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From: <m.thibodeaux@att.net>
To: <GrandGulfEIS@nrc.gov>
Date: Thu, Jul 14, 2005 5:13 AM
Subject: Nuke EIS for Grand Gulf

Wind energy can replace the anticipated output for the new nuke at Grand Gulf without the environmental 10,000 years of waste. NRC has to the public's interest and wants to condemn the poorest delta region to the highest operating cost facility. What the commission must consider is total life cycle costs.

Entergy has produced no evidence that they can secure its wasteful production for the entire life and through its de-commissioning.
Entergy has produced no evidence that future generations will honor its wasteful protection promises.

Louisiana is equally committed to Grand Gulf determinations through Entergy's System Agreement scheme. Entergy has spread its environmental costs into La.

Therefore, Louisianians have a public duty to chose the most environmental begin energy products, but the wrong comparrisions by this Commission will forever condem these poor captive ratepayers to an eternal excessive yoke.

CC: Julie D. Buckner <larenew1@hotmail.com>, Heather Borst-Persson <hborst@gmail.com>, Thomas Milliner <tmilliner@anzelmolaw.com>, Paul Gunter <pgunter@nirs.org>, Grand Gulf <GrandGulf@lists.nonewnukes.org>

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Synapse
Energy Economics, Inc.

A Responsible Electricity Future:

An Efficient, Cleaner and Balanced Scenario for the US Electricity System

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1. Introduction and Summary

1.1 Introduction

The current electric power system in the US is heavily dependent upon central station plants, fossil and nuclear fuels, and an increasingly strained system of wires to deliver that generation to customers. "Business as usual" development of the system, as depicted for example in the US Energy Information Administration's latest *Annual Energy Outlook* (EIA's AEO 2004) shows consumption of electricity increasing by more than 50 percent by 2025 and massive investment in new coal and gas central station power generation to meet that demand.[1] The increasing demand and supply in this scenario place stresses upon the electricity transmission and distribution system which then requires its own massive investment in new equipment.

In this context, Synapse Energy Economics was asked to develop a reasonable and balanced scenario for the future evolution of the electric power system in the US. This "Balanced Case" includes stepped up investment in energy efficiency and in renewable and distributed generating technology. These clean additions to the system avoid the addition of new coal and gas plants in the reference case and also allow the retirement of a significant portion of the older existing nuclear and fossil generating plants. They also allow a much reduced level of investment in new transmission and distribution infrastructure.

Not surprisingly, the environmental impacts of the Balanced Case are far lower than those of the Reference Case. For example, the Reference Case carbon dioxide emissions increase from 2.2 billion metric tonnes in 2001 to 3.3 billion metric tonnes in 2025. In the Balanced Case, instead of this 50 percent increase carbon dioxide emissions decrease by 21 percent to 1.8 billion metric tonnes in 2025.

It may surprise some that costs are projected to be lower in the Balanced Case than in the Reference Case. How can we realize a diverse and clean electric system without paying substantially more for it? The Reference Case includes a tremendous investment in expensive new fossil fueled central station power generation and the investment in wires to bring that generation to consumers. The Balanced Case also requires substantial new investment, primarily in energy efficiency measures and in a mix of generating technologies that are renewable and/or distributed. The Balanced Case resource mix avoids the investment in new fossil fueled central station capacity, the costs of the fuel to operate that capacity, and much of the Reference Case transmission and distribution investment. Using EIA's numbers for the technology and fuel costs, we project that the

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[1] The AEO 2004 reference case has demand growth of 54% between 2001 and 2025. This growth is projected by EIA to be met almost entirely by new coal generating capacity (102 GW) and new gas generating capacity (254 GW). Of the reference case gas capacity additions (254 GW) about two-thirds is efficient combined-cycle technology (170 GW) and one-third is combustion turbine capacity for peaking (84 GW).

Balanced Case will begin saving money within a few years, and that by 2025 the annual savings will amount to about $36 billion.

1.2 The US Electricity Industry Today: Risky Business

Most of the electricity consumed in the US today is generated by a few types of power plants that pose significant risks to electricity customers and society in general. For example,

- Fifty percent of US electricity generation today comes from coal, which is responsible for some of the greatest environmental damages facing our society, including climate change, acid rain, fine particulate matter, mercury buildup, regional haze, and pollution from mining and waste.
- Twenty-one percent of US electricity generation today comes from nuclear power plants, which create risks regarding the cost of disposing nuclear waste, risks associated with power plant outages, and risks of routine and accidental radionuclide releases either from fuel mining, power plant operation, or spent fuel transport and disposal, in addition to the threat of a major accident.
- Eighteen percent of US electricity generation today comes from natural gas and oil power plants, which contribute to air pollution and other environmental problems and are prone to extreme price volatility.
- The majority of electric generation capacity is located at large central station power plants, which can impose increasing strains on the US transmission system, strains that translate into transmission constraints, compromising reliability and creating pressure to site and construct additional power lines.

Unfortunately, most of the new power plants and transmission projects being planned and built today are only increasing the risks posed to society from the electric industry. The vast majority of new power plants built in recent years and planned for the next several years are natural gas combined-cycle units, and the markets for that fuel are becoming increasingly volatile. In fact, the heavy demand for new gas power plants is a major contributing factor to that volatility which has strained the economics of other natural gas-dependent sectors of the economy.

