



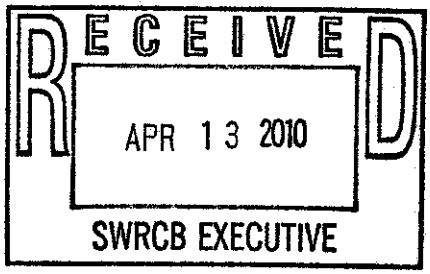


April 13, 2010

Jeane Townsend, Clerk to the Board
State Water Resources Control Board
1001 "I" Street, 24th Floor
Sacramento, CA 95814
Email: commentletters@waterboards.ca.gov

Re: Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling

Honorable Board Members,

As you are aware, California has 17 old once-through-cooling (OTC) gas-fired generation plants that need to be closed. They cause environmental damage to California's marine habitats and do not comply with EPA regulations. The challenge is how to replace their generating potential. Should we replace them with new, more efficient dry cool gas fired generators? Or pursue a renewable energy scenario? The attached article, "Renewables Cost-Effective Replacement for Aging Natural Gas Plants," published in Natural Gas & Electricity, updates an extensive analysis of this issue published by Pacific Environment in November 2009. (*Green Opportunity: How California Can Reduce Power Plant Emissions, Protect the Marine Environment, and Save Money. Robert Freehling and Suzanne Doering; Editor: Rory Cox*). We are submitting this article as an attachment for the record in this proceeding.

Instead of just replacing old gas-fired plants with new ones, the more desirable alternative strategy covered in this study, "Green Energy Replacement," involves replacement with solar power generation, peak demand programs and energy efficiency.

This article concludes that the best strategy for utilities would be to implement a phased replacement within the next five years using the Green Energy Replacement approach. This strategy has several advantages and benefits:

**1. Costs will be much lower** - The total cost for the low-cost scenario of gas-fired replacement is $0.309 / KWh vs. $0.169 KWH for the low-cost Green Energy scenario for a net reduction of $0.14 / KWh or a 45% reduction in cost. This strategy costs less even without considering all external costs such as the environmental damage and carbon costs of the replacement gas plants.

**2. Contain costs to ratepayers** - If new gas plants replace the old ones, the costs for the generation from these plants will increase from $0.09 - 0.153 / KWH or 30-98%. By contrast, under the Green Energy Replacement scenario, the new rates would range from an increase of $.013 to a decrease of $.091 -- or an average overall decrease in rates from current costs.

Furthermore, the renewables will supply dependably-priced power that is not subject to the fluctuations of the natural gas market or to potential carbon charges.

**3. Help utilities close their RPS gap** – California utilities in aggregate are far behind the renewable portfolio standard targets, procuring only about 13% renewables this year, when they're required by law to procure 20%. Eliminating 15,000 MW's of fossil fuel generation capacity, which on average runs only about 10 percent of the time, is an achievable way of helping the utilities catch up in meeting their legally required RPS.

**4. Reduced damage to public health** – By replacing these aging gas fired plants with renewable energy and energy efficiency, the state will benefit by lower criteria pollutants in crowded urban areas, reduced harm to its citizen's health, improved environmental justice.

**5. Help meet AB 32 goals** - Replacing the old gas plants with new or rebuilt ones means a huge commitment of capital resources into more fossil fuel facilities, which will produce greenhouse gases for decades to come. Those same dollars put into renewable energy and energy efficiency will help keep rates down and put California on the track to a lower carbon footprint.

**6. Provide more local jobs** – by installing locally-sited renewables, co-generation and by ramping up efficiency projects, California can invest in our communities instead of sending money out of state for natural gas or out of the country for imported LNG.

This lower-cost conclusion is partly based on recent trends -- cost of conventional power plants is increasing while PV solar has experienced dramatic decreases.

To replace old gas-fired plants with new ones would not only be very expensive to utilities and ratepayers but also set back meeting the state's 33% RPS target by crowding out renewables with new natural gas power plants.

Utilities can plan the timing of retiring and replacing OTC plants to coincide with implementing energy efficiency measures and installing new renewable energy generation. Through proper planning, the plants can be easily and cost effectively replaced.

We respectfully urge you and other California decision-makers ensure that as these old OTC plants are retired, their energy is replaced with load-reduction strategies through energy efficiency plus new clean and cost effective renewable energy.

