POLICY PAPER

# Does California Need Liquefied Natural Gas?

*The Potential for Energy Efficiency and Renewable Energy to Replace Future Natural Gas Demand*

*A project of the Community Environmental Council*

Policy Report

# Does California Need Liquefied Natural Gas?

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## The future of California's energy supply is at an important juncture

California stands at an important fork in the road, facing two possible paths. The first is the path we're on now, which leads to increased dependence on fossil fuels to provide energy for our growing population and industry. If we continue down this path, we can predict some of the environmental and economic outcomes. We will see increased environmental harm from the extraction and burning of fossil fuels – such as air pollution and increasing greenhouse gas emissions that cause climate change. We will also see rapidly rising prices for energy. Because fossil fuels are ultimately limited, the costs will continue to rise. Consumer electricity bills will reflect these economics, as we have already witnessed with a round of sharp rate increases among California's major utilities, due in large part to increases in fuel costs. Utilities are raising rates as much as 43 percent in the last year alone.[1]

The second path leads to a very different future. Along this path, California's needs are met through increased energy efficiency, demand response, and renewable energy resources such as wind, geothermal, biomass, solar, and ocean energy – resources that are plentiful in this state. While large investments will be required for the necessary infrastructure, issues such as air pollution, climate change and volatile electricity and natural gas prices become minor or even irrelevant under this path. The "fuel" for energy efficiency and renewable sources of energy will not change in price, providing additional certainty for future economic planning and growth. Moreover, the capital costs for these technologies will only continue to come down as they are adopted more widely. And in a post-9/11 world, decentralized, and non-fuel burning, power plants such as wind turbines and solar panels will be much less attractive targets for terrorists.

California is poised to continue down the first path if it approves the building of proposed import terminals to receive liquefied natural gas (LNG) from foreign sources. Unfortunately, state and federal policymakers seem to consider approval of one or more of these proposed LNG terminals a *fait accompli*. National and state agencies have drawn attention to the worsening state of natural gas supplies in the U.S. and California, which has caught the attention of elected officials, other policymakers, energy providers, and consumers.

***However, the lack of a robust debate over the need for LNG import terminals in California has created a serious blind spot in the state's energy policy.***

In fact, program managers within the California Energy Commission – the agency responsible for gathering natural gas information in California and monitoring the success of California's renewable energy programs – admit that there has not been a

serious discussion between the Energy Commission's natural gas and renewable energy departments on this issue.[2] There has been no consideration of the effect that LNG import terminals would have on meeting California's stated energy preferences: renewable energy and energy efficiency. Nor has there been sufficient consideration of how increased renewable energy and energy efficiency would affect natural gas prices in California.

Many industry advocates and state and federal policymakers believe California needs LNG, but a quick analysis of the numbers tells a different story:

Californians currently use 6.33 billion cubic feet of natural gas a day to heat our homes and run our power plants. The state Energy Commission projects that by 2016, that number will rise to 6.68 billion cubic feet per day. We need, therefore, to find an additional 355 million cubic feet of natural gas per day in the next decade – or its equivalent.[3]

In California, about half of our power plants use natural gas to generate electricity – which can be generated by other energy sources, such as geothermal, wind and solar power. The balance is used for heating, cooking and industry. Natural gas for electricity generation and residential end use[4] constitute the large majority of natural gas demand increases, so instead of trying to find a source for 355 million cubic feet per day of natural gas in the next 10 years, we can substitute its equivalent: about 38,000 gigawatt hours[5] of *electricity* and/or *conservation* measures per year.

California law requires that 20 percent of our electricity come from renewable resources by 2010 — about 55,000 gigawatt hours (GWh) per year. This amount is included in the Energy Commission's assumptions about natural gas demand, which form the basis for most conclusions that LNG import terminals are needed in California. However, the California Public Utilities Commission recently commissioned a report finding that a 33 percent renewable portfolio standard by 2020 is feasible.[6] Governor Schwarzenegger has actively supported this more ambitious goal,[7] as does the state's 2005 Energy Action Plan, endorsed by the state's major energy agencies. Also, the state legislature is currently considering SB 107, a law that will formally increase the goal to 33 percent by 2020. If adopted, this would provide about 33,000 GWh of additional generation by 2016, almost as much as the additional natural gas demand projected by 2016 (38,000 GWh). This amount of new renewable generation is not included in the Energy Commission's natural gas demand projections.

Conservation and energy efficiency measures can also significantly reduce the need for additional natural gas. California's investor-owned utilities recently received $2

billion in state funding to achieve $5 billion in energy efficiency savings, equivalent to almost 11,000 GWh a year through 2008. The state also plans to save an additional 12,000 GWh per year by 2013.

Under these existing mandates and goals, we will more than offset future energy demand *just by following plans that the state and the utilities already have in place.* When we consider the full realistic potential for renewables and energy efficiency, our conclusion is reaffirmed many times over.

**Our analysis shows that renewables and energy efficiency could produce 133 percent to 381 percent of the projected additional gas demand by 2016.**

Some policy advocates argue that renewable energy resources will take more time than anticipated to come on line, despite existing mandates and goals, and that in the meantime California should hedge its bets by continuing to secure new supplies, treating natural gas as a "bridge fuel."

However, this argument overlooks the projected increase in domestic natural gas supplies, the 16 new LNG import terminals already approved by regulators elsewhere in the U.S. (13) and Baja California (3), as well as plans for gas pipelines from Canada and Alaska – all of which could funnel more natural gas our way if needed. It also overlooks the fact that there is no guarantee that the LNG imported to California through the proposed terminals would stay in state. The gas will, through market forces, be sold to the highest bidder, whether or not the bidder is in California.

Perhaps most importantly, this argument also overlooks the possibility that investing so heavily in LNG import terminals could endanger the future road for renewables by diverting attention – and investments – from renewables and energy efficiency and contravening the state's official policy of preferring energy efficiency and renewable energy over other sources.

Regarding safety issues stemming from LNG terminals, anytime you concentrate a fuel and put it near or in the ocean, there are of course concerns about safety and environmental protection. We do not focus on those concerns in this paper, as they have been addressed adequately by others. But safety and environmental concerns aside, our analysis shows that building LNG terminals simply isn't necessary.

This report looks critically at natural gas supply and consumption projections and concludes that California's energy efficiency and renewable energy mandates could readily meet expected additional natural gas demand and, therefore, eliminate the need for LNG import terminals along our coast. The following chart and table outline how.

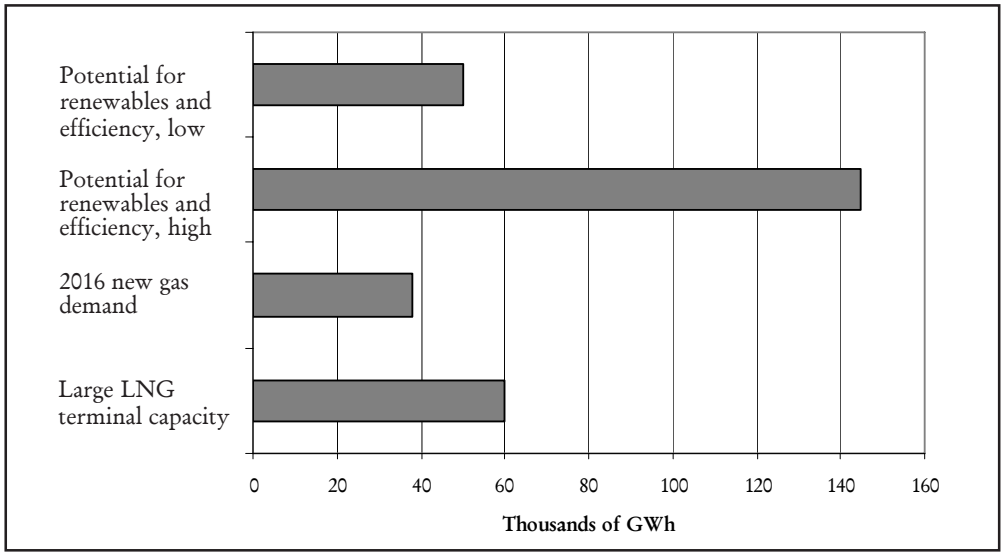


Figure 1. *Energy Efficiency and Renewable Energy Potential vs. Natural Gas Demand*

| | Low | High |
|---|---|---|
| **Energy Efficiency Potential (GWh)** | 17,497 | 68,305 |
| **Renewable Energy Potential (GWh)** | 32,781 | 75,843 |
| **Total (GWh)** | 50,278 | 144,148 |
| **Percent of projected gas demand by 2016** | 133% | 381% |
| **Percent of a large LNG import terminal** | 84% | 240% |

