costs; however, these are also very speculative at this time. If a bond measure is anticipated planning must begin immediately.

The capital costs for 400 MW will be approximately $365 million (1980 dollars). This significant investment will require creative financing approaches in addition to the traditional budget process.

OPTION I—Governor's Budget

Although new General Fund moneys will be limited during the upcoming budget years, it may be possible to fund cogeneration projects from tideland oil revenues.

AB 2973 (Vasconcellos), signed by the Governor in September 1980, will divide windfall oil revenues among the following funds that could be used for cogeneration projects:

- Capital Outlay Fund for Public Higher Education
- Energy and Resources Fund
- Special Account for Capital Outlay

An additional method for financing cogeneration and other energy projects for state facilities through the capital outlay budget process is by establishing a State Energy Reinvestment Fund.

COFPHE Fund

A portion of the $125 million expected to be available from the Capital Outlay Fund for Public Higher Education in FY 1981-82 could be used to support cogeneration projects at the University of California, State University and colleges, and community college campuses. Last year expenditures from the COFPHE Fund totaled approximately $70 million. Historically, annual expenditures have been well under $125 million.

Energy and Resources Fund

In FY 1981-82, $120 million is expected to be available from the Energy and Resources Fund (ERF). Recently enacted legislation is estimated to tie up about $75 million of these revenues in FY 1981-82. It appears that in FY 1981-82, $5 million may be available from ERF for cogeneration. After FY 1981-82, major legislative bills do not draw on ERF and substantial funds could be available for state energy projects including cogeneration.

Current estimates are that over $20 million remain unencumbered in FY 1980-81 from tidelands oil revenues. From $10-$20 million could be made available for cogeneration. This would require special emergency legislation. The use of current year funds would expedite development and assure program support.

Capital Outlay Funds

The 1980-81 Governor's Budget included approximately $6 million for cogeneration design and construction at Metropolitan, Napa and Atascadero State Hospitals. New feasibility studies for additional hospitals could be funded through the normal capital outlay process and could be financed through the balance of tideland oil revenues or General Fund moneys. Approximately $100-$175 million in tideland oil revenues will be transferred to the special account for capital outlay in 1981-82; however, cogeneration projects will have to compete with all other capital outlay proposals.

Proposed Reinvestment Fund

A State Energy Reinvestment Fund established by the Legislature and administered by the Department of Finance would take operating savings, revenues, and possibly "avoided costs" resulting from energy projects at state facilities and reinvest them in new energy projects. The

cogeneration program would require substantial funding in the first few years. Part of these funds could be freed-up by low-cost conservation projects resulting in savings or avoided increases in operating budgets of state facilities. After the first couple years of the cogeneration program, substantial annual savings from operational cogeneration systems could pay for the cogeneration and other energy and resource projects. A special account that would be continuously appropriated should be established similar to the management of state-leased property funds in the Property Acquisition Law Moneys Account for reinvesting operating savings in new energy investments.

OPTION II—State and Federal Grant and Loan Funds

There are three state and federal programs that pertain to cogeneration which might provide a modest portion of the funding needed. They are:

- Cogeneration Grant Program
- Senate Bill 771 (state program)
- The Schools and Hospitals Program (joint state and federal funds)

Cogeneration Grants Program

The federal government has allocated $580,000 in FY 1980-81 to the California Energy Commission to develop a state cogeneration commercialization plan and to co-fund cogeneration feasibility studies. The Commission has encumbered $130,000 for feasibility studies at 16 campuses of the University of California and State University and colleges. Future federal funds for this program are uncertain at this time.

Senate Bill 771

SB 771 allocated $10 million for 20 demonstration biofuels projects. Funds are used to reimburse up to 50% of the cost of equipment only. In the first round of funding, less than $3 million was committed to nine projects. In this first round, several cogeneration projects received funding, including Lassenite Masonry Company which will bum rice hulls to cogenerate electricity and use the waste heat for process heat requirements. The second round of selections began on September 1. It is not likely that a significant number of state cogeneration projects will use biomass and be eligible for SB 771 funding.

Schools and Hospitals Program

This joint federal-state program provides matching grants to public and nonprofit schools, hospitals, public care institutions, and local governments for the identification and installation of cost-effective energy conservation measures. In FY 1980-81 there were $10 million in federal funds and $10 million in state matching funds available. Because of the loan provisions of the state funds, state agencies were unable to participate in the program. Cogeneration is specifically mentioned in the federal guidelines. Language in the state guidelines, while not mentioning cogeneration specifically, does allow for funding this kind of project. Because of the high capital costs of cogeneration and the large demand for these funds, few cogeneration projects are expected to be funded. The amount of money available this coming year and in future years is unknown at this time.