In the past year, there has been a dramatic increase in plans to build new coal plants, which will only serve to increase the US reliance upon fossil-fuels with high environmental impacts. Figure 1.1 below presents the US government's forecast for CO_2 emissions from the electricity industry through 2025, and indicates how the increased reliance upon fossil fuels will lead to significant increases in this important greenhouse gas.

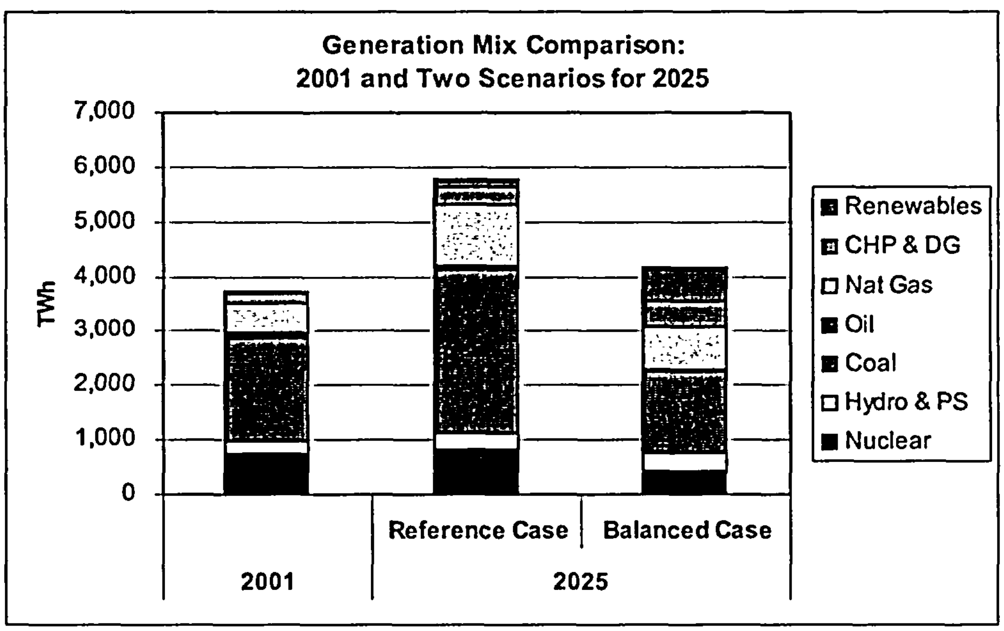
Increased air emissions from fossil-fired power plants will not only increase environmental damages, they will also increase the costs of complying with future environmental regulations, costs that are likely to be passed on to all customers. Power plants built today can generate electricity for as long as 60 years or more into the future. Therefore, it is essential that new power plants be chosen with a long-term perspective that considers not only today's construction and operating costs, but also considers the short and long term consequences for environmental quality and public health.

In recent years there has been dramatic progress in the development of less risky generation facilities, especially wind turbines, biomass facilities and distributed generation technologies. There also have been important advancements in the efficiency with which electricity is consumed by customers (i.e., in their homes and businesses) and much more such end-use efficiency remains to be tapped. However, despite this progress these less risky technologies still only represent a small portion of the total electricity resources in the US.

1.3 A Balanced Approach

The purpose of this study is to investigate the opportunities for creating a more balanced, less risky electricity industry. Instead of continuing to rely upon fossil-fueled power plants to meet new demand for electricity, we assess the potential for a more diverse mix of new electricity resources, including end-use energy efficiency, renewable resources, and combined heat and power. We also investigate the effects of retiring some of the older, more risky power plants sooner than might otherwise happen.

Figure 1.1: Generation Mix Comparison



We begin our analysis with a "Reference Case" that is based on the US Energy Information Administration's most recent forecast of the US electricity industry under "business-as-usual" conditions. We then construct a "Balanced Case" by modifying this forecast in several ways:

- Energy efficiency reduces US electricity demand by nearly 28% by 2025, relative to the electricity demand forecast in the Reference Case.
- Renewable resources, especially wind, provide roughly 15% of US generation by 2025, relative to the less than one percent forecast in the Reference Case.[2]
- Combined heat and power facilities provide roughly 10% of US generation by 2025, relative to the 5% forecast in the Reference Case.
- Oil and gas plants are assumed to be retired after about fifty years of operation. Coal plants are assumed to be retired after they operate for approximately fifty years and new generation has become available. Nuclear plants were assumed to retire at about forty five years of operation.