Table 1. *Energy Efficiency and Renewable Energy Total Potential by 2016.*[8]

## Fossil fuels and 'business as usual' are bad for California

Liquefied Natural Gas (LNG) is natural gas that has been cooled to the point where it becomes a liquid, making it easier to transport. In California, four energy companies have current proposals for constructing LNG import terminals, two of which would be in the Central Coast region. One is planned for a site about 14 miles offshore from Oxnard by BHP Billiton, an Australian energy company. The other has been proposed for Platform Grace, a retired oil rig off of Ventura, by Houston-based Crystal Energy. A third terminal, which would not include a gasification facility, has been proposed 22 miles offshore from Malibu, by Australia's Woodside Energy. A fourth proposal for a terminal in the Port of Long Beach was put forward by Sound Energy Solutions, a partnership between Chevron and Mitsubishi.

In addition, 16 new LNG import terminals have already been approved by federal regulators elsewhere in the U.S. and Baja California, many of which will likely be built. One Baja terminal is currently under construction by Sempra, Inc., a San Diego-based company. It was originally approved to process one billion cubic feet per day (cf/d), but Sempra recently requested an expansion to 2.5 billion cf/d – enough natural gas to satisfy almost one half of California's needs[9] if it were all consumed in California.

### *Why do some policymakers advocate LNG?*

Why are so many LNG terminals being proposed – with state and federal policymakers largely supportive of these proposals thus far? On the surface, it seems to be an issue of simple supply and demand.

The California Energy Commission projects a 0.55 percent annual growth rate in natural gas demand between 2006 and 2016, while natural gas production in California is expected to remain flat or decline.[10] With demand growing from 6.33 billion cf/d in 2006 to 6.68 billion cf/d by 2016,[11] California needs to plan for an increase in natural gas demand – or its equivalent – of 355 million cf/d by 2016.

The core question is how to best meet this increased demand. Increasing California production would be one place to look; however, the California Energy Commission paints a bleak picture:

> *California's dependence on imports will increase, because in-state natural gas production is slowly declining and only meets 15 percent of the state's total natural gas demand. Total U.S. production from conventional sources has flattened despite increases in drilling and wellhead prices. Canada's natural gas production statistics*

*indicate similar resource depletion trends. Remaining North American natural gas supplies will be more costly, because the less expensive resources have already been produced.*[12]

However, U.S. domestic production of natural gas, outside of California, is projected to increase through 2016, according to the Energy Commission's most recent natural gas assessment:

*Natural gas production from the Lower 48 is expected to increase by about 1.6 percent per year. Imports of Canadian supplies are expected to decrease over the same period at an annual average rate of 2.3 percent even though the MacKenzie Delta supplies show significant potential and could provide about 0.8 trillion cubic feet per year to Canadian markets if regulatory approval is obtained.*[13]

The 1.6 percent increase in domestic supplies will far outweigh the 2.3 percent decrease in Canadian imports because imports are a small fraction of the United States' total use.[14] The Energy Commission also discusses the impact on California's gas supplies from proposed Alaskan natural gas pipelines – and LNG – but fails to make any conclusions regarding the need for LNG terminals in light of projected increases in domestic natural gas production and LNG import terminals constructed elsewhere in North America.

Accordingly, if we are looking at supply and demand projections from the most pertinent state agency for California, it is not very clear what has motivated state and federal policymakers to advocate LNG as a solution to our energy needs. We discuss natural gas supplies from domestic U.S. sources, Alaska and Canada, in more detail below, subsequent to our discussion of the potential for renewable energy and energy efficiency to meet future natural gas demand.

### *What's wrong with this picture?*

The conclusion that flat or declining California production requires building LNG import terminals in California fails to take into account several key points, in addition to those mentioned above.

First, the California terminals would far exceed the 355 million cf/d of LNG needed in the next decade – with *each* terminal capable of funneling 800 million to one billion cf/d. The infrastructure created[15] could lock California and other states served by the terminals into natural gas generated electricity for decades to come and give a false sense of comfort, making it difficult to pursue other, more preferable, options such as renewables and energy efficiency.

Second, the California Energy Commission's projections do not include all of the state's plans to generate more energy from renewable sources and reduce energy demand through funded demand response and energy efficiency programs, (which have reduced statewide power equivalent to twenty 500 MW power plants since 1975[16]). The Energy Commission's projections do include the California Public Utility Commission's (CPUC) energy efficiency programs through 2008, but do not include additional targets through 2013 or later.[17] Similarly, the projections do include the 20 percent Renewable Portfolio Standard (RPS) by 2010, but not the 33 percent RPS by 2020 that has been called for by the Governor, the state's 2005 Energy Action Plan, and SB 107.[18] Nor do the projections include Governor Schwarzenegger's mandate that all state-owned buildings reduce energy demand by 20 percent by 2015, or his strong encouragement that non-state owned buildings meet the same goal.[19]

Third, the state has made it clear that energy efficiency, demand response, and renewable energy generation are preferred over additional fossil fuel generation. The state's Energy Action Plan II (2005), a document jointly produced by the Energy Commission, the CPUC, and the Independent System Operator (an independent agency that manages California's electricity grid) states, in no unclear terms:

> ***The loading order identifies energy efficiency and demand response as the State's preferred means of meeting growing energy needs.*** *After cost-effective efficiency and demand response, we rely on renewable sources of power and distributed generation, such as combined heat and power applications. To the extent efficiency, demand response, renewable resources, and distributed generation are unable to satisfy increasing energy and capacity needs, we support clean and efficient fossil-fired generation.*[20]

Demonstrating the seriousness of this loading order, the CPUC recently approved $2 billion for energy efficiency and demand response programs for the state's largest three utilities, expected to save $5 billion for consumers and eliminate the need to build three large power plants.

Fourth, some California cities will likely increase energy efficiency targets and markets for renewables even further through implementation of the Community Choice Aggregation law (AB 117). This permits cities to aggregate the electric loads of residents, businesses and municipal facilities, allowing cities to negotiate better rates on behalf of their constituents and/or to purchase renewable electricity in higher amounts than would otherwise be the case. Aggregation may also

create business opportunities for renewable energy, energy efficiency and conservation by providing new markets for these services. Over 20 local governments examining Community Choice Aggregation in California have adopted an RPS target of 40 percent by 2017 as a pre-condition for obtaining a low-cost[21] feasibility study,[22] making it likely that aggregation will lead to a higher level of renewables than without.[23]

**These areas — energy efficiency and conservation goals, the Renewable Portfolio Standard, and community choice aggregation — will greatly reduce the demand for traditional forms of electricity generation, particularly natural gas-fired generation, as well as demand for natural gas for heating and cooking.**

### *Energy policy by default*

The pie is only so big for electricity demand – and emphasizing one type of generation over another will lead to less from other types of generation. In this case, the state is emphasizing both LNG and renewables and energy efficiency, leading inevitably to competition at some level, for policy attention, investments, and public awareness.

