Public Comment
Once Through Cooling
Deadline: 5/20/08 by 12 p.m.

RECEIVED
MAY 20 2008
SWRCB EXECUTIVE

PACIFIC ■ ENVIRONMENT

Protecting the living environment of the Pacific Rim

20 May 2008

Jeanine Townsend, Clerk to the Board
State Water Resources Control Board
PO Box 1977
Sacramento, CA 95812

Dear Ms. Townsend,

We appreciate the state's leadership on the issue of once through cooling being used in the fleet of aging power plants. Attached is data submitted by Pacific Environment regarding the State Water Resources Control Board's Scoping Document on "Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling."

This is a draft of a report that we are developing which will examine the costs and benefits of replacing aging power plants not just with newer power plant technology, but other electricity producing and saving technologies that will minimize our need for fossil fuel power plants. With this letter and draft report, we are bringing into this proceeding the state's existing initiatives to develop renewable energy and energy efficiency, and how those efforts will affect the need for natural gas power plants.

As you will see from our data, there are other costs in question besides those that are incurred in retrofitting existing plants, and that when these are factored in, replacement of generation with efficiency and renewable technologies can be cost effective.

We appreciate your attention to this matter, and please do not hesitate to contact me if you have questions.

Yours,

/S/

Rory Cox
California Program Director

Ph: 415.399.8850 x302
Email: rcox@pacificenvironment.org

311 California Street, Suite 650 ■ San Francisco, CA 94104
tel. 415.399.8850 ■ fax. 415.399.8860 ■ www.pacificenvironment.org

Options for Replacing California's Aging Natural Gas Power Plants

Robert Freehling & Suzanne Doering for Pacific Environment

20 May 2008

Introduction

California is heavily dependent today on natural gas to generate a large portion of its electricity. While natural gas is much cleaner than coal, it still has many problems, including air pollution, greenhouse gases, damage to water resources, and price volatility. And though there are still considerable supplies of natural gas in North America, these are not unlimited.

A confluence of events is creating an opportunity to move to a new paradigm for how we meet our energy needs. An impressive raft of policies, rules and legislation in California are aiming to address global warming, to increase environmental protection, to reduce dependency on fossil fuels, and to secure a stable and economical energy supply for the future. Leading examples include:

- AB 32, California's Greenhouse Gas law that would roll back carbon dioxide emissions to 1990 levels by 2020, equivalent to a reduction of about 25%.
- The Renewable Portfolio Standard that requires all utilities to obtain at least 20% of their electric energy needs from renewable sources by 2010.
- The Energy Action Plan that sets a goal of 33% renewable energy by 2020.
- The California Solar Initiative that commits $3 billion to subsidizing the construction of 3,000 megawatts of rooftop solar installations by 2017.
- Energy Efficiency programs that have been ramped up over the last few years to a total state budget of nearly $1 billion per year to reduce electricity consumption.
- Programs that require utilities to procure 5% of their peak capacity needs by reducing their customers' peak demand, *additional to energy efficiency savings.*

Aging natural gas-fired power plants provide a considerable portion of the state's electric power during times of peak demand. These plants, all built more than 30 years ago, continue to operate despite their inefficiency and damage to air and marine environments, because they can be economically justified sources of "high value" peak and load-following electricity for electric companies. When the social and environmental costs of these plants are factored in, however, they may no longer be a cost-effective source of power. Several major types of cost arise:

- The higher than average amount of fuel required to power many of these plants translates into wasted natural gas. This is referred to as a "high heat rate", which means low efficiency.

- Many plants are located near high-density populations and emit substantial pollution, though pollution has been reduced in recent years either by installing modern control technology or limiting generation.

- A majority of these plants are coastal and use seawater for cooling. Once-through cooling (OTC) uses huge volumes of water and inflicts considerable damage on the surrounding marine environment.

- Greenhouse gas emissions have a very real risk of creating a direct cost burden on emitters in the near future. Utilities are required to include a "virtual adder" of $8 to $25 per ton of CO2 to all fossil fuel electric generation contracts to account for—and partly internalize—this risk.

Recognizing these problems, the California Energy Commission has recommended that 15,000 megawatts of aging plants be retired by 2012. Currently, a portion of this capacity is planned for replacement by new natural gas power plants. In general replacing an older plant with a modern plant will reduce the fuel consumption significantly, but this is not true in all cases. Out of the 19 plants examined in this report, nearly half either operate at a similar level of efficiency as a modern plant, or run relatively few hours a year, or both. Replacing these with modern natural gas plants is more difficult to justify, since they will save little if any fuel and will fail to reduce greenhouse gas emissions or other pollutants.

By applying its policy tools, California can allow most of these plants to be retired while achieving significantly lower levels of greenhouse gas emissions, air pollution, and natural gas consumption. One of the most important policies is the state's mandate to increase renewable energy to 20% by 2010, and the Energy Action Plan goal to increase renewables to 33% by 2020. A study by Lawrence Berkeley National Laboratory for the California Energy Commission examined the effect of a 33% renewable energy supply on the need for natural gas generation, and found that a large amount of the state's natural gas power plants would have to be retired. Replacing all the aging power plants with new natural gas plants would thus seem to be at odds with the goal of achieving significantly higher levels of renewable energy.

While it may be necessary to replace a significant part of the aging plants with new natural gas power, replacing all—or even most—of them in this way would represent failure for almost every major clean energy policy that the state has. There is no doubt that continuing to rely heavily on natural gas power plants is technically and conceptually easier for grid operators, and we will continue to need some amount of this resource for decades into the future. Yet, it is imperative that alternative ways of meeting our future energy needs be given as high, or even higher, priority than simply taking the technically easier path. Along with answering the real technical question about how grid reliability can be maintained while reducing reliance on natural gas, there needs also to be an examination of the alternatives from the point of view of state policy and the environment. The challenges of climate change and depletion of fossil fuels will only increasingly make it necessary to face and surmount the technical challenges of moving to a new paradigm.

This report is an effort to look at how to reconcile the needs of the electric power system and the needs of the environment. We take a rather different approach from other reports on this topic. In most cases, the utilities, the electric grid's Independent System Operator (ISO), as well as staff and consultant reports have considered the implementation of the state's clean energy policies as an uncontrollable variable. On the contrary, as we will show, the decisions of the state's Water Resources Board, the California Public Utilities Commission, the Air Resources Board, and others, can serve as direct inputs to help create the needed changes. In particular, requiring that electric generators be responsible for avoiding damage to the environment will internalize the real costs of operation. This will in turn directly affect choices for how power supply needs will be met in the future.

The report analyzes the costs and benefits of replacing or repowering aging natural gas plants in two different ways: with "business as usual" continuing to build more natural gas power plants, or to adopt California's stated policy goals. In the first scenario, plants are repowered at their current sites, if possible with more efficient and less environmentally harmful combustion turbines and closed-cycle cooling. The second scenario replaces aging plants with a combination of renewables, strategic deployment of energy efficiency, and a greatly reduced number of natural gas-fired units. Elements would be brought on- or off-line in a timeframe according to need and opportunity. Benefit and cost criteria are calculated for each scenario.