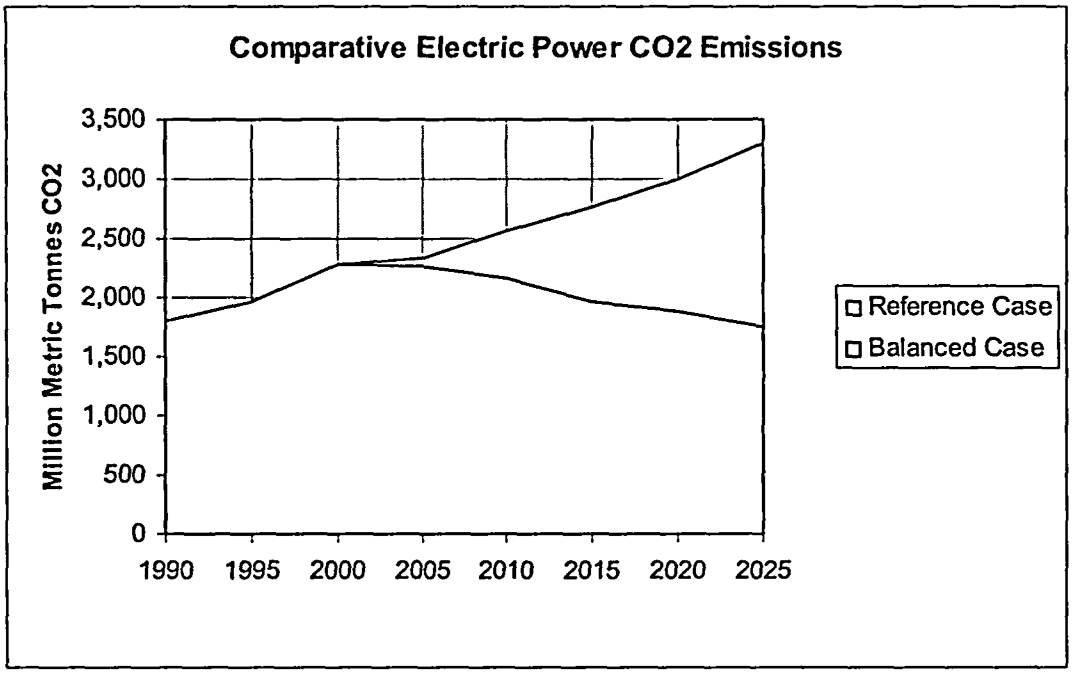
We find that these resources that make up the Balanced Case can be implemented at a *lower* cost than those in the Reference Case. By 2025 the total annual cost of meeting electricity demand in the Balanced Case is roughly $36 billion less than the Reference Case – which represents an annual savings of roughly 10%. Most of these savings come from the fact the energy efficiency resources cost significantly less than the cost of generating, transmitting and distributing electricity, and thus lower the total cost of providing electricity services to all customers.

The Balanced Case also reduces the demands and constraints on the US electricity transmission grid. First, by reducing future electricity demand through energy efficiency much less power needs to be transmitted through the grid, and there is much less need for new transmission capacity. Second, the renewable resources and CHP facilities installed in the Balanced Case tend to be smaller and constructed closer to load, relative to large nuclear and fossil-fired plants. Reduced transmission and distribution construction also lowers the total cost of the Balanced Case.

Furthermore, the Balanced Case results in a dramatic reduction in CO_2 emissions, as indicated in Figure 1.2. In the Reference Case CO_2 emissions are forecast to increase by 48% over today's levels, while in the Balanced Case the CO_2 emissions are expected to be *reduced* by roughly 21%. These reductions in emissions will not only assist in mitigating climate change, they will also result in lower costs associated with future climate change regulations. (The annual cost savings we estimate for the Balanced Case do *not* reflect any benefit from reducing the cost of complying with potential CO_2 emission reductions.)

[2] The renewable generation included in this figure is "non-hydro renewables" only. Throughout this report we break out and report hydroelectric generation (of which there is considerable existing capacity) from "non-hydro renewables" (for which new policies are targeted to develop and promote capacity additions).

Figure 1.2 US Electric CO_2 Emissions: Reference Case versus Balanced Case



2. Study Methodology and Assumptions

2.1 The Reference Case

Our Reference Case is based entirely on the US Energy Information Administration's (EIA) most recent forecast of the electricity industry, as presented in the Annual Energy Outlook (AEO) 2004. We made use of the various public tables and reports to analyze the underlying modeling relationships and the components that went into producing the AEO results. We made no changes to the basic results, but disaggregated some categories (e.g. separating conventional hydro from renewables) to better present items of interest.

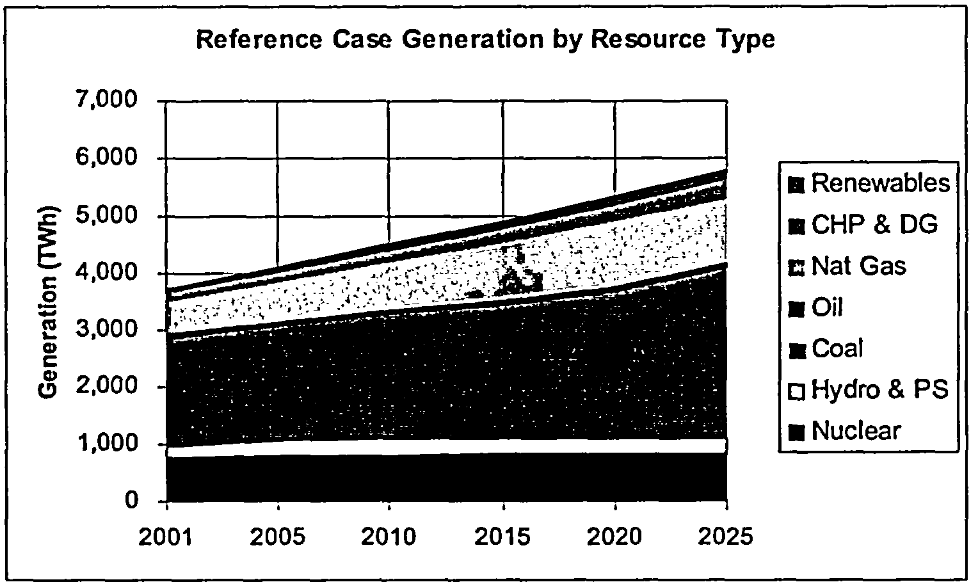
The AEO 2004 Reference Case has energy demand growing slightly under 2% per year for an overall increase of 53.8% in 2025 compared to 2001. The commercial sector has the highest rate of growth and exceeds the residential sector by 2010.