As mentioned, the state's Energy Action Plan explicitly calls for energy efficiency, demand response and renewable energy to be the first three items in the state's "loading order," specifying what energy sources are to be preferred. Natural gas supply is number six in the loading order.[24] Rather than focusing on natural gas for new electricity and natural gas demand, the state should follow its stated loading order and emphasize the fact that renewable energy and energy efficiency, under existing goals, can meet future energy demand without additional natural gas supplies.

Since renewable energy and energy efficiency are the officially preferred options, the need for LNG in California should be fully examined because of its potentially detrimental impact on meeting the state's renewable energy and energy efficiency goals and because it is a less desirable fuel source from an environmental and energy security perspective.

Unfortunately, no such examination has been performed by any of the state's energy agencies. Despite this fact, in September of 2004, the CPUC tacitly approved LNG as an option for California.[25] In its decision, D.04-09-0922, the CPUC states:

> *[T]oday's decision authorizes the gas utilities to release upcoming capacity contracts that are expiring so long as they fulfill the requirements of meeting their core procurement needs as discussed in this decision. [Southern California] Edison is granted the same authority so that it can take advantage of opportunities to better fulfill its gas procurement needs for electric generation.*[26]

This statement, and the decision as a whole, set the gears in motion to provide customers for proposed LNG import terminals, by endorsing LNG as a fuel source for California in theory – without actually endorsing any particular LNG project (which was not at issue in the decision):

> *[W]e point out that we are not deciding in this decision whether certain proposed LNG projects should be built in California, or on the West Coast. Instead, today's decision is only addressing what needs to be in place for potential sources of LNG supply to connect to the gas transmission and distribution systems of the California gas utilities. Such an analysis furthers the Energy Action Plan's goal of ensuring that California has a reliable supply of reasonably priced natural gas.*

The Commission also states that it "discussed [in D.04-09-022] how diverse gas supplies, including potential sources of LNG, can benefit California."[27] The discussion in the decision is, however, cursory at best and does not even mention the detailed analysis provided by the California Energy Commission in its 2003 *Public Interest Energy Strategies Report* and other official documents regarding the potential of energy efficiency and new renewables to meet future demand instead of new natural gas supplies.

The Commission also states, on this issue:

> *The focus of this proceeding is to ensure that policies and rules are in place to ensure long-term supplies of gas. The focus of the [previously] mentioned rulemaking proceedings has been energy efficiency and renewable energy programs. It would be duplicative for this [rulemaking] to address the additional energy efficiency and renewable energy concerns raised in this proceeding. We therefore decline to address those concerns in this proceeding.*[28]

A similar argument has been made by many LNG proponents, an argument which ignores the fact that LNG import terminals in our state will likely be detrimental to achieving the state's goals for energy efficiency and renewables (the preferred energy sources). Accordingly, an examination of the effect of LNG on achieving the state's preferred energy policies should be conducted, instead of cursorily dismissed as a concern.

As Ratepayers for Affordable Clean Energy (RACE) noted in a brief in its lawsuit against the CPUC, for violating its own rules in the proceeding that produced the decision: the CPUC "failed to conduct a single evidentiary hearing on LNG's safety, quality, cost, alternatives, or environmental impacts, or on the need to rely on LNG as a fuel source given the availability of domestic natural gas."[29] This matter is still pending court resolution.

It is due to the lack of any comprehensive review of the need for LNG in California that a bill, SB 426 (Simitian), was proposed in 2005, requiring that the Energy Commission conduct a detailed "needs assessment" for LNG, and a ranking of existing LNG proposals, should a need be found for one or more terminals. This bill is pending in the Legislature as of March, 2006 and is expected to be voted upon in July of 2006, and if not vetoed by the Governor would come into effect January 1, 2007.[30] If the bill does pass (which seems unlikely given the Governor's strong support for LNG), there is considerable time between now and the time it would come into effect. Therefore, it is imperative that the Energy Commission and other appropriate entities look at these issues prior to deciding on any of the pending project applications in California and prior to SB 426 taking effect.

In short, the CPUC set the state policy gears in motion for construction of LNG import terminals in California after a relatively cursory examination of whether LNG is actually needed in the state, now or at any point in the future. The decision issued without an examination of the effect of LNG terminals in our state on meeting the preferred energy options: renewables and energy efficiency.

## Energy efficiency and renewables are better options for California

### *California's energy efficiency potential*

According to the state's own Energy Action Plan, "Energy efficiency is the least cost, most reliable, and most environmentally-sensitive resource, and minimizes our contribution to climate change. California's energy efficiency programs are the most successful in the nation and we want to continue to build upon those successes."[31]

From 1975 to 2001, California's energy efficiency efforts eliminated the need to build more than 10,000 megawatts (MW) of generation capacity, equivalent to 10 large nuclear plants, or 20 large natural gas plants.[32] This is equivalent to 15 percent of today's electricity demand. In other words, California has been able to do more with less, leading the nationwide trend of producing more economic output per unit of energy since the profligate early 1970s.

More recently, during the 2001 energy crisis, Californians successfully reduced their energy consumption significantly, proving their ability to immediately and effectively employ energy efficiency measures.

We can replicate this history – without an energy crisis – if we plan well. Consider some of the state's own mandates, as well as some ambitious voluntary goals, which are summarized in Tables 2 through 4.

- In 2004, the CPUC set ambitious goals that called on the state's four largest privately owned utilities[33] to reduce their annual electricity demand by 23,183 GWh by 2013 [34] — equivalent to 38 percent of a large LNG import terminal.[35] For natural gas, the CPUC set an annual reduction goal of 444 million therms by 2013 — equivalent to 22 percent of a large LNG import terminal. With these goals, the CPUC expects energy efficiency to meet 55 to 59 percent of the utilities' additional electricity generation needs between 2004 and 2013.[36]

- A year later, the CPUC approved $2 billion in funding to ensure that some of the goals outlined in its 2004 decision are met. The funding approved in 2005 is expected to save $5 billion for consumers and obviate the need to build three "large power plants over the next three years."[37] More specifically, the plans are expected to reduce electricity demand by 7,371 GWh per year from 2006 to 2008 and reduce natural gas use by 122 megatherms per year from 2006 to 2008 — equivalent to 3,575 GWh — for a total of 10,946 GWh per year.[38] These programs alone will reduce the need for 18 percent of a large LNG import terminal.[39]

| Efficiency mandate | % of new natural gas demand by 2016 | Equivalent large LNG terminals |
|---|---|---|
| CPUC mandate to reduce electricity and natural gas demand by 10,946 GWh per year by 2008[44] | (already included) | 18% |
| Green Building Initiative mandate to reduce electricity use in state-owned buildings by 1,935 GWh by 2015[45] | 5% | 3% |
| Total percentages | 5% | 21% |

Table 2. *Current California Energy Efficiency Mandates*

| Efficiency target | % of new natural gas demand by 2016 | Equivalent large LNG terminals |
|---|---|---|
| CPUC goal to reduce natural gas consumption by 444 million therms by 2013[46] | 25%[47] | 16% |
| CPUC goal to reduce electricity demand by 26,508 GWh by 2013[48] | 41%[49] | 26% |
| Total | 66% | 42% |
| Total GWh | 24,997 | |

Table 3. *California's Non-Mandated Energy Efficiency Goals*.

| Efficiency target | % of new natural gas demand by 2016 | Equivalent large LNG terminals |
|---|---|---|
| Re-power California's aging non-peaking natural gas plants[50] | 134% | 85% |
| Total GWh per year | 50,808 | |

Table 4. *Other Energy Efficiency Potential.*

- Meanwhile, the California Energy Commission and the CPUC outlined a similar goal in their joint Energy Action Plan II, mirroring the CPUC decisions relating to the investor-owned utilities, calling for saving 23,000 GWh of electricity per year by 2013 primarily by implementing the state's most recent energy efficiency standards, such as new Title 24 requirements for new buildings.[40] This amount is not in addition to that called for in the CPUC decision, but reflects the fact that the state's three energy agencies (CPUC, CEC, and Independent System Operator) are on the same page in terms of California's potential for energy efficiency savings.