California's Electric Power Resources

Today, California gets the largest share of its electricity from natural gas, a flexible power source that can meet a wide range of needs. Modern natural gas "combined cycle" electric generators can operate as a continuous 24/7 "base load" supply with extraordinary efficiency, wringing out up to 60% of the heat energy in the fuel. This compares with 33% to 37% for coal plants, and only about 30% for conversion of nuclear fuel into electricity. Natural gas can also be used in a "simple cycle" to ramp electric generators up and down rapidly in response to changing needs of customers. This is far less efficient, in fact closer to a nuclear or coal plant, but it is the key to the flexibility of natural gas as a fuel. In general, all power plants operated by the action of heat—whether coal, nuclear or natural gas—must be run at relatively stable output, or they lose much of their efficiency. It is important to understand that even combined cycle units lose much of their efficiency when they are cycled on and off, as they will then function in a "simple cycle" mode. [1] Cycling the turbines and generators on and off also tends to age the equipment rapidly and increases maintenance costs.

Natural gas power plants tend to go through a "normal" aging process. When they are new, for the first decade or so, they operate as base-load plants. As their efficiency falls, and as newer and more efficient plants come on line, the middle-aged plant will be moved over to a more variable operation, ramping up and down in power output as the daily demand changes. An aging plant, one that is 20, 30 or more years old, will generally be used least of all and be frequently turned on and off, or eventually be only operated a few hours a year.

There are huge resources available to the state's electric power grid, including conventional generation from natural gas, nuclear, hydroelectric and renewable power sources. Under state law hydro under 30 megawatts is considered "renewable", however, for purposes of grid reliability small hydro is "dispatchable," meaning it can be ramped up and down in a controlled manner, unlike solar and wind which are said to be "intermittent" according to when the sun shines or the wind blows. The table below shows power supplies from different sources, adjusted for reliability factor called "effective load carrying capacity" (ELCC): [2]

	Capacity mw	elcc	reliable mw
Natural Gas	40,832	100%	40,832
Other Thermal	3,446	100%	3,446
Nuclear	4,472	100%	4,472
Hydro	10,549	100%	10,549
Pumped Storage	3,670	95%	3,487
Renewables	5,739	50%	2,870
Total Database	68,707		65,654

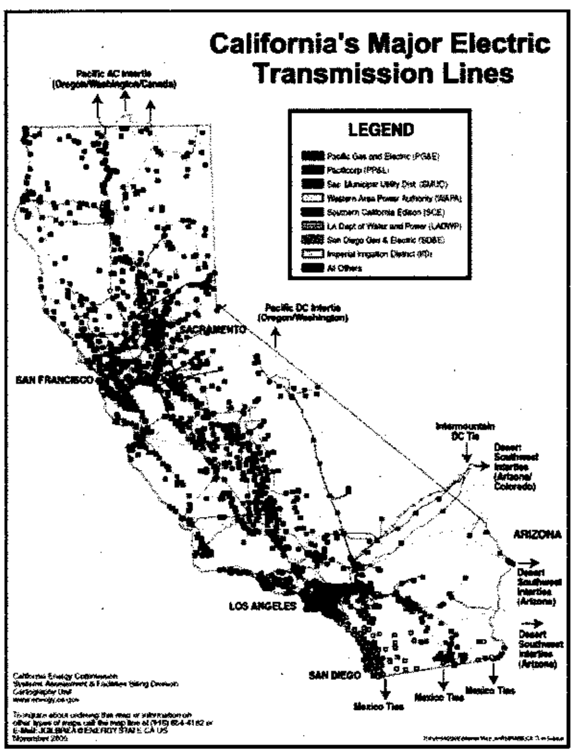
[1] New General Electric Combined Cycle turbines operating in "Simple Cycle" mode range between 9250 and 10,642 btu/kwh, with the most efficient model being the MS9001FA. Gas Turbine and Combined Cycle Products, GE Power Systems,

[2] Totals derived from California Power Plants Database, California Energy Commission. http://www.energy.ca.gov/database/POWER_PLANTS.XLS

Conventional power sources such as natural gas, nuclear and hydroelectric plants are considered to count 100% of their capacity toward reliability needs, and thus are rated with 100% Effective Load Carrying Capacity. About half of the state's renewable power is wind, which is quite variable and has closer to a 25% ELCC. For purposes of estimation a factor of 50% was used, which is conservative, since the other in-state renewable resources such as geothermal and the solar thermal power plants with natural gas backup have 100% ELCC.

The total generation resource above, of over 65,000 megawatts, exceeds the summer heat storm peak demand needs in 2006, which was just over 60,000 megawatts. That heat storm represented an event expected less than once in 30 years, a level of demand that is thousands of megawatts higher than the long term growth trend line.[3] Current state reliability criteria only require demand projections for a 1 in 2 year event, plus a margin of 15% to 17% for extra security. It is noteworthy that these design criteria for system resource planning were more than sufficient to meet the needs for the extraordinary 2006 event.

In addition to the power plants considered above, there are several other significant resources. For example, Investor Owned Utilities (IOUs) are required by the California Public Utilities Commission to obtain 5% of peak energy needs from peak demand reduction programs, called Demand Response. While the utilities have fallen short of meeting this target, other programs allowing the utility to curtail their customers' energy usage during power emergencies—called Interruptible Load—has more than picked up all the slack. In all, 236,195 customer "Service Accounts" participated in the demand reduction programs offered by the Investor Owned Utilities. Another resource is the wide assortment of small customer-owned generation, particularly Backup Generators (BUGS), and rooftop solar photovoltaics (PV).



Finally, there are several major power transmission lines that bring in electricity from the north, the east and the southwest.[4] Import capacity includes 7900 megawatts from the Pacific Northwest, 1900 megawatts from Utah, 7500 megawatts from the Desert

---

[3] The OTC Reliability Study cited correctly an expected long term growth rate in demand of 1.1 to 1.2 percent "for the foreseeable future" (p. 19), but did not point out that the cited peak demand in 2006 was an extraordinarily high anomaly, not a baseline for future expected growth.

[4] Map source: California Energy Commission, http://www.energy.ca.gov/maps/transmission_lines.html

Southwest, and 800 megawatts from Baja region of Mexico. [5]

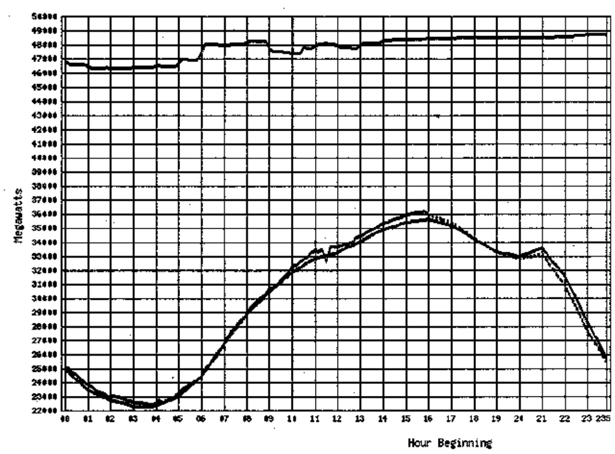
Total Resources Available to California Electric Grid

Resource	Mw	elcc	reliable mw
Conventional Instate Generation	68,707		65,654
Transmission Import	18100		18100
BUGS Database [6]	3,880	90%	3,492
Peak Demand Resource (DR/IL) [7]	2,669	100%	2,669
Rooftop Solar	300	40%	120
Total All	93,656		90,035

If all these above resources are included, the power capacity for the state—at least in theory— exceeds a staggering 90,000 megawatts, 50% higher than has ever been recorded as a peak need. Not all of this is always available when and where needed, but a surprising amount is, sometimes even in excess of the ISO's forecasts. [8]

The chart below helps to picture what a "typical" day of demand looks like for the California ISO grid. During the spring and fall daily electricity demand peaks at about 30,000 megawatts, while in the summer it can rise in the late afternoon to 40,000 megawatts or more. After the peak demand falls over a period of 10 to 12 hours to a low point in the early morning before dawn, when the demand begins to rise again.