Table 2.1: Reference Case Electricity Demand

Reference Case	Demand (TWh)						% Increase
End-Use Sector	2001	2005	2010	2015	2020	2025	2001-25
Residential	1,203	1,319	1,428	1,531	1,641	1,747	45.3%
Commercial	1,197	1,296	1,480	1,653	1,828	2,003	67.3%
Industrial	964	1,030	1,120	1,216	1,310	1,422	47.4%
Transportation	22	24	26	29	32	35	63.5%
Total Demand	3,386	3,669	4,055	4,429	4,811	5,207	53.8%

The Reference Case very much represents a conventional technology "business-as-usual" future with increasing reliance on fossil fuels, and only a very modest increase in renewables. The following graph summarizes the key aspects of this case. Between the years 2001 and 2025 the amount of total generation increases by more than 50%. Generation from coal increases by 60% and that from natural gas more than doubles. By 2025 non-hydro renewables account for only 3% of the total generation.

Figure 2.1: Reference Case Generation by Resource Type



In this Reference Case total customer electricity costs increase from $255 billion in 2001 to $367 billion by 2025, for a percentage increase of 44%, which is a little less than the percentage increase in total demand growth.[3] Generation accounts for about 65% of the customer costs.

Table 2.2: Reference Case Electricity Costs

Reference Case	Costs (Million Y2003$)						% Increase
Service Category	2001	2005	2010	2015	2020	2025	2001-25
Generation	166,223	161,127	170,297	196,752	218,368	240,372	44.6%
Transmission	18,997	20,658	25,030	29,593	32,757	36,263	90.9%
Distribution	69,616	74,411	79,596	82,006	85,750	90,857	30.5%
Total Costs	254,836	256,196	274,923	308,351	336,875	367,492	44.2%

Fossil fuel consumption increases by 48% overall in the Reference Case. Petroleum use declines by 35%, while natural gas and coal use increase by approximately 50%. Note that fossil fuel costs account for about one third of the generation costs paid by the users. The remainder of the generation charges represent capital costs, O&M, and administrative expenses.

[3] Costs throughout this report are presented in constant year 2003 dollars. To express future costs in "nominal dollars" a forecast of general price inflation should be applied. To express future costs in "present value" or "discounted dollars" a discount rate should be applied.

Table 2.3: Reference Case Fuel Consumption & Costs

Reference Case	Fuel Consumption (QBtu)						% Increase
Fuel Type	2001	2005	2010	2015	2020	2025	2001-25
Petroleum	1.25	0.66	0.66	1.04	0.85	0.81	-35.1%
Nat Gas	5.48	5.81	6.79	7.78	8.78	8.55	55.9%
Coal	19.68	20.96	23.05	24.20	26.22	29.67	50.8%
Fossil Fuel Consumption	26.41	27.43	30.51	33.02	35.85	39.03	47.8%

Reference Case	Fuel Costs (Million Y2003$)						% Increase
Fuel Type	2001	2005	2010	2015	2020	2025	2001-25
Petroleum	6,339	2,833	2,842	4,795	4,052	4,014	-36.7%
Nat Gas	29,552	24,676	27,910	37,831	43,286	42,760	44.7%
Coal	25,031	26,233	28,545	29,466	31,235	35,547	42.0%
Fossil Fuel Costs	60,922	53,741	59,297	72,092	78,573	82,321	35.1%

A full description of the AEO 2004 study can be found on the EIA website at: http://www.eia.doe.gov/oiaf/aeo/index.html

2.2 The Balanced Case

The Balanced Case was developed by making several key modifications to the Reference Case, as summarized below.