- Also addressing building efficiency, California's Green Building Initiative, signed by Governor Schwarzenegger in September of 2004,[41] calls for reducing electricity use by 20 percent in state-owned buildings by 2015. This amounts to 3,870 GWh per year and is equivalent to 6.5 percent of a large LNG import terminal.[42] (The initiative also calls for all commercial buildings in California to achieve the same 20 percent by 2015 goal, but does not mandate reaching this goal).

- In addition, there is substantial potential for energy savings through re-powering California's aging natural gas-fired power plants. If only 17 of the 25 natural gas plants over 500 MW were re-powered with modern, more efficient gas turbines, 174 billion cubic feet per year would be saved, equivalent to 50,808 GWh and 85 percent of a large LNG import terminal.[43]

### *California's renewable energy potential*

Although California still has significant potential for reducing energy demand through conservation and efficiency, much of the "easy pickings" have been tapped during previous energy crises and other efforts. This makes the renewable energy sector all the more important.

California currently obtains about 11 percent of its electricity from renewable energy sources.[51] We have an abundance of additional renewable resources, still largely untapped due in part to a lack of sufficient investment, infrastructure and policy support.[52] Recognizing the potential for renewables, Governor Schwarzenegger has called for a 33 percent renewables goal by 2020, mirroring the recommendations in the state's Energy Action Plan II. The Energy Commission and the other state energy agencies agree that California must adopt more ambitious goals and have stated their support for this target.[53] This target was found to be feasible and cost-effective in a recent report completed for the CPUC by the Center for Resource Solutions.[54]

According to the Energy Commission, 55,170 GWh per year will be produced from renewable sources if the state meets its 20 percent by 2010 goal, equal to approximately one large LNG import terminal.[55] This includes renewable energy produced by investor-owned utilities, publicly-owned utilities and electric service providers. Publicly-owned utilities are not required by state law to meet the renewable standard, but the two largest — the Los Angeles Department of Water & Power and the Sacramento Municipal Utility District — are subject to their own mandates that approximately match the state renewable energy mandates.[56] Many other municipal utilities currently procure large amounts of renewable electricity and plan to procure more in the future.[57] Accordingly, we can consider approximately all load-serving entities to be subject to the same 20 percent renewable portfolio standard by 2010.[58]

Under the more aggressive renewable portfolio standard goal – 33 percent by 2020 – as much as 108,561 GWh per year would be produced from renewable sources,[59] equivalent to about 16,500 MW of electrical generation capacity and 180 percent of a large LNG import terminal.[60] The 33 percent standard could become law in 2006, given that the Governor signed a law in 2005 calling for an examination of the feasibility of this level of renewables, and the subsequent completion of this examination, finding that the 33 percent Renewable Portfolio Standard (RPS) is both feasible and cost-effective.

The Energy Commission already includes 32,000 GWh of renewable energy in its natural gas assessment for 2016 (the projection assumes that the 20 percent by 2010 RPS goal will be met). The Energy Commission does not, however, consider the effects of a 33 percent RPS by 2020 on its natural gas assessment. Assuming that a 30 percent RPS is achieved by 2016 – as a likely proportion of the 2020 goal – about 32,781 GWh of additional renewable generation will be produced by 2016, which was <u>not</u> included in the state's natural gas projections.[61] In other words, 108,561 GWh total would be produced under a 33 percent RPS by 2020, but only 32,781 GWh of new renewables, not already accounted for by the Energy Commission in its natural gas assessment, would be produced by 2016.

| Mandate | Generation (GWh) | % of 2016 new gas demand | Equivalent large LNG terminals |
|---|---|---|---|
| 20% by 2010 | 29,533[62] | (already included) | 49% |
| 30% by 2016 | 32,781[63] | 87% | 55% |
| 33% by 2020 | 47,323[64] | 125% | 79% |

Table 5. *California's Current and Prospective Renewable Energy Mandates*.

### *Is California's renewable energy market viable?*

For those who would say that the state's mandate for 20 percent renewable electricity by 2010 – let alone 33 percent by 2020 – is an unachievable goal, we would argue that there is more than enough technical *and economic* potential for renewables in California to meet this goal.

The following sections discuss estimates of California's renewable energy potential, from the Energy Commission and other reliable sources. Table 6 summarizes the potential from the various renewable resources in California.

**Wind**

In 2004, California generated 4,258 GWh of electricity using wind power, 1.5 percent of the gross system power and equivalent to about seven percent of a large LNG import terminal.[74]

Expanding wind power capacity from the 2,096 MW of capacity in 2004 to about 8,540 MW in 2017, as is expected by the Energy Commission,[75] would produce 19,760 GWh per year,[76] equivalent to 33 percent of a large LNG import terminal. The technical potential for wind power is of course much larger – the Energy Commission recently estimated 127,000 MW of potential in the state.[77]

| Resource | Estimated generation by 2017[65] (GWh) | % of 2016 new gas demand | Equivalent large LNG import terminals |
|---|---|---|---|
| Wind | 19,760[66] | 52% | 33% |
| Solar PV | 4,139[67] | 11% | 7% |
| Solar thermal | NA[68] | NA | NA |
| Concentrating solar | 18,615[69] | 49% | 31% |
| Geothermal | 22,654[70] | 60% | 38% |
| Biomass/landfill gas | 35,000[71] | 93% | 58% |
| Small hydroelectric | 2,947[72] | 8% | 5% |
| Ocean power | 4,728[73] | 12% | 8% |
| Totals | 107,843 | 285% | 180% |

Table 6. *California's Renewable Energy Potential.*

**Solar**

Solar energy is another renewable resource that is easily accessible in many parts of California with significant expansion potential. The technical potential for photovoltaic and concentrating solar power systems in California exceeds 17 *million* MW.[78] For comparison, the state currently has about 60,000 MW of generation capacity. Assuming, however, that photovoltaic systems in the near term will be applied primarily to commercial and residential rooftops, as is likely, a total of 75,000 MW is developable in the next decade or so, with economics being the primary barrier.[79] We don't expect this full potential to be developed over the next 10 years because of cost and supply problems. Instead, we assume that the Governor's goal of 3,000 MW of new solar PV will be installed by 2016, in light of the CPUC's recent approval of a new system of rebates over an 11-year period.[80] Solar photovoltaic technology is still the most expensive of the renewable technologies and is dependent on incentives for its success.

In addition, 16 counties throughout the state receive an annual average of solar radiation of six kWh per day per square meter — enough to meet the requirement for concentrating solar power (CSP) systems. CSP is generally utility-scale solar, so may lead to much larger capacity additions than solar PV. This insolation data leads to a technical CSP potential in California of over one million MW of capacity, capable of producing about 2.7 million GWh.[81] Again, the state's total generation capacity today is about 60,000 MW, so this potential is about 15 times the total generation in California today.

As CSP technology improves, many other areas of the state will be suitable for CSP, not just the 16 counties described above. Moreover, with existing technologies such as those used in Kramer Junction, California, a natural gas generator can be integrated into the CSP plant, making it appropriate for any insolation level since natural gas backup can operate any time there is insufficient insolation for CSP generation alone. The Kramer Junction trough-system plants have achieved on-peak capacity as high as 80 percent with solar alone, but over 100 percent of capacity by using the gas-assist generator to sell additional amounts of peak power.[82]

Again, we don't envision the full technical potential being developed by 2016. We assume, instead, the construction of 10 CSP plants similar to that being built near Barstow for Southern California Edison, which will be 850 MW at full capacity.[83] We believe it is realistic to expect 8,500 MW of CSP plants to be built in California by 2016, or shortly thereafter – a tiny fraction of the technical potential – utilizing either dish systems or trough systems. (Our estimate is based on recent advances in Stirling engine technology and a resurgence of interest in trough

systems.[84]) This estimate of 8,500 MW of CSP would produce about 18,615 GWh per year, at a 25 percent capacity factor, or about one third of a large LNG import terminal.[85]

A poll of CSP manufacturers taken by the Western Governors Association found that the industry could supply the southwestern U.S. with up to 13 GW of CSP by 2015.[86] Given the fact that California has approximately the same power demand as the entire Western states combined (excluding Texas), it is not unreasonable to project 8,500 MW being built in the state. This conclusion is reinforced when we consider the strong renewable energy and climate change policies already enacted in California.