California ISO Forecast and Demand for June 24, 2004



[5] US Transmission Capacity: Present Status and Future Prospects, by Eric Hirst, prepared for Edison Electric Institute and Office of Electric Transmission and Distribution, US Dept. of Energy, August 2004, p.34.
[6] BUGS 1 – Database of Public Back-Up Generators (BUGS) in California, Updated January 2004. California Energy Commission, http://www.energy.ca.gov/database/EDITED_PUBLIC_BUGS_INVENTORY.XLS
[7] The State of Demand Response in California, A. Faruqui, R. Hledik, Publication Number CEC-200-2007-003-F, California Energy Commission Division of Electricity and Demand Analysis, September 2007. Table 6, p. 16.
[8] July 2006 CAISO Actual System Daily Peak Demand,Generation and Imports at Time of Daily Peak, CAL_ISO_08_29_2006.

There are clearly abundant resources available today to the electric grid as a whole, yet planners ranging from the IOUs and regulatory bodies like the ISO, and all the way to the White House, keep insisting that reliability in California is a problem, and that there is a great need to build new power plants and wires. It is important to keep in mind that this reliability is not a lack of total generation and transmission capacity for the state. In fact, the state has been on a major construction binge for natural gas power plants for the past eight years.

Power Plants On-Line by Year		
2008		
2007	2 facilities	177 MW
2006	5 facilities	1,487 MW*
2005	7 facilities	3,112 MW
2004	0 facilities	0 MW
2003	7.5 Facilities	3,668 MW*
2002	7 Facilities	2,729 MW*
2001	9.5 Facilities	1,914 MW
1999 & 2000	0 Facilities	0 MW
2001-2007	38 Facilities	13,087 MW
* Note: Some units split date they come on line. We generally use the earliest date project first unit is on line in the totals for each year. See below for years. 2006: Riverside (Unit 1 on line 6/1/06, Unit 2 on line 7/26/06) 2005: Mountainview (Unit 3 on line 12/9/05, Unit 4 on line 1/19/06, total MW added to 2005) 2003: Sunrise Combined Cycle (265 MW in 2003) is added separately from Sunrise Simple Cycle (320 MW in 2001) because was done as amendment, but is counted as one facility in 2001. 2002: Huntington Beach (Unit 3 on line 7/31/02, Unit 4 on line 8/7/03, total MW added to 2002.)		

Source: California Energy Commission [9]

The table above omits additional generation that was built in the state but not under the licensing jurisdiction of the Energy Commission. Since 1999, this has amounted to 2,664 megawatts, for a grand total of 15,751 megawatts. This was accompanied by the retirement or mothballing of 7548 megawatts of old power plants, for a net gain of 8203 megawatts. [10] This updating of the electric generation infrastructure produced some important benefits, especially in reducing demand for natural gas fuel to generate electricity over the past eight years.

---

[9] Power Plant Fact Sheet, California Energy Commission Media Office, updated 5/07/08. http://www.energy.ca.gov/sitingcases/FACTSHEET_SUMMARY.PDF

[10] Ibid.

Transformation of the Grid

As the state contemplates retirement of aging natural gas power plants, it is important to keep in mind that there are a number of opportunities for meeting California's energy needs with alternatives to conventional power generation. These include preferred resources in the "Loading Order", which is the state's priority rankings of energy resources: 1) Energy Efficiency and Demand Reduction, 2) Renewables and Distributed Generation (i.e., local or on-site), and last 3) fossil fuel. The need to enforce this order has become more acute under the pressure of AB 32's mandate to decrease greenhouse gas emissions.

The higher loading order resources are potentially quite large. About 30% of the peak demand, sometimes 15,000 megawatts or more, during the summer is driven directly by air conditioning struggling against the California heat. There is tremendous potential to reduce this need through more efficient technologies, through better home insulation, through "cool roofs" that reflect the heat rather than absorb it, through timed cycling of air conditioners, and through shade trees.

The resources of renewable energy and reducing demand have only been partly tapped. This is rapidly changing as the regulators come to terms with the increasingly urgent need to reduce greenhouse gas emissions and the dependency on fossil fuel. However, it is notable the ISO, the agency that regulates the state's electric grid, in its 5 year Strategic Plan failed to mention efficiency or conservation as available resources, or even the state's goal of achieving 33% renewable energy in 2020. [11]

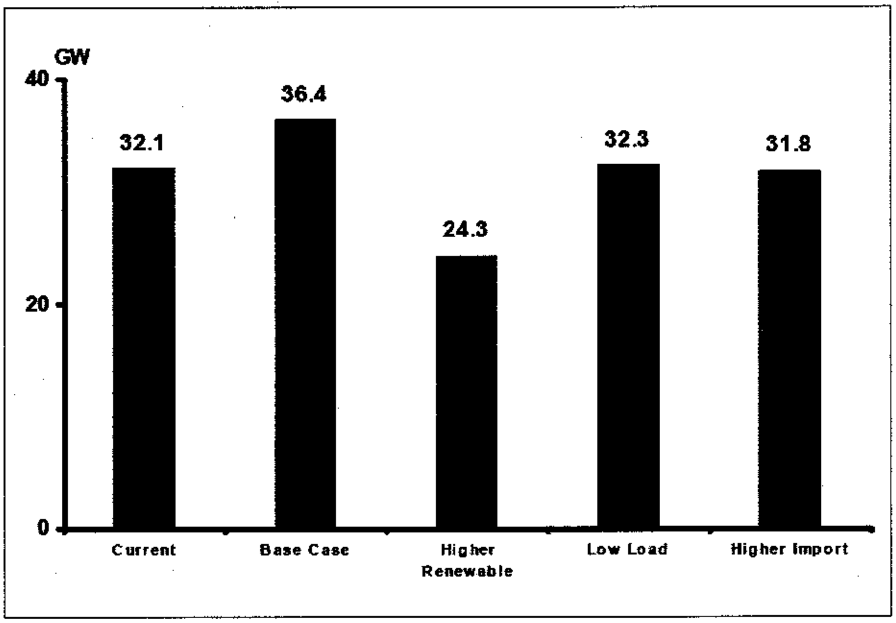
Bringing the preferred resources on line will significantly reshape the profile of California's energy supply. The CPUC has ordered utility companies to consider the state's renewable requirements to be a floor, not a ceiling, and procurement plans are being designed that assume much higher than the 20% level as they move toward 2016, the end of the current planning horizon. Thus, the groundwork is already being established for achieving the 33% target.

The effect of moving toward a 33% renewable target on the need for natural gas generation capacity was examined in a 2003 report by Lawrence Berkeley National Laboratory. The report found that the state would need to retire 8,000 megawatts of natural gas power plants by the time the renewable goal was achieved. This assumed starting at 32,000 megawatts, an amount that has already been exceeded by thousands of megawatts. Thus, achieving the 33% renewable level means that a retirement of over 10,000 megawatts of natural gas power plants will be necessary over the next decade.

---

[11] http://www.caiso.com/1fa4/1fa4c0d125c80.pdf

Figure 14
Gas Fueled Generation Capacity –
Current and for 2030 Under Different Scenarios



Source: Lawrence Berkeley National Laboratory [12]

The "current" natural gas fueled electric generation in 2003 is represented by the bar on the left, showing 32,100 megawatts (32.1 gigawatts). Under the base case, low load, and higher import scenarios, renewables grow only to 20%, while in the "higher import" scenario, load growth is assumed to be 1.5% per year, which is also a high growth assumption. Higher imports means that more transmission capacity is built beyond the 18,000 megawatts that currently exists.

