MINUTE ITEM
This Calendar Item No. 25
was submitted for information
only, no action thereon
being necessary.

INFORMATIONAL

CALENDAR ITEM

25

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Johnson

JOINT CALIFORNIA ENERGY COMMISSION/STATE LANDS COMMISSION
PUBLIC WORKSHOP TO EXPLORE COGENERATION
IN THE LONG BEACH HARBOR AREA
LOS ANGELES COUNTY

The State Lands Commission and the California Energy Commission jointly sponsored a public workshop to explore possibilities for a cogeneration project to serve the City of Long Beach harbor area. The purpose of the project would be to enhance State revenues through increased recovery in oil field projects and reduce air emissions from oil field operations and energy generating facilities. The power produced by the project could provide an economic energy source for port operations and local industries. The workshop agenda is attached hereto as Exhibit "A".

Topics presented and discussed included:

(a) The State Lands Commission's interest in increasing economic oil recovery while improving the environment.

(b) The Energy Commission's mandate to promote generating efficiency, an overview of its power plant siting process, new developments being studied in gas turbine designs and fuel options which increase efficiency and reduce emissions, regulations and pending legislation affecting cogenerated electricity and steam power sales.

(c) Wilmington oil field enhanced oil recovery through steam flooding and possibilities for additional oil recovery using cogenerated steam.

(d) The scope of possibilities and economic benefits for potential uses of cogenerated power in the harbor area.

(e) Possibilities for cogeneration combined with desalinization to increase regional water supply and provide feed-water for steam generation.

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(f) Public utility electric power generating capacity and demand forecasts for the port area.

A summary of presentations and discussions is attached as Exhibit "B".

The one day workshop was attended by seventy persons representing oil producers, refiners, public utilities (electric and gas), port industries, cogeneration developers, engineering consultants, environmental consultants, gas turbine manufacturers and representatives from state and city government agencies.

A questionnaire was distributed soliciting interest and concerns related to a cogeneration project in the port area. A copy of the questionnaire and a tabular summary of responses are attached as Exhibits "C" and "D". The responses requested more information on cogenerated electric power (82%), generation capacity/needs in the port area (68%) and cogenerated steam (63%).

The workshop indicated a desire for further exploration of a port area cogeneration project. Of the responses received, 14 expressed interest in participating in a working group and 36 requested to be informed on the progress of such a group.

The next phase will be to assemble such a group, scope exploratory tasks and further delineate the feasibility, opportunities and constraints of developing a cogeneration project in the Long Beach Harbor area.

AB 884:
N/A

EXHIBITS:
A. Workshop Agenda.
B. Workshop Minutes Summary.
C. Questionnaire.
D. Questionnaire Results.

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CALIFORNIA STATE LANDS COMMISSION — CALIFORNIA ENERGY COMMISSION

PUBLIC WORKSHOP

COGENERATION IN THE LONG BEACH HARBOR AREA

MARCH 13, 1991
10 AM - 5 PM

LONG BEACH CITY COUNCIL CHAMBERS

333 West Ocean Boulevard
Long Beach

********** AGENDA **********

A.	WELCOME	Mr. James Trout Assistant Executive Officer State Lands Commission
B.	OPENING REMARKS	Mr. Zen Colazas, Director City of Long Beach Department of Oil Properties
		Mr. Paul Mount, Assistant Chief Mineral Resources Mgmt. Div. State Lands Commission
C.	CEC SITING PROCESS	Mr. Norman Wilson Siting Office Manager California Energy Commission
D.	ELECTRIC GENERATING EFFICIENCY	Mr. Steve Baker Engineering Office California Energy Commission
E.	WILMINGTON OIL FIELD STEAM FLOOD OPERATIONS	Mr. Mike Autlick Manager, Investment Analysis Union Pacific Resources Company
F.	COGENERATOR FUEL OPTIONS	Mr. Rick Cassinis Executive Director Harbor Cogeneration Company
G.	ELECTRIC GENERATION IN THE PORT AREA	Mr. Ray Juels Project Manager Southern California Edison
H.	OPEN SESSION	Participants and speakers
I.	SUMMARY	Mr. Paul Mount State Lands Commission

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EXHIBIT WILSON 1 (Governor)