If thermal energy storage systems currently being examined by the industry, such as molten salt systems, are included with trough or dish systems, capacity factors could be as high as 60 percent, much higher than the current 25 percent. This conclusion is based on the 60 percent capacity factor achieved with Solar Two's (a now defunct solar power tower array) thermal energy storage system in California during the 1990s.

**Geothermal**

Though wind and solar resources have perhaps the largest potential in California, geothermal, biomass, and small hydroelectric facilities currently contribute more to California's total renewable energy resource base.[87] Geothermal power contributed 13,571 GWh, or about 4.9 percent of the gross system power in 2004.[88]

In a recent draft report, the Western Governors' Association's Clean and Diversified Energy Advisory Committee found 2,400 MW of new geothermal capacity in California — capable of producing as much as 15,768 GWh per year.[89] The Energy Commission reported a slightly larger potential of 2,862 MW, or 22,564 GWh per year, in its 2005 geothermal resources report.[90]

**Biomass and Waste to Energy**

Biomass energy is generated from organic wastes such as woody agricultural wastes and forest thinnings. Biomass power plants provided 5,997 GWh of electricity in California in 2004 – about 2.2 percent of the gross system power.[91] In its 2005 updated biomass assessment, the Energy Commission found an additional technical potential of 4,700 MW of biomass power by 2017, using current technologies.[92] The report also estimates a 7,100 MW potential in a best case scenario[93] and states that as much as 60,000 GWh per year could be generated from biomass by 2017 – but acknowledges this is an optimistic projection.[94] Taking the more realistic potential of 4,700 MW, or 35,000 GWh, per year by 2017 leads to a reasonable estimate of potential production.

**Small Hydroelectric**

Small hydroelectric plants (30 MW capacity or less) are considered renewable due to the relatively small amount of water required for their operation and consequent minimal environmental impacts when compared to large hydroelectric projects. In 2004, about 1.7 percent of the electricity generated in California was produced by small hydroelectric plants.[95] Small hydroelectric power potential is estimated at 2,280 GWh from new facilities,[96] plus 667 GWh from water pipelines among municipal water utilities and irrigation districts.[97]

**Ocean Power**

The ocean is also a viable resource for energy production, especially in California. Wave power along the coast – from surface wave energy conversion alone – has a technical potential of 18,912 GWh, at *primary sites* only.[98] We are, for the purposes of this report, not considering *secondary sites*, which amount to 75 percent of the potential of the primary sites in terms of GWh of production.[99] We also assume that only 25 percent of the primary site potential will be developed by 2017, resulting in 4,728 GWh of ocean power, equivalent to eight percent of a large LNG import terminal. We do not consider the potential of ocean current power devices, which may be appropriate in some locations along our coast, because no statewide assessment for this technology exists.

## Additional North American gas supplies can meet demand

It is certainly possible that the state will not meet its renewable energy mandates by 2010, let alone the likely new mandate of 33 percent by 2020. It is even possible that the CPUC's ambitious and funded energy efficiency programs with the investor-owned utilities will not produce expected savings. We believe this possibility is unlikely, but we have to consider it.

However, even if the state slips in meeting its own mandates, California need not be overly concerned about natural gas supplies, as significant additional supplies will come online in North America in the next decade from a number of sources:

- Domestic U.S. natural gas production is expected to increase over the next decade, while Canadian imports are projected to decrease.[100] However, the decrease from Canada is projected to be more than offset by increases in U.S. production.[101] According to the Energy Commission, pipeline bottlenecks for natural gas deliveries to California have been resolved such that the historical price differentials between California and the rest of the U.S. have disappeared.[102]

- Three LNG import terminals have been approved by the Mexican government for Baja California and will provide over 2.4 billion cubic feet per day (cf/d) of natural gas to Mexico and the U.S.[103] This figure may soon be increased by 1.5 billion cf/d because Sempra, the company currently building the first of these terminals, has, as mentioned, requested an expansion of its one billion cf/d facility to 2.5 billion cf/d, half of which is slated for the U.S. The Energy Commission expects the first of these Mexican plants to be online by 2008 and also expects a portion of this gas to service the San Diego region.[104]

- 13 additional LNG import terminals (or expansions of existing terminals) have been approved in the U.S., outside of California, and 25 other projects have been proposed for other sites within the U.S.[105]

- A consortium of oil companies has proposed a natural gas pipeline from Alaska and Canada to the contiguous U.S. This project will provide 1.5 to 2 trillion cubic feet of natural gas per year and should be completed by 2016.[106] If completed, this pipeline would forestall the apparent peak in North American natural gas production by a number of years because it would provide access to otherwise stranded natural gas resources.[107]

- An additional pipeline, from the MacKenzie region of Canada's Yukon, is expected to come online by 2013. If it does, it will forestall by a number of years the expected declines in Canadian production.[108]

Although it is impossible to predict where exactly these additional natural gas supplies will be used in the contiguous U.S., they are certain to provide additional downward pressure on North American natural gas prices and ease any supply constraints to California.

**We are not endorsing any LNG import terminals in other states or outside of the U.S.** However, we do acknowledge that additional supplies from sources outside of California have either already received permitting approval and are being constructed, or will likely receive approval and be constructed at some point before 2016. State and federal planners need to consider that these additional supplies are coming online over the next decade when making any decision about LNG import terminals not yet approved for construction, in a similar calculus to that provided above for renewable energy and energy efficiency.

**It is evident that significant new natural gas supplies will soon be available in the U.S. and that additional downward pressure on natural gas prices will be exerted, even if California builds no LNG import terminals. Additionally, previous natural gas pipeline constraints into California from other western states have been resolved, making it much easier to transport additional natural gas supplies from elsewhere in the U.S. to California.**[109]

## CONCLUSION

It should be clear at this point that energy efficiency and renewable energy could readily replace the need for any LNG import terminals in California.

California's future energy path will depend largely upon the willingness of policy-makers to fully embrace energy efficiency and renewable energy as the preferred approach to the state's most pressing environmental issues. The reasons for supporting renewable resources and energy efficiency, rather than supplementing natural gas supplies through LNG, may be boiled down to a few main points.

First, **California's natural gas demand projections are likely too high** due to exclusion of California's full energy efficiency and renewable energy goals and other potential in the state's natural gas demand projections.

Second, **California benefits from a variety of energy efficiency and renewable energy resources that, if developed to their full potential, could eliminate the need for any addition to our current fossil fuel supply base –** and could eventually eliminate a large portion of our fossil fuel demand, or perhaps even all of our fossil fuel and nuclear demand.

Third, **significant additional supplies of natural gas are likely to be available in California** even if California builds no LNG import terminals. This is the case because of increased domestic production, numerous new LNG import terminals being built in Mexico, Canada and other parts of the U.S., and the proposed natural gas pipelines from Alaska and Canada. Additional natural gas supplies from North American sources and LNG terminals outside of California are an effective hedge against the possibility that the state might not reach its full renewable energy and energy efficiency potential by 2016.

* * * * *

So how would the future look if California does not approve any LNG import terminals?

Any decision in the short term by state and federal agencies would have limited effect on California's natural gas supplies until roughly 2008 at the earliest, since it will take at least that long before any of the proposed terminals come online. During that same time, the new three-year round of Public Goods Charge funding for the utilities will probably reduce electricity demand significantly and, at the same time, will reduce natural gas demand for electricity generation, and for natural gas used for heating and cooking in homes and businesses.