OPTION III—Utility Grants and Loans

California's largest utilities have, on occasion, funded feasibility studies, engineering designs, and construction of cogeneration projects in their service area. Currently Southern California Gas Company has the only program advertising available money. The company will fund up to 50% of the cost of a feasibility study ($10,000 maximum), up to 50% of the costs of final engineering ($40,000 maximum), and up to $60,000 for construction. It is not known if the company has a total investment limit in cogeneration projects. There are approximately 25 potential near-term state projects totaling 87 MW in the Southern California Gas Company's service area. Therefore, under the company's program the state could be eligible for $2,500,000 in matching funds.

Other utilities are being approached regarding possible funds for state projects. No immediately available funds have been identified; however, some utilities such as PG&E requested a letter proposing such arrangements so that they could be reviewed by the company.

OPTION IV—Third-Party Cogeneration

Third-party cogeneration is generally used to describe an arrangement in which a private firm finances and installs a cogeneration unit, and then sells steam on-site (to the state in this case) and electricity to the utility. Other arrangements of this sort are possible, although they are not, in the strictest sense, developed by third parties. For example, a utility can finance and build a cogeneration facility, sell steam on-site,

and distribute electricity through its own grid. This type of arrangement is similar to current state lease-purchase agreements for office buildings. The policy of third-party cogeneration agreements may require Legislative review. In developing cogeneration potential in state facilities, potential third-party cogenerators would be:

- A utility
- A private firm
- The Department of Water Resources

Utilities

Utilities can come into a potential site at a state facility, finance and build a cogeneration system, sell steam at a reduced cost to the state, and use the electricity itself. Utilities have been reluctant to finance cogeneration projects. However, PG&E and Southern California Edison own and operate cogeneration systems which provide steam to private industries. San Diego Gas and Electric Company operates several cogeneration systems through a subsidiary company, Applied Energy, Inc. Utility funds appear substantial, however it is unclear at this time if funds will be made available for development of cogeneration projects at state facilities.

Private Firms

Private firms can arrange for financing and construction of a cogeneration system at a state facility, selling steam to the state and electricity to the utility. One company which has acted as a third-party cogenerator is Optimum Energy Systems. This firm is building plants in the Kern County oil fields to sell steam to oil companies and electricity to PG&E. Limited discussions have indicated two additional companies are interested in developing 50 MW or less each. Private funds required for developing 50 MW could range between $15 million and $75 million.

The Department of Water Resources

DWR can finance and construct a cogeneration system at a state facility out of the California Water Fund or other funding sources to provide energy for the state water project. DWR would sell the steam for use in the state facility. DWR has expressed interest in developing 50

MW of cogeneration power in the next few years. Capital funds required to develop 50 MW could range between $15 million and $75 million.

OPTION V—New Bond Issue

The proposed cogeneration projects appear to be capable of generating significant revenues through the sale of new electrical power and could be financed through the sale of revenue bonds. However, tax-exempt revenue bonds are moving slowly in today's money market and a new bond issue may not generate adequate capital. General obligation bonds, which are backed by the full faith and credit of the state, are currently more marketable even though they carry a lower interest rate.

Both revenue and general obligation bond issues require legislation and voter approval (2/3 majority for general obligation bonds). No statewide election will be held until 1982.

POSSIBLE CONSTRAINTS TO COGENERATION

There are a few constraints to developing the 400 MW at state facilities, excluding financial and institutional barriers. The expedited development called for in *Investment Strategy B* may be constrained by the ability of manufacturers to supply the equipment.

Air Pollution Permit

The principal regulatory concern for most cogeneration projects is obtaining an air pollution permit. As a direct result of numerous state and federal ambient air quality standards, air pollution permits are required when a project emits greater than a significant amount of pollution—generally 150 pounds per day. Steps must be taken to reduce existing pollution at the site or nearby to affect a net reduction in air pollution emissions.

Recent changes to state law and efforts by the Air Resources Board to consult with local air pollution control districts have made it easier to obtain an air pollution permit for cogeneration projects. Depending on the size of the system, there are two critical points involved. First, the cogeneration facility may have to use emission controls, which must be determined on a case-by-case basis. Cogeneration systems between I

and 4 MW using gas turbines generally have available emission controls that will meet emission standards and add little to the project costs. Reciprocating engines are many times considered in the smaller cogeneration applications, e.g. 1 MW and less. Emission control devices may not be available for some gas turbines and lean burning reciprocating engines. Some new control devices have recently come on the market that show promise for these engines. Smaller systems that emit less than 150 lbs. per day of NO_x or other pollutants (limit may differ in some areas of the state) are generally exempt from the emission standards.

Second, if the increase in emissions resulting from the cogeneration system is large enough, additional emission reductions will have to be made within the existing facility. For existing facilities, any reduced emissions from the nonoperating boiler are taken into consideration in estimating the emissions from the cogeneration system. This will result in many cogeneration systems meeting standards with available control devices. The larger cogeneration systems at the University of California campuses may, however, require other actions such as reducing emissions from other sources on the campus.