PUBLIC WORKSHOP

COGENERATION IN THE LONG BEACH HARBOR AREA

MARCH 13, 1991

LONG BEACH CITY COUNCIL CHAMBERS

333 West Ocean Boulevard
Long Beach

***** WORKSHOP SUMMARY *****

A. WELCOME

Mr. James Trout

The workshop was opened at 10 AM by Mr. James Trout, Assistant Executive Officer of the State Lands Commission. Mr. Trout welcomed the participants on behalf of the California Energy Commission and State Lands Commission, and summarized the involvement of State Lands staff in the Long Beach Unit Cogeneration Project which was studied several years ago. This 50 MWe plant was scoped to power the Unit and provide steam for limited thermal recovery and crude dehydration. The project was shelved in 1986 when the oil price dropped and air emission restrictions tightened.

Mr. Trout then explained why interest in a cogeneration project has been renewed. Today's higher oil price has improved the economics of cogeneration, the potential exists for increased recovery through enhanced thermal recovery, and equipment has become more efficient and less polluting.

B. OPENING REMARKS

Mr. Zen Colazas/Mr. Paul Mount

Mr. Zen Colazas, Director of the City of Long Beach Department of Oil Properties, which operates the Long Beach Unit oil field, extended the City's welcome to the workshop participants. Mr. Colazas cited the long history of cooperation between the city and the state in operation of the Long Beach Unit oil field and stated that, although the City is cautious about the environmental and economic impacts of a cogeneration project, there is potential for positive impacts to port area industry, economy, and job markets. He added that representatives of all City departments, who would have input and impact in approving a cogeneration project, were present, and would help and answer questions as needed.

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Mr. Paul Mount, Assistant Chief of the Mineral Resources Management Division of the State Lands Commission, presented an overview of possible cogeneration project scope, purpose and format of the workshop, and benefits of a cogeneration project. Mr. Mount stated that Mr. Charles Warren, Executive Officer of the State Lands Commission, is interested in the benefits a cogeneration project would give the State, port area cities, and the environment, and has directed his staff to investigate the feasibility of such a project in the port area. Mr. Mount indicated that the size of such a project could range from the 50 MWe plant previously studied for the Long Beach Unit oil field to a much larger plant serving a wide range of port area needs.

Mr. Mount stated that the purpose of the workshop was to identify areas of interest in cogeneration, uncover benefits and adverse impacts of such a project, and determine how to proceed with the investigation of these matters. After listing the speakers scheduled to discuss various aspects of cogeneration, Mr. Mount listed possible benefits of a cogeneration project in the port area, including reduced power costs, Enhanced Oil Recovery (EOR) opportunities, reduced air pollution, and desalination.

Copies of the slides presented by Mr. Mount are attached as Appendix I.

C. THE CEC SITING PROCESS

Mr. Norman Wilson

Mr. Norman Wilson, Siting Office Manager of the California Energy Commission, presented an overview of the Energy Commission's power plant siting process, and provided insight into the Commission's mandate and role in cogeneration plant permitting. Mr. Wilson discussed Energy Commission policy regarding consolidation versus decentralization of power generating facilities. He stated that a consolidated approach to cogeneration facilities in the Long Beach port area may have both environmental and economic advantages compared to a series of smaller dispersed energy projects.

Mr. Wilson then discussed the Energy Commission's role in the permitting process, which he explained is limited by law to thermal plants generating 50 megawatts or more. Mr. Wilson stated that he assumes a cogeneration project, meeting the interests of the State Lands Commission, would have a capacity larger than 100 MW. Therefore, his remarks focused on the Energy Commission's Application for Certification (AFC), or licensing process. Mr. Wilson stated that one of the major features was the determination that a project would be able to comply with all applicable laws, ordinances, regulations, standards, etc, (LORS). Another major feature is the analysis of environmental impacts and a determination to avoid, lessen or mitigate the impacts. The last major feature discussed was the "need' test in which the Commission must determine that the proposed project complies with the most recently adopted demand forecast as set forth in the Commission's Electricity Report which is published every two y

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Mr. Wilson characterized the Energy Commission's AFC process as a "one stop siting process." He explained that an applicant can begin construction as soon as the Commission approves the project unless there are conditions to the contrary. The AFC process has been declared to be the functional equivalent of the CEQA process. Therefore, no Environmental Impact Report is prepared for an AFC.