If you have questions or would like more information, please contact Rory Cox at 415.399.8850 x302 or rcox@pacificenvironment.org.

Sincerely,

Jim Metropulos
Sierra Club California

Rory Cox
Pacific Environment

CC: California Energy Commissioners, California Public Utilities Commissioners, Senate Natural Resources Committee, Assembly Utilities and Commerce Committee

# Renewables Cost-Effective Replacement for Aging Natural Gas Plants

*Robert Freehling and Rory Cox*

Once-through cooling (OTC) for power plants is a decades-old technology that uses 177 billion gallons a day of surface water to cool the boilers in natural gas, coal, and nuclear plants. Unfortunately, OTC plants also suck in and instantly kill fish, larvae, and even marine mammals that happen to venture in their path. OTC plants are estimated by the Environmental Protection Agency (EPA) to kill 3.4 billion fish and shellfish a year in United States.[1] Because of this, there has been an increased effort to shut down OTC power plants.

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In 2004, the EPA issued regulations requiring power plants throughout the nation to reduce OTC and its environmental impacts. California proposed a regulation that details phasing out the OTC technology used in 17 natural gas power plants and two nuclear plants in the state. One proposed remedy has been to repower the plants using dry or closed-cycle cooling.

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California has been struggling to meet a 20 percent renewable energy mandate for investor-owned utilities by 2010. With less than a year to the deadline, the state is procuring about 13 percent renewable power, a smaller percentage than the state had in 2003. California's OTC burden and the lagging renewables program are two problems that can be solved cost-effectively with one solution.

This is detailed in a new report,[2] which concludes that replacing aging power plants with renewable energy and efficiency is more cost-effective and will provide greater environmental, public health, and climate benefits than new natural gas–fired power plants. The report presents a cost-benefit analysis of two different scenarios. The first scenario, "Fossil Replacement," examines the costs of building new natural gas power plant technology that does not use OTC.

Renewable energy can cost less than traditional gas-fired sources.

The second scenario, "Green Energy Replacement," examines replacement with solar power, peak demand programs, and energy efficiency. Both scenarios include externalized costs of damage to the climate and to public health, but even if these are excluded, the Green Energy Replacement scenario pencils out as more economical than replacing with a natural gas–fired plant (**Exhibit 1**). The finding that renewable energy can cost less than traditional gas-fired sources builds on recent reports of increasing cost of conventional power and decreasing cost of photovoltaics. Areas of the country where solar energy is abundant are the first to see this emerging trend.

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Exhibit 1. Summary Comparison of Report Scenarios

| Scenario | Capacity Megawatts | ELCC Megawatts | Annual Generation Megawatt Hours | Internal Cost Rate per Kilowatt Hour | External Cost Rate per Kilowatt Hour | Total Cost Rate per Kilowatt Hour | Annual Cost |
|---|---|---|---|---|---|---|---|
| Current Aging Plants | | | | | | | |
| Aging Plants Low Cost | 15,400 | 15,400 | 12,152,397 | $0.133 | $0.023 | $0.156 | $1,895,773,932 |
| Aging Plants High Cost | 15,400 | 15,400 | 12,152,397 | $0.202 | $0.100 | $0.302 | $3,670,023,894 |
| Replacement Scenario 1 | | | | | | | |
| All Natural Gas Low Cost | 15,400 | 15,400 | 12,152,397 | $0.303 | $0.006 | $0.309 | $3,756,090,573 |
| All Natural Gas High Cost | 15,400 | 15,400 | 12,152,397 | $0.348 | $0.044 | $0.392 | $4,763,739,824 |
| Replacement Scenario 2 (High Cost) | | | | | | | |
| Green Energy-Generation Only | 18,700 | 10,800 | 36,012,368 | $0.289 | | $0.289 | $10,412,991,337 |
| Green Energy-with Efficiency | 23,400 | 15,500 | 51,352,872 | $0.211 | | $0.211 | $10,860,848,545 |
| Replacement Scenario 2 (Low Cost) | | | | | | | |
| Green Energy-Generation Only | 18,700 | 10,800 | 36,012,368 | $0.224 | | $0.224 | $8,072,791,672 |
| Green Energy-with Efficiency | 23,400 | 15,500 | 51,352,872 | $0.166 | | $0.169 | $8,686,454,906 |