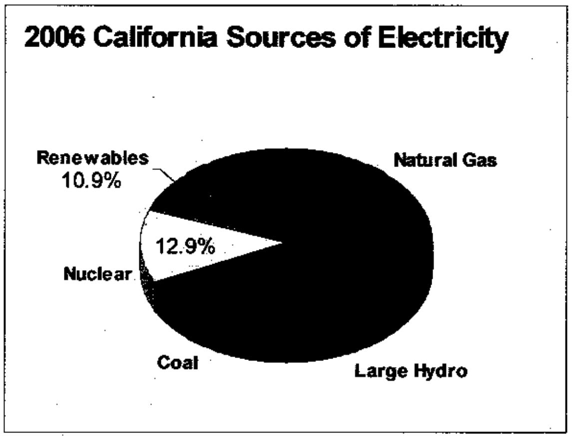
The fundamental message of the analysis is that there are multiple options for avoiding the need for more natural gas power plants than what existed in 2003. In addition, if the state and utility companies carry out their renewable obligation, then 10,000 to 15,000 megawatts of retirements will be necessary from the current level of 40,000 megawatts. [13] The following charts show the effect of moving to a 33% renewable supply from the standpoint of energy supply (kilowatt-hour) rather than capacity (megawatt) needs.

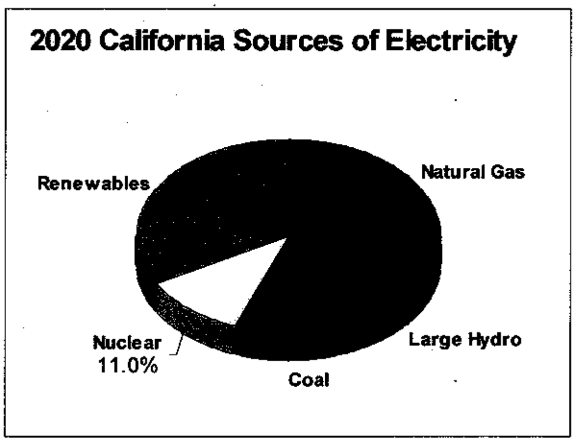
---

[12] California's Electricity Generation and Transmission Interconnection Needs Under Alternative Scenarios, CERTS, LBNL, 2003. CEC, 500-03-106

[13] It appears likely that the LBNL report did not include an exhaustive list of all natural gas power plants, but likely only those of a certain minimum size that are engaged in establishing power planning and system reliability. However, this leaves out a significant amount of resources.

Looking Ahead: Implementing California's Renewable Portfolio,[14], [15]





The pie charts above only show the effects of the renewable portfolio standard, and thus leave out of consideration the potential for energy efficiency improvements, rooftop solar, and other local resources.

[14] Data from **2006 Net System Power Report**, Energy Commission Publication # CEC-300-2007-007. (Acrobat PDF, 8 pages, 48 kilobytes, date on line April 12, 2007)California Energy Commission, http://www.energy.ca.gov/electricity/gross_system_power.html

[15] 2020 portfolio projected by Local Power, Inc. from 2006 data at 1.2% annual demand growth and implementation of 33% renewable portfolio standard. Coal and hydro are assumed to decline modestly in absolute generation levels, while nuclear holds steady.

Power Plant Characteristics

The power plants selected for this analysis are the 19 natural gas plants with the largest capacities built before 1980 containing operational steam turbine units, totaling roughly 15400 MW of capacity. Table 1 summarizes their relevant characteristics. Our study group is based on that of the California Energy Commission, detailed in its 2004 report on aging power plants, with minor changes and updates[16]. Following the CEC, we consider only steam turbine units, not smaller simple-cycle units used only for peaking, as the private and social costs of these smaller units is negligible. We also omit units, such as Humboldt Bay 1 and 2, that were originally powered by steam turbines but have been or will be repowered with more efficient technology. Thus, when referring to a "plant" we include only the units listed in Table 1, although the plant may house other types of generation. Finally, we note that the shutdown or repowering of South Bay Power Plant by 2010 is very likely and omit it from our baseline study group[17]. All remaining plants in the study group have no definite plans for retirement at present. Once through cooling (OTC) is used at generators totaling 13,673 megawatts of capacity.

Plant	Units	Owner	Location (County)	Year first unit online	Capacity (MW)	Capacity Factor 2005 (%) 18	OTC
Alamitos	1-6	AES	Long Beach (Los Angeles)	1956	1950	7.68	Y
Broadway	B3	City of Pasadena	Pasadena (Los Angeles)	1965	66	12.26	
Contra Costa	6,7	Mirant	Antioch (Contra Costa)	1964	680	5.56	Y
Coolwater	1,2	Reliant	(San Bernardino)	1961	146	2.28	
El Centro	3,4	Imperial County	El Centro (Imperial)	1952	118	15.99	
El Segundo	3,4	Dynegy	El Segundo (Los Angeles)	1964	670	11.32	
Encina	1-5	Dynegy	Carlsbad (San Diego)	1954	929	22.91	Y
Etiwanda	3,4	Reliant	(San Bernardino)	1963	640	12.92	
Haynes	1,2,5, 6	LADWP	Long Beach (Los Angeles)	1959	1126	13.90	Y
Huntington Beach	1-4	AES	Huntington Beach (Orange)	1958	888	19.98	Y
Mandalay	1,2	Reliant	Oxnard (Ventura)	1959	430	9.26	Y
Morro Bay	1-4	Dynegy	Morro Bay (San Luis Obispo)	1955	1002	3.64	Y

[16] California Energy Commission (CEC), "Resource, Reliability and Environmental Concerns of Aging Power Plant Operations and Retirements." 2004. pp. 9-13. Notes on plants in CEC's group not in ours: Humboldt Bay has been repowered since the CEC's report; Hunter's Point has closed; Coolwater Units 3 and 4 were repowered; Long Beach is closed pending repowering; Grayson is a small facility using landfill gas for fuel and no OTC, so its environmental impact is minimal. Huntington Beach Units 3 and 4 are included in our study but not the CEC's; they were retooled, but with steam turbines and OTC, not combined-cycle technology.

[17] Local Power performed an extensive study on the South Bay Power Plant

Moss Landing	6,7	Dynegy	Moss Landing (Monterey)	1968	1478	3.61	Y
Olive	1,2	City of Burbank	Burbank (Los Angeles)	1959	101	3.62	
Ormond Beach	1,2	Reliant	Oxnard (Ventura)	1971	1500	3.92	Y
Pittsburg	5-7	Mirant	Pittsburg (Contra Costa)	1960	1370	5.44	Y
Potrero	3	Mirant	San Francisco	1965	207	21.27	Y
Redondo Beach	5-8	AES	Redondo Beach (Los Angeles)	1954	1310	3.74	Y
Scattergood	1-3	LADWP	(Los Angeles)	1958	803	13.32	Y

Because of their age – some have been online over half a century – these power plants use fuel inefficiently compared to modern turbines and experience higher forced outage rates. Heat rates for modern units designed to provide peak power vary between 9200 and 10,500 Btu/kWh, whereas the average heat rate of the study group in 2005 was 11,202 Btu /kWh.[19] Modern baseload technologies operate even more efficiently, with heat rates as low as 5700 Btu/kWh. Hence, although originally designed for baseload generation, the fuel costs of most units are too high for owners to justify operation except at times of peak demand. Hence the majority of these plants are load-following, many operating primarily or exclusively during the summer months. Just six of the plants have capacity factors above 10%, and none exceed 25%.