Mr. Wilson noted that all meetings between the applicant and Energy Commission staff during the siting process are publicly noticed at least fourteen days in advance, and that meetings are held in the project locale to facilitate public involvement. After approval of a project, its construction and operation are monitored by Energy Commission staff to ensure compliance with the approved permits, and amendments to the approved plans must receive prior approval.

A question was received from the floor regarding new source review. Mr. Wilson answered that during the AFC, the air district provides a Determination of Compliance (DOC) which is the same as an Authority to Construct (ATC). The DOC contains air quality construction and operating conditions and these are included in the Commission's decision when a plant is approved. Therefore, the applicant does not have to go back to the air district for an ATC.

Another question was asked concerning the Energy Commission's role in permitting plants of less than 50 megawatts output. Mr. Wilson answered that The Energy Commission has no jurisdiction in such projects. Mr. Wilson gave a brief explanation of the Small Power Plant Exemption (SPPE) process which exempts a project from the Commission's AFC process and returns the project to the local agency for permitting. He said that the exemption is anchored on two findings: 1) as for an AFC, the project must pass the "need" test, and 2) the project must not have a significant impact on the environment.

Mr. Wilson repeated that part of the Energy Commission's legal mandate is to take measures to increase the efficiency of energy generation, and introduced Mr. Steve Baker of the Commission's Engineering Office to discuss new technology in turbine generation efficiency.

D. ELECTRIC GENERATING EFFICIENCY — **Mr. Steve Baker**

Mr. Baker provided a summary of his presentation and slides, which are attached as Appendix II. His presentation highlighted the section of the Warren-Alquist Act which directs the Energy Commission to carry out technical assessments of advances in power generation, the objectives of the Energy Commission's program on generation efficiency enhancement, and some advantages of increased generation efficiency, including reduced fossil fuel usage, reduce emissions, increased safety, energy security, and more reliable service.

Mr. Baker was asked during this presentation to define the meaning of "promote an increase in system-wide generation efficiency" to

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reduce demand for non-renewable fossil fuels." He answered that this largely takes the form of jaw-boning and arm-twisting. Mr. Baker was then asked what the Energy Commission's position is on renewable fuel sources. He answered that the Commission enthusiastically promotes them, but the economics of such projects make fossil-fueled projects attractive for the time being.

Following this, Mr. Baker presented an informative overview of conventional and advanced gas turbine designs, including technological advances now in various stages of development. He concluded this overview by stating that the Energy Commission has some funding to support demonstration projects of new turbine technology, and that applicants for such projects enjoyed several siting process benefits.

A question was asked from the floor regarding the incorporation of desalination techniques into cogeneration projects. Mr. Sam Tadros, president of SuperSystems, Inc., cited the capabilities, applications, and benefits of desalination in the port area. He stated that current desalination technology could produce fresh water having 25 ppm total dissolved solids, which is better than tap water. He also cited one such project currently under consideration, the injection of desalinated water into the groundwater aquifer to prevent encroachment of salt water from the ocean. This project would involve a six million gallon per day distillation plant. Without selective catalytic reduction to reduce stack emissions, the plant would cost $55 million to construct, and would produce 150 ppm water. With SCR, which is required by SCAQMD, the plant would cost $80 million to construct, and could produce 90 ppm water. The increased capital cost makes the economics of this plant marginal. Mr. Tadros asked if increasing plant size to more than 50 MWe would help in the permitting process. Mr. Baker answered that plants between 50 and 100 MWe may receive a "Small Power Plant Exemption", which is equivalent to a Negative Declaration in the CEQA process.

Mr. Tadros further stated that selective catalytic reduction units use ammonia to reduce emissions of nitrogen oxides. The use of ammonia presents safety hazards, Mr. Tadros said, and results in slippage of ammonia to the atmosphere, which he characterized as "replacing pollutants with poisons." Mr. Rick Cassinis, Executive Director of Harbor Cogeneration Company, offered that the Siemens catalytic reduction unit is capable of reducing oxides of nitrogen to nine ppm without slippage and uses aqueous ammonia instead of anhydrous ammonia, thus reducing safety hazards significantly. Mr. Cassinis stated that the catalyst used in the Harbor Cogeneration plant, which is made by Mitsubishi, has operated for over two years without signs of reduction, and is projected to have a four to five year life. This extended life, Mr. Cassinis said, makes the use of the SCR technique for emission reduction economic. Mr. Cassinis further stated that use of dry low-NOx combustion technology combined with SCR has attractive economics as well as environmental benefits. Mr. Baker added that use of NOx control techniques based use of urea instead of ammonia further reduced safety hazards.