## RENEWABLE REPLACEMENT CHEAPER THAN FOSSIL REPLACEMENT

The combined capacity of the 17 once-through cooling natural gas plants in California is about 15,400 megawatts. The cost of operating these plants can only vaguely be estimated by limited public information. At best, we know the general cost of fuel, all the plant heat rates, and fixed revenue requirements for a few plants. Based on this information, we extrapolated the average cost of energy from the plants as about 13 cents a kilowatt-hour when gas costs $6 a million Btu's. On the other hand, the cost of environmental damage from these plants is very high, estimated at between 2.3 and 10 cents a kilowatt-hour. There is wide variation in cost between plants, due to differing heat rates and different operations and maintenance (O&M) costs, with increased costs if plants had been recently sold and thus required new capital investment.

Replacing aging plants with new natural gas plants is projected to greatly increase the cost of power compared to the current generators. A big cost driver is that these plants only operate at an average capacity factor of 9 percent, and power plant construction costs have more than doubled over the past decade.[3] While O&M costs for a new plant will be lower, and efficiency improved, these factors are outweighed if the plant is constrained to meet the same need as the current plants (i.e., operating in summer to provide local reliability and peak energy). New plants will reset the capital expenditure clock and must provide attractive rates of return.

Our report considers the long-term costs of the plants, including construction, fuel, O&M, and profits. These costs can be very different from market prices. On the other hand, if long-term market prices are below costs, the plants may generate electricity but not profits.

## SCENARIO 1: FOSSIL REPLACEMENT

This scenario replaces all OTC natural gas plants with new natural gas plants, assumed to have a book life of 20 years. The effect is a much higher cost of electricity, estimated to range between 30.3 and 34.8 cents a kilowatt-hour. **Exhibit 2** shows electric generation costs, assuming different natural gas prices and 9 percent capacity factor. The cost of energy only varies by about 20 percent even if natural gas prices vary by a factor of three. This model was tested using the same input cost assumptions as the California Energy Commission (CEC) had used in a different study


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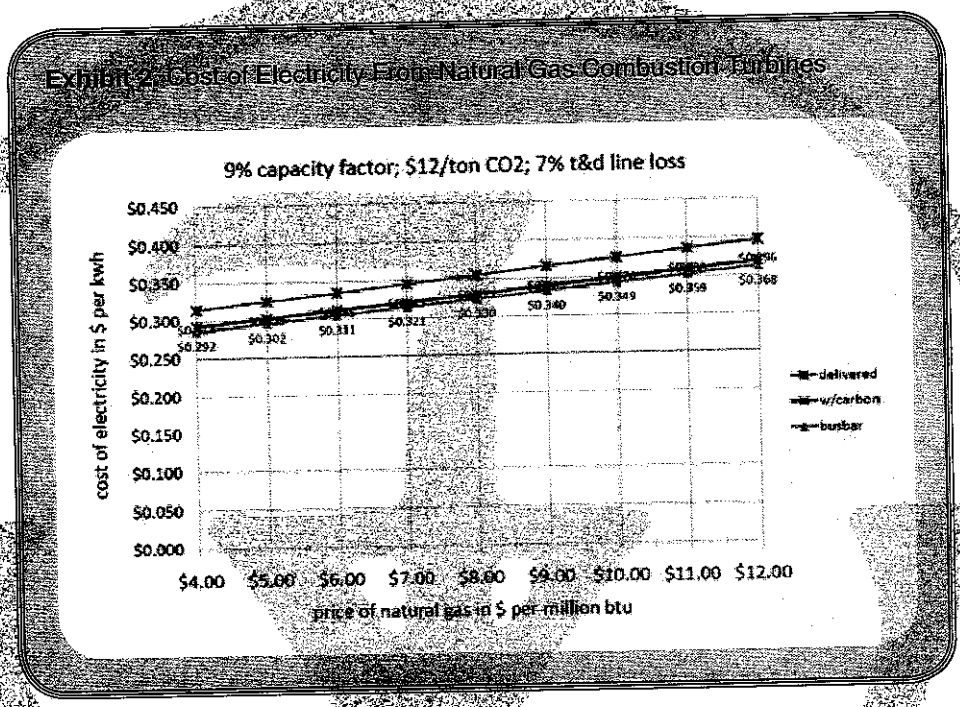
Exhibit 2: Cost of Electricity From Natural Gas Combustion Turbines




and resulted in a total cost of energy within 4 percent of the commission's result.