The OTC Reliability Study reported significantly higher capacity factors for a number of plants during 2001; however, that year was characterized by a failed "deregulation" scheme that resulted in many generators going off-line when they could not recoup the skyrocketing cost of natural gas fuel. A significant feature of that year's so-called "energy crisis" was that low efficiency power plants were being called to provide for a much larger share of the power supply. This further increased the cost of generating power. Including 2001 data in the performance record is likely to exaggerate the actual need for these plants in terms of energy supplied. Similarly, failing to step back to look at the larger options and policies will exaggerate the capacity needs.

There is one need that these power plants meet that is particularly significant. Due to their load-following ability and proximity to major population centers, these plants contribute to the reliability of the electrical grid, especially in transmission constrained areas. In order to protect the power supply from the disruptions that occurred during 2000 – 2001, certain power plants were placed under contract with the California ISO to provide power when needed for reliability purposes. This has the additional benefit of limiting options for price manipulation under times of market stress. These obligations are placed on certain strategically important power plants, and are called "Reliability-Must-Run" contracts. The CAISO has given Reliability Must Run (RMR) designations to six plants, although all but one will be released from RMR status in 2008 in an effort to deregulate.[20]

---

[18] EIA generation data

[19] CEC, "Comparative Costs of California Central Station Electricity Generation Technologies." 2007, p. 34; also GE

[20] http://www.caiso.com/18c6/18c6b8955af80.pdf

Annual Costs of Aging Power Plants

We enumerate the private and social costs of plants in the study group in 2005, and will extrapolate costs in future years based on these figures.[21] All dollar figures are $2005 unless noted otherwise. For reference, the table below lists net generation, fuel consumption, and emissions of the plant study group in 2005.[22]

Plant	Net Generation 2005 (MWh)	Fuel consumption 2005 (MMBtu)	NOx emitted 2005 (tons)	CO2 emitted 2005 (tons)	PM10 emitted 2005 (whole plant) (tons)
Alamitos	1,311,102	15,359,638	61.3	974950.4	40.6
Broadway	70,886	849,285	9.8	50472.5	7.8
Contra Costa	331,036	3,567,028	19.6	212645.8	5.3
Coolwater	29,214	284,537	11.2	17224.8	13.1
El Centro	165,259	1,651,662	191.6	112808.7	31.0
El Segundo	664,237	7,342,706	24.4	437845.2	20.6
Encina	1,864,797	21,796,483	124.6	1308280.6	168.8
Etiwanda	724,305	8,660,722	28.5	546027.1	5.8
Haynes	1,371,086	12,017,360	33.7	885883.2	62.8
Huntington Beach	1,554,597	16,939,417	59.1	1000720.4	19.3
Mandalay	348,956	3,652,157	8.8	216244.7	4.6
Morro Bay	319,258	3,177,100	49.0	189494.5	11.8
Moss Landing	467,156	4,632,166	15.3	270750.1	84.5
Olive	32,033	472,338	1.2	28965.0	5.9
Ormond Beach	515,672	5,770,197	20.2	341390.2	6.9
Pittsburg	652,862	7,306,716	38.9	449662.3	11.2
Potrero	385,621	4,159,731	45.0	228314.6	16.9
Redondo Beach	429,505	5,021,739	18.5	296990.1	29.1
Scattergood	937,137	10,456,706	19.8	773853.8	39.4
Total	**12,174,719**	**133,117,687**	**781**	**8,342,524**	**585**

Costs to Owner

Owners of aging power plants pay fixed costs and costs that vary with the amount of electricity generated. Because every plant in the study group is more than 25 years old, the

---

[21] For Broadway plant only, generation and emissions figures are for 2002.

[22] Generation and Fuel Consumption data from EIA; NOx and CO2 emissions data from EPA Clean Air Markets; PM emissions from CARB

financing necessary for initial capital investments has been either fully or largely repaid. The remaining fixed costs, such as capital improvement incurred to keep the unit operational, comprise the annual fixed-revenue requirement (AFRR). In general, companies do not release these costs, and so we must extrapolate from the AFRRs of RMR-designated units, which are public record. The AFRR for these units in 2004 is summarized in the second column of Table 2.[23] Assuming the AFRR does not change significantly from 2004 to 2005, we compute the AFRR per MWh for each plant in 2005 in the third column.

Plant	AFRR 2004 (mil $2004)	Net Generation 2005 (MWh)[24]	AFRR per MWh ($2004/MWh)
Alamitos	52.465	1,311,102	40.02
Contra Costa	44.709	331,036	135.06
Encina	45.242	1,864,797	24.26
Huntington Beach[25]	28.800	1,554,597	18.53
Potrero	17.054	385,621	44.22
Pittsburg	75.690	652,862	115.94

There is a wide variation in costs, although higher total generation correlates roughly with lower AFRR,. Thus, we use $18.53/MWh as a lower estimate of the non-RMR plants' AFRRs, with $135.06/MWh or even higher possible for plants with particularly low capacity factors. Extrapolating the fixed costs of the remaining 13 non-RMR plants in 2005 with these estimates, and converting to $2005 for consistency, we get a total fixed cost in 2005 for all 19 plants of $389 – $1,121 million.[26]

Variable costs include fuel and O&M. The CEC estimates O&M costs for aging plants to be around $2-3 per MWh, totalling $24.3 – $36.5 million for all study group plants in 2005.[27] Fuel depends, of course, on the price of natural gas, which varies from year to year. For 2005, the 133,117,687 MMBtu used by these plants cost $867 million at a price of $6.31/kcf.[28] This cost will increase if natural gas prices increase, as they have over the past few years.

Pollution Damages

Pollution is the first of two major externalities associated with these aging power plants. Natural gas plants, even those with pollution reduction technology, emit substantial amounts of nitrogen oxides (NOx), carbon dioxide (CO_2), and particulates (PM). (Sulfur dioxide emissions

23 CEC, "Resource, Reliability and ..." page 35
24 EIA
25 Units 3&4 were not included in the CEC, but were estimated to have the same AFRR as Units 1&2 since they have the same capacity.
26 US Department of Labor, Bureau of Labor Statistics, Consumer Price Index inflation calculator. http://www.bls.gov/cpi/
27 CEC "Resources, Reliability ..." 2004, page 33
28 EIA Natural Gas Monthly Table 22, http://www.eia.doe.gov/natural_gas/data_publications/natural_gas_monthly/ngm.html

are negligible.) In this section we attempt to quantify the health and environmental impacts to the state of California of these emissions.

NOx emissions react with the atmosphere to form ozone, particulates, and acid rain. Ozone and particulates contribute to respiratory ailments and other human health impacts, with fine particulates – and possibly ozone – linked to premature death. Acid rain erodes structures and damages crops. Burtraw, Bharvirkar, and McGuinness summarize the results of several studies that estimate the monetary damages per ton of NOx emitted, with results ranging from \$64 - \$5,200 per ton (\$1997).[29] This wide variance of estimates is due in part to differing characteristics of the affected population and the emissions sources of each study. Because effects of these pollutants are localized, estimates for one area may not accurately reflect conditions at another site. Additionally, the assignment of monetary damages to health impacts is controversial and unstandarized, particularly the Value of Statistical Life (VSL) used to calculate damages from premature death. Keeping these uncertainties in mind, we use the EPA's estimates of nationwide benefits for NOx reduction, which total \$1667 – \$6336 per ton for health, visibility, and ecological damages. The EPA uses a higher VSL of \$6.7 million, and assumes for the upper estimate that ozone does contribute to premature mortality.[30] With this estimate, total annual damages from the NOx emissions of all power plants amounts to between \$1.3 – \$4.9 million, as calculated in the table below.