1. Plant Retirements – We took the Reference Case retirements as the base-line level. Then we added the retirement of existing oil and natural gas plants after about fifty years of operating life. For nuclear plants we assumed a retirement after about 45 years of operating life. Coal plants were retired incrementally as new generation became available after approximately fifty years of operation.
2. Energy Efficiency – We reviewed several recent studies of energy efficiency potential as the basis for developing an aggressive but feasible amount of energy efficiency resources. The details of the energy efficiency analysis are provided in Section 3.
3. Additions of Conventional Power Plants – We included the capacity additions projected through 2005 in AEO, but assumed that AEO additions after 2005 would not be installed in the Balanced Case. We also applied AEO's estimates for the upratings of all existing nuclear plants. Where necessary in the later years natural gas peaking capacity was added to meet reserve margin requirements.
4. Additions of Renewable Generators and Combined Heat and Power (CHP) – The Balanced Case is designed to include enough renewables to generate three percent

of electricity in 2010 and six percent by 2020, relative to the Reference Case generation levels.[4] The details of the renewables analysis are provided in Section 4. The Balanced Case also includes additional CHP beyond the Reference Case CHP additions.[5]

5. Transmission and Distribution Costs – We used AEO costs for the short term, but then phased in savings from reduced load growth over ten years. We reduced T&D costs to account for distributed resources, but we added additional interconnection costs for remote wind generation.

6. Power Plant Capacity Factors – We used the AEO Base Case capacity factors for the base load units (coal and nuclear) as well as for renewable resources. Where necessary, we made proportional adjustments in the capacity factors for oil and natural gas units to bring generation into balance with the load.

7. Emission Rates – For conventional generation we used the average annual emission rates as derived from the AEO results.

8. Fuel Usage – For conventional generation we used average heat rates based on generation technology and fuel type to derive fuel usage.

Power Plant Costs

The figure below, based on AEO 2004 data,[6] shows the comparative levelized costs of energy (including transmission) from new technologies in 2010 and 2025. While the individual cost components (capital and fuel) differ, the total costs are quite similar across the technologies. In 2010, wind is cheaper than coal and only marginally more expensive than natural gas. Even by 2025, when wind costs are assumed to rise because of the need to use less desirable sites, the differences are still fairly small. The higher transmission costs for wind are because the energy needs to travel longer distances from the wind resources to the areas of need. Note too the relative importance of fuel costs for conventional resources. The production tax credit (PTC) for wind is not included in the numbers presented here (nor is it accounted for in the total cost results presented elsewhere in this report). The PTC, if extended out into this time period, would make wind look substantially better relative to the conventional generating technologies.

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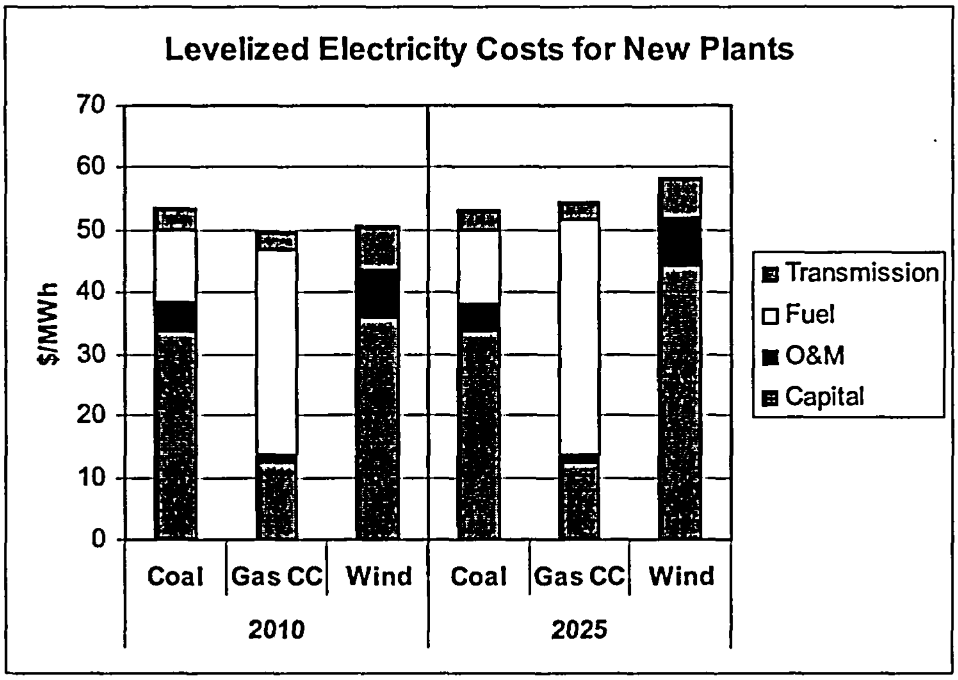
4 The Balanced Case total generation levels are significantly lower than the Reference Case total generation levels, so the percentages would be higher expressed relative to the Balanced Case totals. For example, the 6% new renewables figure relative to the Reference Case total generation would be about 8 percent of the Balanced Case total generation.

5 In the Reference Case CHP electricity generation roughly doubles between 2001 and 2025. In the Balanced Case CHP electricity generation roughly triples between 2001 and 2025.

6 This data corresponds to that of Figure 72 in the AEO 2004 report.

Figure 2.2: Comparative Levelized Electricity Costs from AEO



Source: EIA 2004a, page 82.

3. Energy Efficiency in the Balanced Case

3.1 Energy Efficiency Opportunities

Throughout the United States there is a vast potential to improve the efficiency with which electricity is used. All types of electricity customers have numerous opportunities to replace aging electric equipment with newer, more efficient models, or to upgrade their homes, businesses and industries with more efficient designs and systems.