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Mr. Mike Auflick

E. WILMINGTON OIL FIELD
STEAM FLOOD OPERATIONS

Mr. Mike Auflick, Manager of Investment Analysis for Union Pacific Resources Company (UPRC), spoke about the advantages of cogeneration in supplying steam for Thermal Enhanced Oil Recovery (TEOR) operations and the potential additional oil recovery that is possible through application of this technique. Copies of the slides used by Mr. Auflick are attached as Appendix III.

Union Pacific operates an active steamflood and waterflood on Terminal Island, which receives steam and power from the Harbor Cogeneration 80 MWe plant. Mr. Auflick stated that the primary economic advantage of cogeneration is reduced power costs. He elaborated that 30 percent to 40 percent of the total cost of the waterflood operation is the cost of power, and that producing electricity cheaply extends the life and ultimate recovery of the field. He said that cogenerated power has proven to be very reliable, and meets the utility's need for additional generation capacity during peak power periods as well. A second goal of cogeneration, Mr. Auflick said, is to convert the waste energy produced during electric generation to steam that can be used in TEOR projects or for refinery processes. Mr. Auflick cited the environmental compatibility of Union Pacific's project, saying that it is an active example of being in compliance with current and future air regulations.

Mr. Auflick then discussed the potential for additional TEOR projects in the LA Basin. He started by describing the Wilmington oil field as an extensive deposit of heavy oil comprising numerous layers which are chopped up by many faults. Mr. Auflick mentioned that the leases operated by Union Pacific are separated into 32 zones and four fault blocks. Mr. Auflick stated that there is potential to recover one to two billion barrels of oil from the Wilmington field using EOR techniques.

Mr. Auflick then discussed some techniques which are or may be used to recover additional oil. He described the waterflood techniques currently in use in many parts of the field. Mr. Auflick characterized waterflood operations as being energy intensive, and stated that these operations may leave 500 million barrels of unrecovered oil upon completion. He then described thermal recovery operations, which he said could recover 50 to 100 percent additional oil. Mr. Auflick then mentioned other enhanced recovery techniques which may come in the future, such as carbon dioxide flooding.

Mr. Auflick then expanded upon TEOR opportunities using cogeneration in the Wilmington field. He stated that a 100 MWe plant would be economic to build to supply steam and electricity for a steamflood project if one barrel of oil is recovered for each five barrels of steam injected, using a thirty year project life. Mr. Auflick stated that ten to fifteen 100 MWe plants would be required to steam the entire Wilmington field comparing

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steamflood to waterflood operations, Mr. Auflick stated that steamflood techniques are less energy intensive than waterflood techniques, and also require less surface property to implement. Mr. Auflick stated that steamflood operations could free up 80 percent of the surface currently used in the port area for waterflood operations.

Mr. Auflick provided details of Union Pacific's steamflood to illustrate the benefits of cogeneration. He stated that the project uses the 80 MWe Harbor Cogeneration plant for electricity and steam and is expected to recover eight million barrels of oil. Studies conducted during the pilot project have shown that, contrary to popular belief, continuous injection of steam is not necessary. Steam injection can be shut down for days or weeks without adverse impacts on the recovery process. This means, Mr. Auflick said, that the cogeneration plant can be operated in a load-following mode.

Mr. Auflick then detailed other beneficial uses of cogenerated heat in oil field operations. Waterflood wells benefit from thermal enhancement. Heat does not have to be applied continuously, but can be applied in a "huff and puff", or heat soak, mode. Thus the thermal enhancement can be done as heat is available. Another beneficial use noted by Mr. Auflick is the scavenging of waste heat from the production fluids of thermal wells. These fluids can range from 300 deg F to 400 deg F, and additional efficiencies can be realized by recovering this heat with heat exchangers for use at production and dehydration facilities. Mr. Auflick also stated that produced saltwater brine, with proper treatment, can be recycled. By recycling produced brine, UPRC has achieved low fresh water usage in their steamflood.

Mr. Auflick then detailed some of the problems of steamflood operations. The first is that application of heat to a petroleum reservoir produces a sort of subsurface refining process. This leads to the production of natural gas containing hydrogen sulfide. This problem can be overcome by commingling the produced gas with local refinery gas or gas purchased from Southern California Gas Company and burning it in the cogenerator.