In the longer term, disapproving the proposed LNG import terminals in California may have little effect on natural gas supplies in the state because of the avail-

ability of additional natural gas (either natural gas or LNG) from domestic sources, Canada, and LNG terminals outside of California.

However, a decision(s) to approve LNG import terminals in California could have significant effects on renewable energy and energy efficiency, potentially inhibiting necessary investments in these technologies and impeding the state in meeting its energy efficiency and renewable energy goals. This result would, among other things, cause more air pollution, lead to more greenhouse gas emissions that contribute to global warming, heighten our exposure to terrorist attacks through creating new attractive targets, and exacerbate our dependence on foreign sources of energy.[110] At the same time, there is no guarantee that the natural gas from LNG import terminals would stay in California, given how natural gas markets function (the highest bidder will receive the gas, whether in California or not).

Given the existence of viable alternatives to LNG, in the form of energy efficiency and renewable energy, the choice by local, state and federal regulators is clear: we don't need LNG.

A final thought: if we assume a worst-case scenario in which the state's renewable energy and energy efficiency goals are delayed by two or three years, it should also be clear that a large increase in renewable generation in California is the obvious preferred solution for the long-term. Renewable energy is, by definition, renewable! This means that we will not run out of these energy sources, as is the case with fossil fuels such as natural gas, oil and coal. With peak oil[111] – and peak gas – concerns increasing by the day, it is imperative that we do everything we can as a state to rapidly increase our share of renewable energy generation. It is equally imperative that we not commit the state to further dependence on natural gas, a disappearing fuel source when we consider the long-term. While natural gas supplies, both domestically and from international sources, will likely be sufficient for the next decade or two, there is no certainty that global supplies of natural gas will remain viable for much longer than that -- in fact there is plenty of evidence to suggest it won't.[112]

Given the obvious environmental benefits of renewable energy, its increasing cost-effectiveness, its immunity from terrorism concerns, its price stability due to lack of any fuel costs,[113] and its diversity in terms of different resources and generation technologies, it should be obvious to any impartial observer that the renewable energy transition must happen, and as soon as possible.

## END NOTES

[1] Southern California Edison raised residential rates 9 to 18 percent in the first quarter of 2006. Los Angeles Times. <http://www.latimes.com/business/la-fi-utility21dec21,1,4494411.story?coll=la-headlines-business> (January 16, 2006). Pacific Gas and Electric raised residential electric rates by 11 percent and gas rates by 18 percent in January 2006. However, with natural gas price hikes in 2005, total natural gas rate hikes amount to a 43 percent increase. CBS News. <http://cbs5.com/topstories/local_story_365173833.html> (January 16, 2006). San Diego Gas and Electric will raise combined gas and electric rates 20 to 30 percent beginning in the winter of 2005/2006. <http://sdge.com/winter/index.shtml> (January 17, 2006).

[2] Phone conversation with Dave Maul, former Manager of the Natural Gas Office, November 4, 2005; phone conversation with Drake Johnson, Renewable Energy Program Manager, November 1, 2005.

[3] All figures are cited in the body of this paper.

[4] Residential use is comprised of natural gas for heating and cooking. Residential use is expected to grow 1.33 percent per year through 2016, according to the latest figures from the California Energy Commission (personal correspondence with Jairam Gopal, Natural Gas Office Manager).

[5] It is important to distinguish energy from power, or, in this paper, gigawatt hours from gigawatts, as they are fundamentally different measures. A gigawatt hour, or GWh, is equivalent to one million kilowatt hours, a unit used on residential or business electricity bills. A gigawatt is a unit of power (or capacity), the ability to produce energy. 355 million cf/d x 365 days x 0.292 kWh/cf = 37,836 GWh.

[6] The Center for Resource Solutions Report for the California Public Utilities Commission. *Achieving a 33% Renewable Energy Target*. November 1, 2005, p. 1. "It is economically and technologically feasible to achieve a 33% RPS in California by 2020. Moreover, a 33% RPS is likely to result in net savings to California's electricity customers over a twenty year period." <http://www.cpuc.ca.gov/word_pdf/misc/Achieving_33_Percent_RPS_Report.pdf> (March 28, 2006).

[7] Governor Schwarzenegger recently signed into law a bill (September 2005) that requires the California Public Utilities Commission to examine the feasibility of legally mandating a 33 percent RPS by 2020 and to include this goal in its Integrated Energy Policy Report.

[8] See the body of this paper for the derivations of each of these numbers.

[9] Rose, Craig. "Sempra weighs expansion of Baja LNG plant." San Diego Union-Tribune, March 14, 2006: <http://www.signonsandiego.com/news/mexico/20060314-9999-1b14sempra.html> (March 28, 2006).

[10] California Energy Commission. Staff Report, *Revised Reference Case in Support of the 2005 Natural Gas Market Assessment.* CEC-600-2005-026-REV, September 2005.

[11] Personal correspondence with Jairam Gopal, Natural Gas Office Manager, February 7, 2006.

[12] California Energy Commission. *Natural Gas Assessment Update.* CEC-600-2005-003, February 2005, p. iv.

[13] California Energy Commission. Staff Report, *Revised Reference Case in Support of the 2005 Natural Gas Market Assessment.* CEC-600-2005-026-REV, September 2005, p. 25.

[14] *Ibid.* at p. 26.

[15] It is not simply a matter of building the LNG import terminals (and export terminals in other countries, with their own environmental concerns), but also a matter of pipeline upgrades required to turn natural gas capillaries into major distribution points, as is the case for the currently proposed terminals. Such upgrades would be paid for by California's ratepayers, not the companies building the LNG import terminals.

[16] California Energy Commission. *Public Interest Energy Strategies Report.* 100-03-012F, December 2003, p. 39.

[17] Conversation with Lynn Marshall from the Demand Analysis Office, part of the California Energy Commission, January 6, 2006.

[18] SB 1078 set a goal of 20 percent renewables by 2017 at the latest, and the California Public Utilities Commission recently confirmed the accelerated goal of 2010 called for in the *California Energy Action Plan* (2003) and *California Energy Action Plan II* (2005).

[19] The Governor's Green Building Initiative requires state-owned facilities reduce their energy consumption 20 percent by 2015: <http://www.energy.ca.gov/greenbuilding/index.html> (January 19, 2006).

[20] California Energy Commission and California Public Utilities Commission. *California Energy Action Plan II, Implementation Roadmap for Energy Policies.* September 21, 2005, p. 2 <http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF> (January 13, 2005).

[21] The bulk of the costs are paid through a grant from the California Energy Commission from its Public Goods Charge funds.

[22] The studies were financed through a partnership with the Local Government Commission under a grant from the California Public Utilities Commission for this purpose.

[23] At this point in time, it is impossible to quantify the likely renewable generation capacity, or additional energy efficiency improvements, to be achieved through Community Choice Aggregation, so we mention this development as a qualitative consideration only.

[24] California Energy Commission and California Public Utilities Commission. *California Energy Action Plan II, Implementation Roadmap for Energy Policies.* September 21, 2005 <http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF> (January 13, 2005).

[25] California Public Utilities Commission. D.04-09-022, 2004. Available at <http://www.cpuc.ca.gov>.

[26] Ibid., p. 20.

[27] Ibid, p. 42.

[28] Ibid., p. 41.

[29] Ratepayers for Affordable Clean Energy v. California Public Utilities Commission, RACE Supporting Memorandum of Points and Authorities. September 2005, p. 2, on file with author.

[30] Conversation with Alan Gordon, Senator Simitian's office, February 1, 2006.

[31] California Energy Commission and California Public Utilities Commission. *California Energy Action Plan II, Implementation Roadmap for Energy Policies.* September 21, 2005, p. 3 <http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF> (January 13, 2005).