Energy efficiency as used in this report is defined as technologies, measures, activities and programs designed to reduce the amount of energy needed to provide a given electricity service (e.g., lighting, heating, air conditioning, refrigeration, motor power). Energy efficiency allows customers to maintain or improve their electricity services, while reducing their electricity consumption and their electricity bills.

There is a long and ever-expanding list of technologies and measures available to improve the efficiency with which electricity is consumed. Most of these efficiency measures have been commercially available for many years, and are continually improved over time, while some have been developed recently in response to public policies and customer demand. Some of the more common measures include:

- For residential customers the key electric efficiency measures include: efficient light bulbs; efficient light fixtures; refrigerators; clotheswashers; dishwashers; hot water heating measures; heating ventilation and air conditioning measures; weatherization, insulation and other building shell measures; and building design measures, such as daylighting and shade trees.
- For commercial customers the key electric efficiency measures include: efficient lamps and ballasts; daylighting; efficient exit lamps, street lights and traffic lights; heating ventilation and air conditioning measures; refrigeration measures; office equipment measures; and energy management systems.
- For industrial customers the key electric efficiency measures include: efficient motors and motor drives; industrial process improvements; heating ventilation and air conditioning measures; efficient lamps and ballasts; and energy management systems.

3.2 Energy Efficiency Benefits

The primary benefit of energy efficiency is that it reduces costs for the electric utility and all of its customers. Many efficiency measures cost significantly less than generating, transmitting and distributing electricity. Most of the efficiency measures listed above can be installed for a cost of 1 ¢/kWh to 4 ¢/kWh, while electricity generation, transmission and distribution can cost in the range of 5 ¢/kWh to 10 ¢/kWh, and even more depending upon the location and time of day. Thus, energy efficiency programs offer a huge potential for both lowering system-wide electricity costs and reducing customers' electricity bills.

In addition to its economic benefits, energy efficiency offers a variety of benefits to utilities, their customers, and society in general.

- Energy efficiency can help reduce the demand for new (or upgraded) transmission and distribution facilities. The demand for transmission and distribution investments is primarily driven by increased customer demand for electricity, and energy efficiency is most cost-effective and has the greatest potential when targeted at new customer demand. In addition, efficiency can have a substantial impact on peak demand, and thereby help reduce the stress on local transmission and distribution systems.
- Energy efficiency can help reduce the risks associated with fossil fuels and their inherently unstable price and supply characteristics.
- Energy efficiency can improve the overall reliability of the electricity system. First, efficiency programs can have a substantial impact on peak demand, during those times when reliability is most at risk. Second, by slowing the rate of growth of electricity peak and energy demands, energy efficiency can provide utilities and generation companies more time and flexibility to respond to changing market conditions.
- Energy efficiency can result in significant benefits to the environment. Every kWh saved through efficiency results in less electricity generation, and thus less pollution.[7]
- Energy efficiency can also promote local economic development and job creation by increasing the disposable income of citizens and making businesses and industries more competitive.
- Energy efficiency can help a utility, state and region increase its energy independence, by reducing the amount of fuels (coal, gas, oil, nuclear) and electricity that are imported from other regions or even from other countries.

3.3 Energy Efficiency in the Balanced Case

Over the past two decades there have been many studies that assess the potential for energy efficiency across the US, in various regions, in various states, and for various electric utilities. While there are some important differences across the studies, there is also a consistent theme across them all: there is a large amount of untapped, cost-effective energy efficiency available in all parts of the country and from all types of customers.

We have reviewed some of the most recent, leading studies of energy efficiency potential to determine the amount of efficiency to include in our Balanced Case. In particular, we

[7] Unlike other pollution control measures – such as scrubbers or selective catalytic reduction– energy efficiency measures can reduce air emissions with a *net reduction* in costs. Thus, energy efficiency programs should be considered as one of the top priorities when investigating options for reducing air emissions from power plants.

reviewed four nation-wide studies (Five Labs 2000, WWF and EF 1999, ACEEE 1999, UCS 2001), and four regional studies (ELPC 2001, REPP 2002, Tellus 2002, SWEEP 2003).

These studies include forecasts of the amount and cost of energy efficiency available through 2010 and, in most cases, 2020. They find that there is enough cost-effective efficiency available to reduce electric demand in 2010 by as much as 11% to 23%, and in 2020 by as much as 21% to 35%. The primary difference between these studies, and thus their findings, is the amount of public policy support they rely upon to achieve the future efficiency savings. Those studies that assume, and promote, more aggressive public policies predict greater amounts of efficiency savings. In other words, the key barrier to achieving the efficiency savings is not in the technical or economic availability of the measures, but in the ability of governments, institutions, and customers to take the necessary actions to adopt those measures.

For the purposes of our Balanced Case, we used the average results of these eight efficiency studies. In general, these studies found that future electricity demand could be reduced by roughly 1.6% per year, averaged across all sectors. This represents a very aggressive but very feasible level of energy efficiency savings. It is based on the assumption that there will be several concerted, long-term, aggressive, and successful public policy initiatives to transform the markets for efficiency measures, and change the way that customers purchase and use electricity products.