Mr. Auflick stated that a TEOR project is not cheap. The 80 MWe Harbor Cogeneration plant cost $50 million, and UPRC invested another $50 million in drilling wells and production and injection facilities. The 80 MWe plant currently in operation represents one quarter of UPRC's total recovery plan.

Mr. Auflick concluded by stating that UPRC is working with the Los Angeles Department of Water and Power to install another cogeneration plant in the area. UPRC, which is 70 percent owner of Harbor Cogeneration Company, also holds significant natural gas reserves in Colorado, and would like to market this gas in California.

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F. COGENERATOR FUEL OPTIONS — Mr. Rick Cassinis

Mr. Rick Cassinis, Executive Director, Harbor Cogeneration Company, provided information on fuel options for cogeneration projects. Copies of the slides presented by Mr. Cassinis are attached as Appendix IV.

Mr. Cassinis emphasized the importance of fuel price in project economics by stating that fuel cost is 70 percent of cogenerator operating costs. A competitive fuel market is therefore needed to assure viability of cogeneration projects. For most projects, the fuel of choice is natural gas.

Mr. Cassinis stated that a typical cogeneration plant, consisting of a gas turbine with an exhaust heat exchanger to generate steam, has two fuel injection points. The first is the turbine itself, which requires a 300 psig supply pressure. To build a new cogeneration plant on Terminal Island, would probably require compression or installation of a new gas pipeline across Cerritos Channel. The second injection point is in the duct burner of the Heat Recovery Steam Generator, which uses natural gas at 30 psig. Duct burners typically run at 30 percent excess air in the exhaust stream, and they can be used to boost output for peaking use.

Mr. Cassinis continued his presentation by discussing the different types of fuel which may be used in cogenerator turbines. He started by discussing gaseous fuels available in the port area. The preferred fuel is natural gas. It is in good supply, due to an extensive network of intrastate pipelines and planned interstate pipelines. The second fuel source is LPG, which may be either propane or butane. The third source is local refinery gas, which has high hydrogen content and high btu content. Ultramar refinery has a distribution system to other refineries for its refinery gas. The fourth source is local produced gas. This gas, Mr. Cassinis said, has high carbon dioxide and oxygen content, and correspondingly low btu content. The fifth source of cogenerator fuel is coal derived gas. This type of gas is also low in btu content, ranging from 250 to 300 btu per cubic foot, but can be used in a gas turbine.

Mr. Cassinis continued by saying that liquid fuels may also be used in a cogenerator turbine. These may be conventional fuels, such as distillate, crude oil, and resid, or unconventional, such as naphtha, natural gas liquids, and natural gasoline. Methanol is another important class of liquid fuel. Mr. Cassinis noted that projected air quality regulations may eliminate liquid fuels from use in the basin due to the difficulty of scrubbing stack emissions.

Further discussion between the speakers and the participants of cogeneration economics and the need to bring together on and off peak power users, steam users, and competitive fuel suppliers to

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realize a successful project followed. Mr. Trout noted that the purpose of the workshop is to bring such people together. Mr. Ron Svendsgaard, President of the American Cogeneration Society, congratulated all involved in this effort.

G. ELECTRIC GENERATION IN THE PORT AREA

Mr. Ray Juels

Mr. Ray Juels, Project Manager, Southern California Edison, spoke next on Edison's view of electric generation needs in the port area. Mr. Juels discussed the issues of electric generation needs, legislative hurdles to independent power production, and reliability of generation facilities.

Mr. Juels reported that the current Edison Resource Plan does not forecast a need for additional electric generation capacity in the near term. The 1990 report listed a total capacity from Qualifying Facilities of 1300 MWe, and a reserve margin of 4772 MWe. Further, the demand forecast estimates a reserve of 3000 MWe capacity at year end 1998. This does not indicate a present need for additional generation capacity in the port area, according to Mr. Juels.

The second point discussed by Mr. Juels concerns Assembly Bill 1234, which was passed in 1988. The definition of an Electric Utility Corporation contained in the bill does not include sale of electrical power to two tenants of a property, nor to tenants of other properties unless the properties are adjacent to the property upon which the generation facility is located. The power is to be produced solely for the tenant's own use.

The third point Mr. Juels discussed is the reliability criteria. He stated that this has already been met by Edison.