[32] California Energy Commission. *Public Interest Energy Strategies Report.* 100-03-012F. December 2003, p. 39.

[33] Southern California Edison, Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Gas Company.

[34] California Public Utilities Commission. Decision 04-09-060. September 2004, p.10. Available at <http://www.cpuc.ca.gov>.

[35] A "large LNG import terminal" means, in this paper, an 800 million cf/d terminal, operating at an average 70% capacity factor, equivalent to 0.7 x 800,000,000 cf/d x 365 days x 0.292 kWh/cf/d = 59,685

GWh per year. We have rounded this to 60,000 GWh per year.

[36] California Public Utilities Commission. Decision 04-09-060, p. 30.

[37] California Public Utilities Commission. Press release, "PUC Launches Groundbreaking Energy Efficiency Effort." September 22, 2005. <http://www.naesco.org/industry/highlights/CPUC_2005-09-22.pdf> (January 11, 2006).

[38] California Public Utilities Commission. Decision 05-09-043. September 2004, attachment 4. Available at <http://www.cpuc.ca.gov>.

[39] These IOU programs were included in the California Energy Commission's recent natural gas forecasts, but subsequent energy efficiency programs, which will certainly be implemented, were not.

[40] California Energy Commission and California Public Utilities Commission. *California Energy Action Plan II, Implementation Roadmap for Energy Policies.* September 21, 2005 <http://www.energy.ca.gov/energy_action_plan/2005-09-21_EAP2_FINAL.PDF> (January 13, 2005).

[41] State of California. Executive Orders S-20-04. December 14, 2004. http://www.energy.ca.gov/greenbuilding/documents/executive_order_s-20-04.html.

[42] We count only half of this figure for our totals, assuming that half of the government buildings will be outside of investor-owned utility territory, for example, in SMUD or Los Angeles Department of Water and Power territory, avoiding double counting.

[43] Synapse Energy Economics, Comments of Synapse Energy Economics on the California Natural Gas Utilities' Phase 1 Proposals. March 1, 2004, prepared for Border Power Plant Working Group in R.04-01-025 at the California Public Utilities Commission (on file with author).

[44] California Public Utilities Commission. D.05-04-093, August 17, 2005, attachment 4. Available at <http://www.cpuc.ca.gov>.

[45] The Governor's Green Building Initiative requires state-owned facilities reduce their energy consumption by 20% by 2015. We assume, for this paper, that half of that reduction will occur in non-investor-owned utility territory, such that there is no "double dipping" in accounting for the savings from IOU programs, under the PUC, and the Governor's independent mandates. Accordingly, 3,870 GWh per year represents a 20% reduction in state-owned facilities by 2015, and 1,935 GWh represents half that amount.

[46] California Public Utilities Commission. D.04-09-060, September 2004, p. 10. Available at <http://www.cpuc.ca.gov>.

[47] This figure does not include the three year natural gas savings goals, from 2006-8, already included in the CEC's natural gas demand assessment.

[48] California Public Utilities Commission. D.04-09-060, September 2004, p. 10. Available at <http://www.cpuc.ca.gov>.

[49] This figure does not include the three year electricity and natural gas savings goals, from 2006-2008, already included in the California Energy Commission's natural gas demand assessment.

[50] Synapse Energy Economics, Comments of Synapse Energy Economics on the California Natural Gas Utilities' Phase 1 Proposals, March 1, 2004, prepared for Border Power Plant Working Group in R.04-01-025 at the California Public Utilities Commission (on file with author). Synapse estimates, using California Energy Commission data, that re-powering the 17 oldest plants would eliminate 174 billion cf/y, equivalent to 50,808 GWh per year.

[51] California Energy Commission. *2004 Net System Power Calculation.* CEC-300-2005-004, April 2005.

[52] California Energy Commission. *2005 Integrated Energy Policy Report.* CEC-100-2005-005-CTF Nov. 21, 2005.

[53] California Energy Commission. *2005 Integrated Energy Policy Report.* CEC-100-2005-005-CTF Nov. 21, 2005.

[54] The Center for Resource Solutions Report for the California Public Utilities Commission. *Achieving a 33% Renewable Energy Target*. Nov. 1, 2005. <http://www.cpuc.ca.gov/word_pdf/misc/Achieving_33_Percent_RPS_Report.pdf>, March 28, 2006.

[55] California Energy Commission. *Public Interest Energy Strategies Report.* 100-03-012F, Dec. 2003, p.96.

[56] SMUD's RPS goal is 20% by 2011, one year behind the current state goal.

[57] California Energy Commission. *Publicly Owned Electric Utilities and the California Renewables Portfolio Standard.* Nov., 2005, p. 10.

[58] As discussed earlier, Community Choice Aggregators, a new type of load-serving entity, will also be subject to the RPS, and most local governments expressing an interest in CCA currently have agreed to double the state's RPS to 40% by 2010.

[59] 33% of projected electricity demand by 2020.

[60] Assuming a 75% capacity factor.

[61] 2016 figures are supplied because this is the time frame for the California Energy Commission's latest natural gas assessment, which looks ahead 10 years.

[62] 20% of projected 2010 electricity demand.

[63] This figure represents an estimate of the new renewable generation by 2016, under a 33% by 2020 RPS, minus 32,000 GWh (for the 2010 goal) and minus existing renewables today.

[64] This figure represents the total new generation by 2020, not already accounted for in the 2010 RPS goal.

[65] We project new generation through 2017, instead of 2016, which is the time frame for the California Energy Commission's natural gas assessment, because state agencies have done a considerable amount of work looking at potential by 2017, which was the original date for achieving the 20% RPS. Due to the large leeway our numbers provide in meeting future natural gas demands from renewable energy, this one year discrepancy should not be that important.

[66] California Energy Commission, *Renewable Resources Development Report*. 500-03-080F, Nov. 2003, p. 98. Estimates 6,644 MW of new wind projects throughout California by 2017. The Center for Resource Solutions Report for the California Public Utilities Commission. *Achieving a 33% Renewable Energy Target*. Nov. 1, 2005. Estimates a larger potential of 6,960 MW in California <http://www.cpuc.ca.gov/word_pdf/misc/Achieving_33_Percent_RPS_Report.pdf>. We use the lower estimate for present purposes.

[67] The Center for Resource Solutions Report for the California Public Utilities Commission. *Achieving a 33% Renewable Energy Target*. Nov. 1, 2005. Estimates a 5,000 MW capacity for solar photovoltaics. <http://www.cpuc.ca.gov/word_pdf/misc/Achieving_33_Percent_RPS_Report.pdf>. The California Solar Initiative's stated goal is 3,000 MW of new solar, in addition to the approximately 150 MW already installed in California. This production figure assumes a 15% capacity factor. We find the lower figure more realistic at this time, but are optimistic that 5,000 MW or more may be installed, given the rapid pace of innovation in this technology.

[68] The California Energy Commission does not currently provide an estimate of solar thermal potential in California, either in its 2005 draft solar power assessment or its 2003 renewable resources development report. We hope this oversight will be corrected soon, as solar thermal technologies have vast potential for displacing natural gas and electricity demand, as evidenced by the fact that the largest source of renewable energy in the world (other than large hydroelectric, which is not considered renewable in California) is solar thermal, due largely to the numerous installations in China.

[69] California Energy Commission. Draft Staff Paper - *California Solar Resources.* CEC-500-2005-072D, April 2005. Estimates one million MW of concentrating solar potential. We don't believe, for obvious reasons, that anywhere near this amount of CSP will be built by 2017 or even 2027. We have assumed that 10 systems like the 850 MW CSP facility recently approved for SCE by the PUC could be built by 2017, leading to a total of 8500 MW of CSP by 2017, and 18,615 GWh per year by 2017, at a 25 percent capacity factor. The Center for Resource Solutions Report for the California Public Utilities Commission. *Achieving a 33% Renewable Energy Target*. November 1, 2005, p. 41. Estimates a similar potential, at 10,200 MW.