Using published values of environmental costs, we determined that new power plants would eliminate between $177 million and $540 million of annual damage to sea life, and are assumed to reduce climate damage by 20 percent (reflecting efficiency improvements). We used test values of $12 and $80 a ton for the future damage from carbon dioxide, within the range of published estimates.[4] $CO_2$ and nitrous oxide would add between 0.6 and 4.4 cents a kilowatt-hour to new plants in social costs. While these are significant, the major costs are the ones paid by the plant owner. In the worst case, the internal plus social cost of energy from replacement plants was 39 cents a kilowatt-hour.

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New data show these assumptions as conservative. Our report assumed an installed cost of $1,000 a kilowatt, reflecting a 2007 CEC estimate[5] for simple-cycle natural gas plants. The CEC used a capacity factor of only 5 percent, which resulted in a dizzying levelized cost of 59.96 cents a kilowatt-hour. The commission's new report for 2009 gives average capital cost over $1,200 a kilowatt, with levelized cost of energy from new merchant generators near 80 cents a kilowatt-hour.[6]

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Any model for future cost of fuel over the next 20 years is speculative, so we assumed a low and high cost for natural gas at $6 and $10 a million Btu's. Our low and high fuel-price assumptions roughly approximate the CEC's low and middle forecast scenarios.

## SCENARIO 2: THE GREEN ENERGY SCENARIO

This would replace the OTC plants with a portfolio that includes solar generation and energy efficiency. Inspection of Exhibit 1 reveals that the cost of energy "supply only" is about 27.4 cents a kilowatt-hour. This is clearly less than the cost of electricity from new natural gas plants. The savings from building a green portfolio are even greater if the avoided external cost is taken into account.

Just as new data is showing that natural gas power is more expensive than we assumed, new data is also showing that solar PV costs declined significantly over the past year. Solar modules


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that used to cost about $4,000 a kilowatt in the last year or two can now be purchased for under $2,000 a kilowatt.[7] The decrease in installed cost could reduce solar electricity to 23 cents a kilowatt-hour or lower in areas of the county with excellent resources.

The following simple model (**Exhibit 3**) shows an updated $5.50-a-watt installed cost for a 20-megawatt tracking solar photovoltaic system placed at a substation, providing local reliability and avoiding the need for transmission. This cost is lower than the $7 figure in our published report[8] and allows placement in a region with 10 percent lower solar resource than was assumed.

Energy efficiency is a sizable portion of the portfolio (Exhibit 1). It is the cheapest resource, estimated at 6 cents a kilowatt-hour, and it reduces average cost of the green portfolio to 21.2 cents a kilowatt-hour. If efficiency is included, this is less expensive than any of the natural gas replacement alternatives, with or without externalities.

The Green Energy scenario cost is more expensive than energy from the aging plants if only internal cost is considered. If externalities are taken into account, the Green Energy portfolio—including energy efficiency—falls into the range of cost of energy from the aging plants.

The total cost of energy—as opposed to cost per kilowatt-hour— is much higher for the Green Energy scenario. This is because it generates far more electricity than the aging plants or the Fossil scenario. The higher generation rate is due to more renewable nameplate capacity being needed to provide the same load-carrying capacity as natural gas plants.

One important function of the OTC plants is to meet local reliability needs and to follow variable load. Retiring these plants will require replacing this capability. Local resources, such as solar built on rooftops or at substations, and energy-efficiency measures, can help but may not be sufficient. The state Water Resources Control Board commissioned a study by ICF Jones & Stokes that included computer modeling of grid operation and found that the main problem was the state's aggressive target of trying to retire all the plants by 2012. If this was delayed by only three years, they found that no new generation and some minor transmission upgrades for as little as $135 million were needed.[9]

## GREEN ENERGY REPLACEMENT IS COST-EFFECTIVE AND CONSISTENT WITH STATE LAW

By applying its policy tools such as the renewable portfolio standard, California can retire its OTC power plants while achieving lower levels of greenhouse gas emissions, air pollution, and