We then determined the energy efficiency savings of the Balanced Case by applying this average annual reduction in electricity demand to the load forecast of the AEO 2004 reference case. The results are shown in Table 3.1.

Table 3.1 US Electricity Sales and Growth Rates: Reference and Balanced Cases

	Reference Case			Balanced Case	
	Electricity Sales 2004 (TWh)	Electricity Sales 2020 (TWh)	Growth Rates 2004-2020 (%)	Electricity Sales 2020 (TWh)	Growth Rates 2004-2020 (%)
Residential	1,302	1,641	1.4%	1,306	0.0%
Commercial	1,254	1,828	2.3%	1,367	0.5%
Industrial	1,003	1,310	1.7%	1,038	0.2%
Total	3,582	4,811	1.8%	3,731	0.2%

In the Reference Case, total electricity demand is expected to grow by roughly 1.8% per year, resulting in a total of 4,811 TWh of annual electricity sales by 2020. In the Balanced Case the electricity sales growth rates are reduced dramatically. The residential sales are reduced to the point where there is essentially no new load growth in this sector. The commercial sector continues to grow at roughly 0.5% per year, because this sector has the highest amount of load growth in the reference case. The electricity demand for all sectors combined increases only slightly, at an average rate of 0.2% per year.

The results are presented graphically in Figure 3.1. As indicated, the 2025 electricity sales in the Balanced Case are only slightly higher than the 2004 electricity sales, with most of the increase coming from the commercial sector.

Figure 3.1 US Electricity Sales: Reference Case and Balanced Case

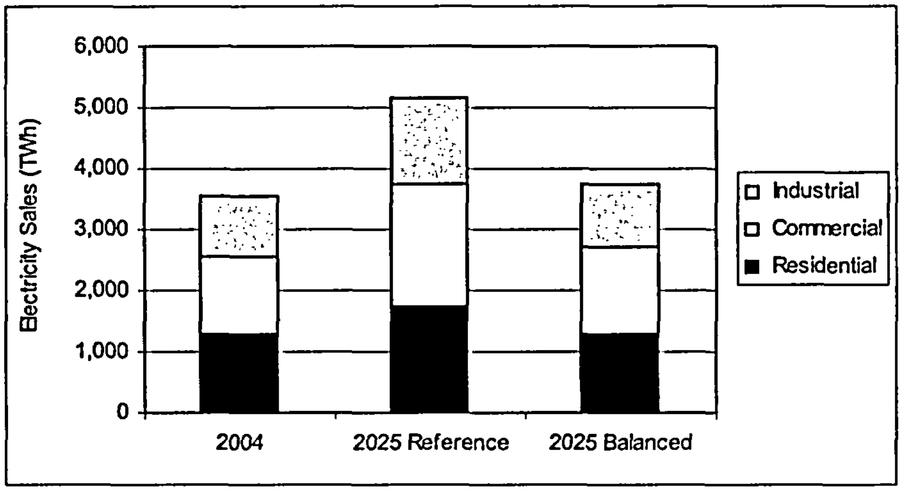


Table 3.2 presents the amount of electricity saved in 2025 relative to the Reference Case. The total amount of savings across all sectors is expected to be 1,080 TWh, which is a reduction of 22% of the electricity sales in the reference case. This amount of electricity savings is roughly equivalent to the amount of generation from over 600 typical new power plants.[8]

Table 3.2 Efficiency Savings in 2025

	Reference Case Sales 2025 (TWh)	Balanced Case Sales 2025 (TWh)	Electricity Saved 2025 (TWh)	Percent Reduction (%)
Residential	1,747	1,303	444	25%
Commercial	2,003	1,391	612	31%
Industrial	1,422	1,051	371	26%
Total	5,171	3,745	1,427	28%

As noted above, these savings will not be achieved without aggressive, concerted, successful public policy initiatives. There are many policies to help achieve these savings, the key ones being: national efficiency standards for a variety of new appliances; national efficiency standards for the construction of new buildings; energy efficiency

8 We assume that transmission line losses equal seven percent, so that power plants would need to generate 1,156 TWh in the absence of these efficiency savings. We also assume that a typical power plant is a 300 MW natural gas combined cycle unit operating at 70% capacity factor, generating 1,840 GWh of electricity per year.

programs administered by electric utilities or other agencies, funded through state and national system benefits charges; pricing mechanisms to encourage wiser customer electric consumption patterns;[9] and government purchasing practices to help increase the demand for energy efficiency products and services. On the other hand, energy efficiency and renewable generation can significantly moderate price volatility due to fuel price fluctuations and supply/demand imbalances, suggesting that there are consumer benefits that could make these programs palatable to the public. (Synapse 2003)

We also rely upon recent energy efficiency studies to estimate the costs of these efficiency savings. The cost of achieving these savings will depend upon the policy mechanism that is used to implement the efficiency measures. Appliance and building standards only require an incremental cost associated with the production of the more efficiency equipment. Utility energy efficiency programs also require additional costs in order to administer the programs, and market and deliver the efficiency measures.