While these numbers may be biased upward, several characteristics of this group of plants support high estimates. Eleven of the 19 plants are located in the Los Angeles area, which has significant air quality issues and dense population [more details?]. Additionally, the immediately surrounding populations of many plants such as Potrero, Haynes, Alamitos, and Huntington Beach are have a high percentage of low-income, minority individuals.[31] Hence, environmental justice concerns demand special consideration for the impact of these plants on the most vulnerable members of the community.

Pollutant	**Emissions 2005 (tons)**[32]	**Damages (\$2005/ton)**	**Total damage (\$2005)**
NOx	781	\$1667 – \$6336	\$1,301,094 – \$4,945,248
CO2	8,342,524	\$3 – 21	\$25,027,572 - \$175,193,004
PM	585	N/A	N/A

Carbon dioxide emissions cause global, rather than local, damages; hence a single universal estimate of per-ton CO2 damages is more feasible. However, since global warming is the primary damage caused by CO2 emissions, and its effects on future climate can only be predicted with limited certainty, there is still disagreement over the precise damage of CO2.

[29] Burtraw, Dallas, Ranjit Bharvirkar, and Meghan McGuinness. "Uncertainty and the Net Benefits of Emissions Reductions of Nitrogen Oxides from Electricity Generation." *Land Economics* Vol 79, No.3, (Aug 2003) pp.382-401.
[30] EPA. "Regulatory Impact Analysis for the NOx SIP Call, FIP, and Section 126 Petitions – Volume 2: Health and Welfare Benefits." 1998. Accessed online at http://yosemite.epa.gov/ee/epa/ria.nsf/vwRef/A.98.4++B?OpenDocument
[31] CEC "Resource, Reliability ... p.104
[32] EPA Clean Air Markets & CA ARB for particulates

Gillingham, Newell, and Palmer reviewed eight studies evaluating the cost of carbon damages and found values ranging from $12 – $76 per ton.[33] Since one ton of CO2 contains approximately 0.273 tons of carbon, this translates to values of $3 – $21 per ton of CO2. Total annual CO2 damages from all plants in the study group thus range from $25 million – $175 milion, as detailed in the table above.

Natural gas plants also emit particulates in addition to those formed from NOx emissions. However, particulates emissions data is only available plantwide rather than per unit, complicating the determination of particulate emissions from plants with newer units not in the study group. Additionally, there may be overlap between particulates emissions and NOx emissions, and their damages should not be counted twice. Hence, we will not quantify particulates damages separately, but recognize that since they contribute to premature mortality, their monetary damages are likely significant. This fact further justifies the use of the EPA's liberal estimates for NOx emissions damages.

Marine Damages

Damage to marine ecosystems is the second class of environmental externality caused by California's aging natural gas plants. Of the nineteen plants, 13 are coastal plants that use once-through cooling (OTC), removing massive volumes of surrounding seawater to cool the plant and discharging the heated water back into the ocean.[34] Large marine life trapped in the intake flow is impinged against intake screens, while smaller animals passing through the screens are entrained in the water flowing through the plant. Both impingement and entrainment (I&E) lead to virtually 100% mortality. They affect not only individual organisms but also, if intake volumes are large enough, the stability of the entire ecosystem. Additionally, heated discharge waters alter the surrounding environment].

In economic terms, the damages incurred by OTC include recreational and commercial fishing damages and biodiversity damages. The former is relatively easy to compute if the amount of fish lost is known, as these fish have market values. The existence value of ecosystems and biodiversity, however, is a newer economic concept with a limited body of research, making precise estimates difficult.

It should be noted that several other coastal plants use OTC, most notably San Onofre and Diablo Canyon nuclear plants, which together have a maximum daily intake that is half the maximum daily flow of all plants in this study combined. While these plants are outside the scope of this analysis, eliminating their OTC usage would have substantial environmental benefits.

Summary of Yearly Costs

A summary of private and social costs of the power plant study group in 2005 is provided in the table below:

[33] Gillingham, Kenneth, Newell, Richard, and Karen Palmer. "Retrospective Examination of Demand-Side Energy Efficiency Policies." Resources for the Future Discussion Paper 04-19-REV. Sept 2004. Pg. 85. http://www.rff.org/rff/Documents/RFF-DP-04-19REV.pdf

[34] State Water Resources Control Board. "Proposed Statewide Policy on Clean Water Act Section 316(b) Regulations. 2006 pp.6-7. El Segundo currently uses OTC, but plans to switch to dry cooling by 2010, and is not included in this figure.

	Cost Per Year
Costs to Owner	$1,289,300,000 – $2,033,500,000
Fixed Costs	$389,000,000 – $1,121,000,000
O&M	$24,300,000 - $36,500,000
Fuel	$876,000,000
Pollution	
NOx	$1,301,094 - $4,945,248
CO2	$25,027,572 - $175,193,004
PM	N/A
Marine Damages	?

For these power plants carbon dioxide emissions are the largest economic externality. Assuming CO_2 is priced at $25 per ton, this would increase the cost of electricity between 1.5 and 2.3 cents per kilowatt-hour, depending on the power plant. This is a significant amount of money, in that it has the potential to shift the economics balance of power generation in favor of cleaner alternatives.

Alternative 1: Repowering Existing Plants

Clearly, this set of aging power plants has significant impacts on the environment, yet the environmental costs represent a relatively small margin of total costs. To determine whether such impacts can be reduced in a cost-effective manner, we first consider the simplest scenario, in which aging units are repowered at existing sites with newer, more efficient units, and closed-cycle cooling replaces once-through cooling systems. We assume that replacement is physically possible at each existing site, since feasibility studies for each of the 19 plants is beyond the scope of this study. [35] Additionally, we assume that when plants are repowered, they are left at the same capacity as previously. Such a plan is not as profitable for power companies as repowering with bigger units, which decreases marginal costs and increases overall generation. However, it is not inconceivable that companies would repower at the same capacity, particularly given the incentives of AB1576, which allows companies to pass on the costs of repowering to consumers.[36] Beyond that, there are serious risks as to whether additional power capacity will be able to be sold into the market, particularly as renewables come on line and displace natural gas generation.

In this scenario, each unit is repowered with a simple-cycle (SC) gas turbine. Combined-cycle turbines are more efficient than steam turbines or simple-cycle gas turbines, because the waste heat from the gas turbine is used to power one or more steam turbines. They are also cheaper per MWh than simple-cycle turbines. However, the efficiency of CC units decreases if they are run as peaking or load-following rather than baseload units. Consequently, for a load-following unit, the more cost-effective choice is usually a modern simple-cycle gas turbine.

Levelized Private Costs

In estimating the costs to repower each plant, we utilize the CEC's 2007 levelized costs of SC technology.[37] The CEC's model is similar to our scenario, except for assuming a greenfield site and non-urban land costs. We propose to repower existing units, and these will have lower land and permitting costs. The CEC's higher cost should be kept in mind when total private costs are calculated in the following section. The models assume a closed-cycle cooling system with access to recycled water.