A permit to construct is issued by the local air pollution control district. The State Air Resources Board generally reviews the district's actions and retains the authority to reverse the district's decision. ARB staff is providing assistance in obtaining an air pollution permit.

In addition, as a result of recent actions on the part of the federal Environmental Protection Agency, many projects may be subject to EPA's construction ban until the state adopts a vehicle inspection and maintenance program. The applicability of the construction ban varies from district to district.

Fuel Use Act

The federal Fuel Use Act prohibits the use of oil or natural gas for cogeneration systems larger than 8-10 MW without an exemption. This regulation will only affect the larger state projects at the University of California campuses. Exemptions may be granted in cases where it can be demonstrated that the amount of oil or gas to be consumed by the facility will be less than that which would otherwise be consumed in the absence of cogeneration, or that it would be in the public interest to grant an exemption. In either case the exemption process, handled by the U.S. Economic Regulatory Administration, can take up to one year to complete.

EFFECTS OF BLUEPRINT

Energy Savings

The development of up to 400 MW of cogeneration will save 8.8 billion cubic feet of natural gas or 1.5 million barrels of oil annually. Additionally, it will produce more than 2.4 billion kWh of electricity annually which is enough to provide up to 1 million new homes built to use electricity.

In order to achieve these net fuel savings, on-site use of natural gas or fuel oil will increase between 50% and 100% at state facilities. This increase is offset by the increased efficiency of the cogeneration system versus continuing to purchase electricity and natural gas from the utilities to produce steam or chilled water. Conventional electric power plants are only about 30% efficient and the state's boilers about 75%-80% efficient. Overall, the thermal efficiency of these current methods used by the state are only about 50%-55% efficient. Cogeneration systems, on the other hand, have an overall thermal efficiency of up to 80% and more. Because they are more efficient, cogeneration systems use 30%-40% less total energy.

Dollar Savings

The savings from cogeneration projects at today's energy prices vary generally between $200,000 to $600,000 annually per installed megawatt (1980 dollars). Savings vary primarily due to thermal load, demand and energy pricing, and capital costs of the cogeneration system. Savings from 400 MW of cogeneration operating at state facilities is conservatively estimated at $140 million annually at today's energy prices. This compares with the estimated $250 minion spent in FY 1979-80 on energy at state facilities. Implementing the projects over ten years will result in a cumulative operating savings of between $735 million and $893 million. The estimated 20-year savings to investment ratio is over 7 to 1. That is, for every dollar the state invests, it will save seven over the life of the projects.

Recently, the economics of cogeneration have become extremely favorable. For example, the cogeneration projects appropriated in the Governor's FY 1980-81 budget have payback periods of between two and five years. The initial costs of these systems are low compared to conventional power plants currently proposed by the utilities. For ex-

ample, the capital costs of most new coal and nuclear power plants range from $1,200 to $2,000 per kW. The cogeneration projects are expected to cost between $300 to $1,500 per kW.

Environmental Impacts

Operating cogeneration systems will most likely increase on-site air emissions. If natural gas is used as the fuel, emissions of all pollutants, except NO_x, are likely to be minor. NO_x emissions can be controlled depending on the combustion system and emission control devices used. For most cogeneration systems at state facilities, emissions can be controlled to meet local air control district regulations. It is anticipated that the California PUC will grant high priority for natural gas allocation to cogeneration customers. For other fuels, such as fuel oil, on-site emissions of SO_x and particulate matter will increase. The increase will depend on the combustion system and available control devices. The systems must meet the local air control district regulations.

Operating cogeneration systems can result in the displacement of electricity generated by conventional power plants using higher polluting fuels thereby resulting in lower power plant emissions. However, a reduction in emissions from conventional power plants will not necessarily occur if the utilities are constrained to achieve a fixed percent of fossil fuel reduction. An increase in cogeneration could reduce the extent to which the utility would otherwise be required to use alternative sources of power. In this case cogeneration would have no impact on conventional power plant emissions.

Benefits to State Power Production Capacity

The development of cogeneration at state facilities will lower the state's new power plant requirements by 400 MW or the equivalent of one medium-sized power plant. The reliability of energy produced from many small cogeneration plants is higher than individual conventional central power plants. Cogeneration plants can be brought on-line in one to four years compared to eight to ten years for conventional power plants. On-site generation also eliminates the energy losses (5%-10%) due to transmission and distribution.

State facilities use about the same total electricity as the steel or chemical industries and more than the petroleum extraction industry in the state. By producing as much electricity as it uses, the state will free-up a significant amount of the electrical supply and be an important

example to other states and major California industries capable of developing cogeneration potential.

Editor's Note

I was unable to contact any of the original authors in the California government who originated this "Cogeneration Blueprint," to congratulate them for the substantial and foresighted program that they developed. Their concepts are, in the main, as valuable today as when their report was first presented. Hopefully, their earlier work will stimulate cogeneration activities by other state energy agencies.