Mr. Joe Falcon of Falcon Associates commented from the audience about Securities and Exchange Commission and Public Utilities Commission purview in the process, and stated that Congress is talking about revisions to the definition quoted by Mr. Juels, and that the legislative issue may not exist tomorrow, if Congress enacts revisions to the 1935 law. Mr. Falcon stated that this issue is central to cogeneration feasibility, and has not been addressed as yet.

H. OPEN SESSION

The open session led off with a discussion of desalination projects by Mr. Sam Tadros, President of SuperSystems, Inc. Mr. Tadros introduced himself as a consulting engineer specializing in cogeneration projects who has extensive experience in desalination plants.

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Mr. Tadros stated that the development of distillation technology is absent in the United States. Japan and Israel currently lead the world in development of this technology. Integration of distillation into a cogeneration plant would, Mr. Tadros said, halve the cost of fresh water produced by reverse osmosis, while producing 25 ppm tds water. Distillation of saline water can also help the cogeneration project meet Qualifying Facility requirements, and, by storing the produced water, load following can be facilitated. Distilled water can be used for boiler feedwater in TEOR projects. Mr. Tadros noted that, by using multistage distillation, a three-stage plant can produce one ppm water. Mr. Tadros also noted that distillation does not complicate the permitting process because there are no emissions to the atmosphere. Blowdown water is 40 percent more saline than source water.

Projected price of fresh water produced by distillation, stated Mr. Tadros, is $2 per million gallons, compared to MWD's price of $1 per million gallons.

After a break for lunch Mr. Norman Wilson discussed CEC demonstration projects and Small Power Plant Exemptions in more detail. He stated that demonstration projects, which test new technology or applications, are exempt from the CEC "Needs Determination" test. Mr. Wilson cited the 100 MWe fluidized bed cogeneration plant at Trona and the Dagget project as examples.

Mr. Wilson then explained that the Small Power Plant Exemption, for plants between 50 and 99 MWe, are not exempt form the Needs Determination unless they are demonstration projects. They also must demonstrate, however, that they will cause no significant environmental impact. Once the Small Power Plant Exemption is received, such projects require local permits only, Mr. Wilson stated. He cited as examples the plants at the Texaco refinery, Chevron El Segundo and Richmond refineries, and the Champlin refinery.

The question was asked "If a plant is bigger than 100 MWe, how long does it take to get a permit from the CEC?" Mr. Wilson answered that the AFC process takes twelve months, once the application is complete.

Mr. Mount asked if any cogeneration projects were currently being planned in the area. Sam Tadros answered that Seal Beach was considering a desalination plant. A representative of Pacific Energy Resources stated that a preliminary TEOR economics study was underway and asked about the price of steam produced by cogeneration. Mike Auflick answered that the steam price is tied to the fuel price at the Harbor Cogeneration plant. The fuel price formula is calculated using one half the price of fuel gas and one half the price of local crude. At $18 per barrel oil, Mr. Auflick said, this equates to $1.50 per million btus. The calculated price could drop to less than $1 per million btus at a low cost price.

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Wilson expanded on the question of community reaction to a large plant by stating that air quality issues are probably a more difficult issue with the community. He stated that if the plant site is remote from people and houses, such as in a refinery, community reaction problems are eased. He cited a proposed project in Crockett that was to be located 75' from the nearest house as an example. This project was debated for four and one half years before it was ultimately withdrawn. The biggest challenge, Mr. Wilson said, is to find a good plant site first.

Mr. Mount summarized the issues raised at the workshop and stated that a follow-on project would be initiated to explore these issues and opportunities for cogeneration in the port area. This project would be implemented through smaller workshops of interested participants.

Mr. Trout concluded the workshop by thanking the participants for their interest, and the City of Long Beach for its hospitality in providing the use of the excellent facilities.

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APPENDIX I.

Mr. Paul Mount

California State Lands Commission

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COGENERATION IN LONG BEACH HARBOR

- REDUCE POWER COSTS ?

- PROVIDE STEAM FOR ENHANCED OIL RECOVERY ?

- REDUCE AIR POLLUTION ?

- PROVIDE DESALINATED WATER ?

- OTHER?

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APPENDIX II.