**Exhibit 3.** Utility-Scale Photovoltaic System Financial Model—Tracking

| | | | | | |
|---|---|---|---|---|---|
| **capital & equity** | | | **electric generation** | | |
| 1 capital cost | $5.50 | per watt (ac) | 22 generation rate (initial) | 1800 | kwh/kw (dc) |
| 2 loan portion | 60% | | 23 ac derate | 85% | |
| 3 loan amount | $3.30 | per watt | 24 ac generation rate | 2118 | kwh/kw (ac) |
| 4 rate | 7.5% | | 25 degrade rate | 0.50% | per year |
| 5 term | 20 | years | 26 term rate | 1822 | |
| 6 declining balance interest | $3.17 | per watt | 27 avg rate | 1970 | kwh/kw (ac) |
| 7 total loan | $0.13 | per watt | 28 lifecycle generation | 59,095 | kwh |
| 8 annual loan payment | $0.01 | per watt | 29 capacity factor | 22.5% | |
| 9 equity | $2.20 | per watt | | | |
| 10 equity rate of return (pretax) | 11.0% | | | | |
| **tax credit & depreciation** | | | **cash flow** | | |
| 11 federal tax credit | 30% | | 30 loan principal | $3.30 | per watt |
| 12 fed tax rate | 35% | | 31 loan interest | $3.17 | per watt |
| 13 state tax rate | 7% | | 32 equity | $2.20 | per watt |
| 14 total tax rate | 40% | | 33 profit | $7.26 | per watt |
| 15 depreciation tax value | $2.20 | per watt | 34 o&m | $0.45 | per watt |
| 16 tax credit | $1.65 | per watt | 35 inverter | $1.20 | per watt |
| 17 total tax benefits | $3.85 | per watt | 36 lifecycle pretax cost | $17.58 | per watt |
| | | | 37 tax benefits | -$3.85 | per watt |
| **lifecycle cost** | | | 38 net lifecycle cost (pretax) | $13.73 | per watt |
| 18 o&m rate | $0.015 | per kwh | | | |
| 19 inverter lifecycle | 10 | years | 39 tax value | $ (0.065) | per kwh |
| 20 inverter lifecycle cost | $0.60 | per watt | 40 Net Cost of Electricity | $0.232 | per kwh |
| 21 lifecycle | 30 | years | | | |


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natural gas consumption. The most important policy is the state's mandate to increase renewable energy to 33 percent by 2020. According to a report for the CEC by Lawrence Berkeley National Laboratory, this would allow 8,000 megawatts of the state's natural gas power plants to be retired.[10] If the study's results are correct, replacing all OTC plants with new natural gas plants is at odds with achieving the state targets for its green energy programs. And if our results are correct, building a new round of natural gas plants would also be an expensive mistake.

And if our results are correct, building a new round of natural gas plants would also be an expensive mistake.

## AFTERTHOUGHTS

The Green Opportunity report shows that we are at a crossing point where solar energy is beginning to be a lower-cost option than new natural gas power plants. Does this mean "curtains" for natural gas plants? Not necessarily. Solar photovoltaics provide peak power during the day, which is most valuable in regions of the country with hot summer climates that typically drive air conditioning load. In areas of the county where solar does not match peak demand as well, or that do not have as good a solar resource, the cost of solar power will be higher than in California, and the benefits less.

This problem can be addressed through energy storage systems, which will likely increase in the years ahead. On the other hand, the nation has over 450 gigawatts of natural gas plants. Natural gas is well suited to meeting variable load conditions and providing other grid services. It is likely that solar power will increasingly become the "preferred resource," with natural gas playing backup.

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The risk for natural gas power is if new plants are built at today's higher capital costs, and if these operate at low capacity factors. The average capacity factor of the current U.S. fleet of natural gas plants is only 22 percent,[11] and aging plants will frequently operate at lower rates. Once older plants retire, the question for a new plant will be, What role is it going to play in a nation of underused gas plant capacity? If new plants are pushed into low capacity operation, current analysis shows that the cost of energy could become very high.

Our Green Opportunity report found that energy from new natural gas power plants will cost from 30 to 35 cents a kilowatt-hour over the life of the plant. As difficult as that may be for some to swallow, the CEC's model—using what it claims to be the most extensive and up-to-date survey of power plant costs available today—forecasts that a new gas plant in 2018, operating at 5 percent capacity factor, could see cost of energy at over $1 a kilowatt-hour. At that rate, solar energy everywhere in the nation will be cheaper.

The full report is available at www.pacificenvironment.org.

## NOTES

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