Following the CEC, we assign a levelized cost per MWh to each repowering project based on the plant's size. We base the capacity of the hypothetical replacement plant on the capacity of the existing plant, although this is almost certainly much more capacity than is necessary. The CEC estimates a 60% capacity factor for new CC turbines, whereas the highest efficiency plant in the study group had a 23% capacity factor in 2005.[38] Again, this shows that the operational features of the aging plants are a better fit for simple cycle combustion turbines.

---

[35] Local Power investigated replacement options for one aging plant with OTC in its report to the Environmental Health Coalition, Green Energy Options to Replace the South Bay Power Plant, by P. Fenn and R. Freehling, Feb. 15, 2007.

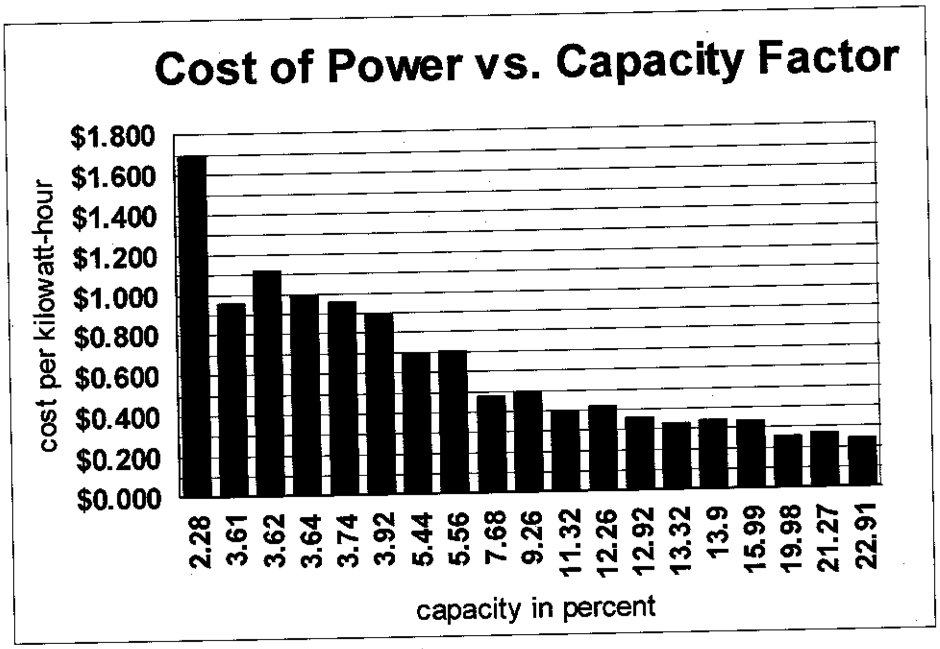
[36] http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_1551-1600/ab_1576_bill_20050929_chaptered.html

[37] CEC "Comparative Costs of California Central Station Electricity Generation Technologies." 2007.

[38] Ibid, pg 40

Even with the slight efficiency loses imposed by closed-cycle cooling, most new units will be more efficient than old units.

From the table below, one can see that the major contributors to this cost are the low operational capacity of the simple-cycle units, as the CEC estimates SC plants to be more than three times as expensive per MWh as CC plants even though the capital costs are comparatively close.[39] The CEC notes that their 2007 model for simple-cycle units assumes a 5% capacity factor. Using the 2003 model's capacity factor of 9.4% instead results in a 40% decrease in levelized costs per MWh for SC plants, reducing the total annualcost to $1.8469 billion ($2005). The repowered simple-cycle units are unlikely to have such a high capacity factor, as most of the peaking plants currently operate around 3.5 – 6% of capacity, but it may well be higher than the conservative 5% estimate. Hence the total annual cost of all the plants together probably lies somewhere in the range of $1.8 - $2.7 billion, perhaps nearer the high end.



The levelized cost of power from these plants would range from 24 cents to well over a dollar per kilowatt-hour, assuming natural gas prices of $10 per million btu and a cost of carbon dioxide of $25 per ton. The operational capacity for power plants with electricity costs under 30 cents per kilowatt-hour is 20% or more. This fact will be significant later when we compare other technology options.

[39] CEC 2007 pg. 41

Fuel Savings

Although the total cost to plant owners of repowering is most probably higher, fuel costs will usually decrease due to lower heat rates of newer turbines. As the future of natural gas prices and demand is the subject of speculation, we calculate the fuel saved by repowering the plants and estimate the value by assuming that natural gas costs $10 per million btu. Table shows that the 19 plants will save 21,108,060 MMBtu each year by repowering, or approximately 19% of their current natural gas usage. Assuming $10 per million btu for natural gas costs, this sums to approximately $4.2 billion in savings over the 20 year economic lifecycle of the power plants.

Plant	Capacity Factor 2005	Capacity	Annual generation	Aging Plant Heat rate	annual fuel	Replacement Heat Rate	Replacement fuel	fuel saved annually	savings
	%	mw	mwh	btu/kwh	mmbtu	btu/kwh	mmbtu	mmbtu	
Alamitos	7.68	1,950	1,311,898	11,715	15,368,880	9,200	12,069,458	3,299,422	$32,994,225
Broadway	12.26	66	70,882	11,981	849,242	9,200	652,118	197,124	$1,971,240
Contra Costa	5.56	680	331,198	10,775	3,568,659	9,200	3,047,022	521,637	$5,216,370
Coolwater	2.28	146	29,160	9,740	284,021	9,200	268,275	15,747	$157,466
El Centro	15.99	118	165,285	9,994	1,651,863	9,200	1,520,626	131,237	$1,312,366
El Segundo	11.32	670	664,393	11,054	7,344,205	9,200	6,112,420	1,231,785	$12,317,854
Encina	22.91	929	1,864,425	11,688	21,791,399	9,200	17,152,710	4,638,689	$46,386,893
Etiwanda	12.92	640	724,347	11,957	8,661,016	9,200	6,663,991	1,997,024	$19,970,243
Haynes	13.9	1,126	1,371,063	8,765	12,017,364	9,200	12,613,776	(596,412)	($5,964,122)
Huntington Beach	19.98	888	1,554,220	10,896	16,934,784	9,200	14,298,826	2,635,957	$26,359,575
Mandalay	9.26	430	348,806	10,466	3,650,600	9,200	3,209,012	441,588	$4,415,880
Morro Bay	3.64	1,002	319,502	9,952	3,179,681	9,200	2,939,416	240,265	$2,402,653
Moss Landing	3.61	1,478	467,397	9,916	4,634,707	9,200	4,300,051	334,656	$3,346,561
Olive	3.62	101	32,028	14,745	472,257	9,200	294,660	177,597	$1,775,970
Ormond Beach	3.92	1,500	515,088	11,190	5,763,835	9,200	4,738,810	1,025,025	$10,250,251
Pittsburg	5.44	1,370	652,865	11,192	7,306,868	9,200	6,006,361	1,300,508	$13,005,076
Potrero	21.27	207	385,693	10,787	4,160,472	9,200	3,548,377	612,095	$6,120,951
Redondo Beach	3.74	1,310	429,187	11,692	5,018,060	9,200	3,948,524	1,069,535	$10,695,351
Scattergood	13.32	803	936,966	11,158	10,454,668	9,200	8,620,088	1,834,580	$18,345,796
Total		**15,414**	**12,174,404**		**133,112,581**		**112,004,521**	**21,108,060**	$211,080,599

fuel price $10 permmbtu

Pollution Reduction

In addition to lower heat rates, new turbines also have lower emissions rates than older steam units, even those with SCR pollution reduction technology installed. The table below summarizes emissions rates of the pollutants with damages quantified for the five types of replacement plants.