Mr. Steve Baker

California Energy Commission

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SLC/LONG BEACH TEOR ALTERNATIVES WORKSHOP
ADVANCED GAS TURBINES
March 13 & 14, 1991

[Slide 1]

The Energy Commission's mandate includes the requirement that "The commission shall continuously carry out...studies, technical assessments, research projects, and data collection directed to reducing wasteful, inefficient, unnecessary, or uneconomic uses of energy, including...advances in power generation... technology...." [Warren-Alquist Act (PRC §25401(e))]

[Slide 2]

Objectives of our program on generation efficiency enhancement include:

- Promoting an increase in system-wide generation efficiency to reduce demand for non-renewable fossil fuels;
- Improving air quality through reduced air emissions per unit of electric energy produced by fossil-fuel-fired means; and
- Reducing electricity costs to hold rates down.

[Slide 3]

Some of the advantages of increased generation efficiency include:

- Reduced environmental impacts due to
  - -less fossil fuel burned
  - -less pollution generated
- Reduced safety impacts due to reduced need for post-combustion air emissions controls (SCR)
- Cheaper power
- Reduced influence of foreign fuel suppliers
- Improved quality of service (voltage support, load response, frequency control) due to ability to retain local generation (in air basins)

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Advanced Gas Turbines and Their Role

- What is a gas turbine?

[Slide 4] A gas turbine is a heat engine similar to, in basic principles, an automobile engine. Air is compressed in a rotary compressor, then fuel is burned to heat this compressed air, which then expands against machinery (a rotary turbine) to produce work.

- The many variations on a theme, and their advantages:

Technology	Efficiency	NOx Emissions
• Simple Cycle Gas Turbine	32-40%	120 ppm
•Dry Low-NOx Combustor (available early 1991)	44%	9 ppm
•Catalytic Combustor	?%	? ppm

[Slide 5,6] One-, two- & three shaft

[Slide 7]

• STAG® (Steam & Gas Turbine Combined Cycle)	40-51%	48-120 ppm

•GE spent >$100 million to develop Frame 7F

•HAT (Humid Air Turbine) cycle (by FluorDaniel) promises η of 53.7%.

[Slide 8]

• STIG® (Steam Injected Gas Turbine)	44%	25 ppm

•STIG uses less water than a non-STIG combined cycle, & about 1/3 the water of a rankine cycle, w/ wet cooling towers.

- Some interesting technological advances now in various stages of development:

[Slide 9]

• ISTIG (Intercooled STIG)	52.5%	25 ppm

•Higher pressure ratio & higher firing temperatures of

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newer gas turbines, made possible by steam turbine blade cooling or cooler air from intercooled compressor, allows efficiencies > combined cycles.

[Slide 10]

- IR-STIG (Intercooled Reheat STIG) — 54% — 25 ppm

[Slide 11]

- IR-CRGT (Intercooled Reheat Chemically Recuperated Gas Turbine) — 55+% — 1-3 ppm
  - As of February 1, 1990 GE & GRI were discussing a $300,000 combustion test of CRGT reformate.

[Slide 12]

- Gas Turbine, STIG or IR-STIG w/ Autothermal Reformer — ≈45-55% — 1-3 ppm
  - ICI Katalco (England)

- Some typical machine statistics:
  - LM5000 = 33 MW, PR = 30, η = 37%
  - LM6000 = 42 MW, PR = 30, η = 40%
  - LM5000 STIG = 49 MW, η = 45%
  - LM8000 ISTIG = 114 MW, PR = 34, η = 52%
  - LM5000-based IR-STIG = 195 MW, η = 56%
  - LM5000-based IR-CRGT = 160 MW, η = 60%

- Some major manufacturers:
  - -General Electric (USA)
  - -Pratt & Whitney (USA)
  - -Rolls Royce (Great Britain)
  - -ASEA-Brown Boveri (Switzerland)
  - -Siemens-Kraftwerk Union (Germany)

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The Energy Commission's mandate includes:

Warren-Alquist Act (PRC §25401): "The commission shall continuously carry out...studies, technical assessments, research projects, and data collection directed to reducing wasteful, inefficient, unnecessary, or uneconomic uses of energy, including...

(e) Advances in power generation...technology...."

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Generation Efficiency Objectives:

- **Promote an increase in system-wide generation efficiency to reduce demand for non-renewable fossil fuels;**

- **Improve air quality through reduced air emissions per unit of electric energy produced by fossil-fuel-fired means; and**

- **Reduce electricity costs to hold rates down.**

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