[70] California Energy Commission. *California Geothermal Resources.* CEC-500-2005-070, April 2005, p. 7. The Energy Commission estimate assumes a 90 percent capacity factor for 2,862 MW. The Center for Resource Solutions Report for the California Public Utilities Commission. *Achieving a 33% Renewable Energy Target*. November 1, 2005, p. 40. Finds a similar figure of 2,565 MW of potential in California. <http://www.cpuc.ca.gov/word_pdf/misc/Achieving_33_Percent_RPS_Report.pdf> (March 28, 2006).

[71] California Energy Commission, *Biomass Resources in California: Preliminary 2005 Assessment.* April, 2005, p. v. The figure cited is the low estimate in that report. The Center for Resource Solutions Report for the California Public Utilities Commission. *Achieving a 33% Renewable Energy Target*. November 1, 2005, p. 40. Finds a much lower potential, at 1,775 MW, equivalent to 13,994 GWh. <http://www.cpuc.ca.gov/word_pdf/misc/Achieving_33_Percent_RPS_Report.pdf> (March 28, 2006). The report explained this discrepancy: "Biomass power in general has favorable economics. But the development potential of biomass is contingent on securing long term fuel supplies, with each project requiring a narrow range of fuel specification. Biomass projects tend to be of modest scale and linked geographically to local fuel sources. For these reasons, biomass was only projected to supply 10 percent of the renewable energy needs." (P. 42). We use the higher estimate due to our expectation that reliable baseload capacity will be developed where it is economically feasible, making biomass generation very attractive where feedstock is available, and due to the more detailed (and more convincing) analysis in the Energy Commission's Biomass Resources report.

[72] California Energy Commission. *California Small Hydropower and Ocean Wave Energy Resources.* CEC-500-2005-074. April 2005, p. 4.

[73] Ibid., p. 16. We ignore the secondary sites identified in this report and assume that only 25 percent of the primary site potential identified by the Energy Commission will be developed by 2017.

[74] California Energy Commission. *2004 Net System Power Calculation.* CEC-300—2005-004, April 2005, p.3.

[75] California Energy Commission. *Renewable Resources Development Report.* CEC-500-03-080F, November 2003, p. 98. Estimates 6,644 MW of new wind projects throughout California by 2017.

[76] With a 35% capacity factor, as the California Energy Commission uses in its report.

[77] California Energy Commission. *California Wind Resources.* CEC-500-2005-071-D, April 2005, p. 21. (The pages are not numbered.)

[78] California Energy Commission. Draft Staff Paper - *California Solar Resources.* CEC-500-2005-072D, April 2005. p. 7.

[79] Ibid., p. 11.

[80] California Public Utilities Commission. D.06-01-024. January 12, 2006 <http://www.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/52898.htm> (January 19, 2006).

[81] California Energy Commission. Draft Staff Paper - *California Solar Resources.* CEC-500-2005-072D, April 2005, p. 19.

[82] National Renewable Energy Laboratory report on file with author.

[83] Edison International. "Major New Solar Energy Project Announced By Southern California Edison and Stirling Energy Systems, Inc." August 9, 2005. <http://www.edison.com/pressroom/pr.asp?id=5885> (January 13, 2006).

[84] A trough CSP company, Solargenix, Inc., recently broke ground on a 65 MW trough CSP system in Boulder City, Nevada. <http://www.renewableenergyaccess.com/rea/news/story?id=36934> (February 6, 2006).

[85] The capacity factor of any given technology indicates the percentage of time that the device is producing full power. For example, a good wind site will provide a 35 to 40 percent capacity factor, meaning that 35 to 40 percent of the maximum possible power for the wind turbines installed was actually produced over the course of a year.

[86] Western Governors' Association. Solar Task Force report. January 2006, p. 7. <http://www.westgov.org/wga/initiatives/cdeac/Solar-full.pdf> (February 13, 2006).

[87] California Energy Commission. *2004 Net System Power Calculation.* CEC-300—2005-004, April 2005, p. 3.

[88] *Ibid.*

[89] Western Governors' Association. Draft - *Geothermal Task Force report.* September 2005. <http://www.westgov.org/wga/initiatives/cdeac/Geothermaldraft9-6.pdf> (March 28, 2006).

[90] California Energy Commission. *California Geothermal Resources.* CEC-500-2005-070, April 2005. The Energy Commission estimate assumes a 90 percent capacity factor.

[91]California Energy Commission. *2004 Net System Power Calculation.* CEC-300—2005-004, April 2005, p. 3.

[92] California Energy Commission. *Biomass Resources in California: Preliminary 2005 Assessment.* 500-01-016, April 2005, p. v.

[93] *Ibid.*

[94] *Ibid.*

[95] California Energy Commission. 2004 Net System Power Calculation. April 2005, p.3.

[96] California Energy Commission. *California Small Hydropower and Ocean Wave Energy Resources.* CEC-500-2005-074. April 2005, p. 4.

[97] Ibid., p. 9.

[98] Ibid., p. 16.

[99] There are a few small commercial projects in place around the globe, and a number of technologies in the R&D phase still. Currently the most commercially advanced design is the Pelamis wave energy converter. www.oceanpd.com

[100] California Energy Commission. Staff Report, *Revised Reference Case in Support of the 2005 Natural Gas Market Assessment.* CEC-600-2005-026-REV. September 2005, pp. 30-31.

[101] *Ibid.*

[102] *Ibid.*, p. 11.

[103] Federal Energy Regulatory Commission. *Existing and Proposed North American LNG Terminals.* <http://www.ferc.gov/industries/lng/indus-act/exist-prop-lng.pdf> (January 10, 2006).

[104] California Energy Commission. *Revised Reference Case in Support of the 2005 Natural Gas Market Assessment.* CEC-600-2005-026-REV, September 2005, p. 42.

[105] Federal Energy Regulatory Commission. *Existing and Proposed North American LNG Terminals.* <http://www.ferc.gov/industries/lng/indus-act/exist-prop-lng.pdf> (March 7, 2006).

[106] California Energy Commission. Staff Report, *Revised Reference Case in Support of the 2005 Natural Gas Market Assessment.* CEC-600-2005-026-REV. September 2005, p. x.

[107] California Energy Commission. *Revised Reference Case in Support of the 2005 Natural Gas Market Assessment,* CEC-600-2005-026-REV. September 2005, p. 42.

[108] *Ibid.*

[109] California Energy Commission. *Revised Reference Case in Support of the 2005 Natural Gas Market Assessment.* CEC-600-2005-026-REV, September 2005, p. 11. "As a result of pipeline expansions completed during 2002 and 2003, which afforded California unconstrained access to regional supplies, California natural gas prices no longer tend to be out of step with the rest of the North American natural gas market. Consequently, from 2006 to 2016 California's end-use natural gas prices mirror the trends of the overall market."

[110] California already imports approximately 85% of its natural gas, mostly from other states and Canada, according to the California Energy Commission: <http://www.energy.ca.gov/html/energysources.html> (January 19, 2006). And, of course, the U.S. currently imports about 60% of its oil supplies largely from unstable regions of the globe, according to the Energy Information Administration.

[111] "Peak oil" is the point at which global demand exceeds global supply for oil. *Energy Trends and Their Implications for U.S. Army Installations,* Donald F. Fournier and Eileen T. Westervelt. September 2005, p. xi. "World oil production is at or near its peak and current world oil demand exceeds the supply." This is an alarming statement from a credible source and strongly supports similar statements made by others over the last few years. <http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=A440265&Location=U2&doc=GetTRDoc.pdf>

[112] Darley, Julian. *High Noon for Natural Gas: The New Energy Crisis.* September 2004.

[113] The European wind industry is now advertising the no fuel feature of wind power as a major selling point: http://www.ewea.org/index.php?id=238.

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