Turbine Type	NOx emissions rate (lbs/MWh)	CO2 (lbs/MWh)
Conventional CC	0.056	817.62
Advanced CC	0.046	761.47
Simple & Conventional SC	0.093	1083.84
Advanced SC	0.076	886.63
Average, Old Plants	0.128	1370.47

Multiplying the emissions rate for each repowered plant by its expected annual generation gives approximate yearly emissions for each plant. The largest portion of environmental benefit is from the CO2 reduction, with relatively little value for NOx reduction, for which reason they are left out of account in this context.

Plant	annual CO2 old	CO2 new	savings	CO2 savings value
	tons	tons	tons	
Alamitos	899,080	706,063	193,016	$4,825,405
Broadway	49,681	38,149	11,532	$288,294
Contra Costa	208,767	178,251	30,516	$762,894
Coolwater	16,615	15,694	921	$23,029
El Centro	96,634	88,957	7,677	$191,934
El Segundo	429,636	357,577	72,059	$1,801,486
Encina	1,274,797	1,003,434	271,363	$6,784,083
Etiwanda	506,669	389,843	116,826	$2,920,648
Haynes	703,016	737,906	(34,890)	($872,253)
Huntington Beach	990,685	836,481	154,204	$3,855,088
Mandalay	213,560	187,727	25,833	$645,822
Morro Bay	186,011	171,956	14,056	$351,388
Moss Landing	271,130	251,553	19,577	$489,435
Olive	27,627	17,238	10,389	$259,736
Ormond Beach	337,184	277,220	59,964	$1,499,099
Pittsburg	427,452	351,372	76,080	$1,901,992
Potrero	243,388	207,580	35,808	$895,189
Redondo Beach	293,556	230,989	62,568	$1,564,195
Scattergood	611,598	504,275	107,323	$2,683,073
Total	7,787,086	6,552,264	1,234,822	$30,870,538

CO_2 energy rate	117 lbs per mmbtu
CO_2 value	$25 per ton

Annual CO_2 savings, assuming a cost of carbon at $25 per ton, would be over $30 million, or approximately $600 million over the economic lifecycle of the plants.

Marine Benefits

Equipped with closed-cycle cooling, the marine damages of the repowered plants will be drastically reduced. We will assume that the plants in the study group can contract with wastewater facilities or other sources of recycled water to eliminate their use of seawater completely. Even if some plants must continue to use seawater, the volume required for closed-cycle cooling is less than 5% of OTC cooling needs. Closed-cycle cooling has some minor disadvantages compared to OTC beyond the increased energy required to operate it and cost to install it: cooling towers emit plumes of vapor which can be abated at a cost of $6/kW, and any pollutants in the source water will be discharged in higher concentrations.[40] Because the damages of these concentrated contaminants have not been extensively studied, we will not quantify their effects and will assume they are negligible. Hence the repowered plants will inflict little to no significant marine damage.

[40] CEC 2007 pg. 28, CEC 2005 OTC Issues Report pg.43

Alternative 2: Clean Energy Replacement

Although new natural gas plants are certainly preferable to the current aging plants from an environmental standpoint, the effect of their pollution still amounts to hundreds of millions of dollars in damages over the course of their operation. The majority of this cost comes from carbon dioxide emissions, which California must curb if it is to reach the goals of AB32 by 2020. Hence, a combination of natural gas and renewable energy sources would be a more sustainable replacement in the long term.

We propose a replacement for the power plant capacity with a few main components.

1. Solar Thermal Generation, the evening portion of the peak demand for electricity during the summer months could be partially replaced by wind energy, while steam turbines powered by solar thermal technology would provide peak energy during the day.[41] If either system is provided with storage or backup fuel supply, then reliability can virtually match that of a natural gas power plant. Because peak electricity demand generally occurs when solar thermal output is also maximized – during the hottest and sunniest part of the day – and because much of California has abundant and reliable sunshine, solar power could indeed provide majority significant portion of peak power needs. Approximately 2000 to 3000 megawatts of California's load curve could be appropriately met by solar thermal plants, which begin production in the early morning shortly after sunrise and maintain a relatively flat level of electric generation through the rest of the day. These plants are best sited in regions with good sun, some of which happen to be located within the same transmission zones where aging power plants are located. For example, eastern San Diego County, Eastern LA County, a swath from the Carrizo Plain extending west toward San Luis Obispo, Imperial Valley, and much of the eastern part of the Central Valley could be ideal locations for solar thermal plants, especially when the value of being close to load demand—and the possibility of avoiding transmission congestion in the summer—is taken into account. According the California Energy Commission, the Cost of Electricity from this kind of technology, which produces at about 24% capacity, is currently about 28 cents per kilowatt-hour for a merchant power plant, and below 20 cents per kilowatt-hour for a publicly owned and financed facility. This compares reasonably with the levelized cost of electricity from natural gas power plants operating at similar capacity.

2. Photovoltaics. This source of energy is provided on-site during the peak hours of demand and closely follows the general shape of the bell-shaped demand curve. It has the benefit of avoiding the need for transmission upgrades, and the delays inherent in siting large power facilities. 3000 megawatts of new photovoltaic capacity is planned, with billions of dollars in rebates committed toward this goal. Photovoltaics complement the energy production of solar thermal plants.

3. Peak Demand Reduction. Reducing peak demand with voluntary curtailments under conditions of stress in the electric system is a valuable and local resource. Like photovoltaics, it does not require transmission, and often it requires little to no deployment of infrastructure.

[41] Local Power, "Green Energy Options to Replace the South Bay Power Plant." Feb 2007.

4. Energy Efficiency. While California has aggressive energy efficiency programs, there has been on limited targeting of the primary driver of peak demand: air conditioning. Ground-source heat pumps, better home insulation and shade trees could go far toward reducing summer demand. A study from the US Forest Service, for example, showed that planting shade trees has the potential to avoid the need for over 700 megawatts of power plants. [42] Geothermal heat pumps use the natural and relatively constant ground temperature of about 55 degrees F. to cool a fluid in pipes that in turn cools your house. Investment in these resources—shade trees and ground heat—is very cost effective.

[42] Green Plants or Power Plants, 'Center for Urban Forest Research, USDA Forest Service, Davis, CA.

Discussion & Conclusion

Implementation of California's goal to get 33% of its electricity from renewable sources is likely to displace the need for 10,000 megawatts or more of natural gas power plants, greatly reducing the need for replacing aging power plants with new fossil fuel units. Certain clean technologies, such as solar energy, can effectively match most of the benefits of natural gas power plants when they are used to meet peak energy needs. And significant quantities of these resources can be deployed into the regions where they are needed for grid reliability. Clean energy plans for San Francisco, San Diego and the LA Basin have shown that there is another path to the future other than 100% reliance on fossil fuels.

It is very important to realize that resource decisions are made at the California Public Utilities Commission, and by the utility companies themselves, according to a "least cost" criteria. For example, when energy efficiency measures are evaluated, they are compared to the cost of generating comparable amounts of electricity. If the efficiency measure is less costly, then it will be prioritized. The same is true of contracts for renewable energy. Contracts are signed and power plants are "dispatched" according to the cost ranking. If costs are imposed on environmentally destructive practices, like once-through cooling (OTC), then priority will shift toward resources that are less destructive. Thus policy-makers do not need to wait passively for an abstract "market" to take the lead on energy decisions, particularly when that market has not internalized the proper costs into its assessements.

Imposing appropriate environmental costs on the power plant, rather than the public at large, is a way to help insure that the state's policy targets are achieved, and that correct market decisions will be made.