We assume that the average cost of achieving the efficiency savings in the Balanced Case will be $30/MWh (in constant 2003 dollars) for all years of the analysis. This represents electricity savings achieved through a combination of efficiency standards and utility programs with associated administration costs. This cost assumption is consistent with several recent regional efficiency studies that also assume a mix of aggressive efficiency standards and utility efficiency programs (ELPC 2001, REPP 2002, SWEEP 2003). It is also consistent with recent experience with utility energy efficiency programs.[10]

We multiply this cost of saved energy by the annual efficiency savings to determine the annual cost of efficiency investments. In 2020 the total annual efficiency savings are estimated to be 1,080 TWh, which implies an outlay for that year of roughly $32 billion. These costs will be more than offset by the avoided generation, transmission and distribution costs, as described in the following chapters.

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9 For example, loading costs into fixed customer charges and rate structures with "declining blocks" can encourage wasteful behavior.

10 For example, the energy efficiency programs implemented by California utilities from 1990 through 1998 cost roughly $25/MWh on average (NRDC 2001). The programs offered by Efficiency Vermont in 2000 cost roughly $26/MWh (Efficiency Vermont). In Massachusetts the utility energy efficiency programs for 1998 through 2002 range in cost from $19/MWh to $30/MWh (MECO 2003, WMECO 2003, NSTAR 2003). The energy efficiency programs offered by the two Connecticut utilities in 2000 cost roughly $23/MWh (CT ECMB 2002).

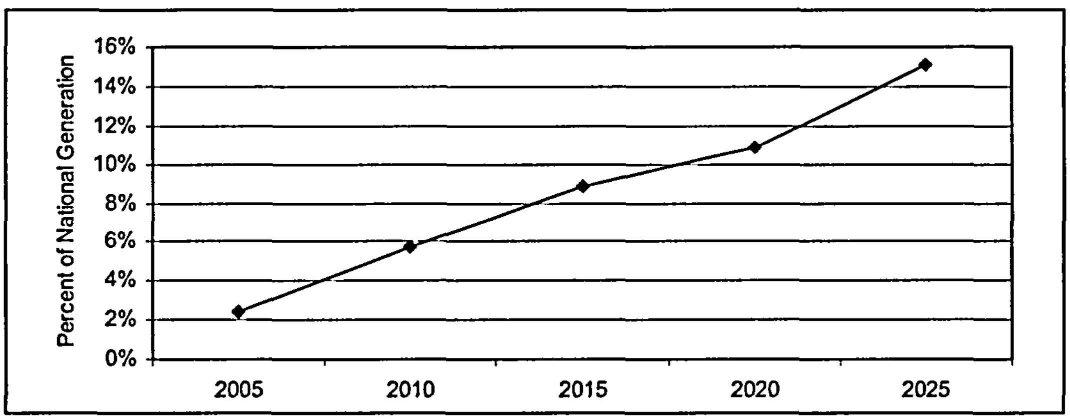
4. Renewables and CHP in the Balanced Case

4.1 Renewable Generation Targets

The growth of renewable electricity generation in the Balanced Case is based on target percentages of total electricity generation in 2010 and 2020. We set out to achieve three percent of total Reference Case electricity generation in 2010 from new renewable resources beginning in 2003, ramping up to six percent in 2020 and continuing to grow thereafter. Note that these are percentages of Reference Case generation. The expanded efficiency investment in the Balanced Case reduces total electricity use relative to the Reference Case, making new renewable generation an even larger percentage of total generation in the Balanced Case. (See Figure 4.1.) These figures are consistent with many of the renewable portfolio standards in the U.S. and more conservative than some of them.

Starting with the percentage targets cited above, we reviewed existing data on the technical and economic potential for each renewable generating technology in each region of the U.S. We reviewed a large number of documents assessing regional potentials, and had discussions with several experts.[11] Based on this research, we developed annual capacity addition assumptions for each technology within each NERC region. In some regions we did not achieve the target percentages of total generation. In other regions we did achieve the percentages, and in some regions we exceeded the targets. As shown in Table 4.1, the contribution of new non-hydro renewable energy grows from just over two percent in 2005 to roughly 15 percent in 2025.

Figure 4.1 Percentage of New Renewable Generation in the Balanced Case



Overall, we were conservative in our assumed capacity additions, and the rates of addition in the various regions are eminently achievable. Renewable capacity additions by year in the Balanced Case are shown in Table 4.1. The vast majority of the renewable

[11] The major sources consulted on regional renewable generating potential's are: ELPC 2001, REPP 2002, Tellus Institute 2002, UCS 2001, and US DOE 1997.

capacity added over the study period is fueled by wind and biomass, and this is consistent with most studies of US renewable generation potential.

Table 4.1 Renewable Generating Capacity Additions in the Balanced Case

Renewable Capacity (GW)	2001*	2005	2010	2015	2020	2025
Geothermal	2.88	3.09	4.18	5.35	6.53	8.88
MSW – Landfill Gas[12]	3.38	3.65	3.89	4.03	4.17	4.44
Wood and Other Biomass	1.79	3.38	12.04	19.02	26.01	39.97
Solar Thermal	0.33	0.36	0.50	0.58	0.66	0.82
Solar Photovoltaic	0.02	0.12	0.58	1.48	2.38	4.18
Wind	4.15	8.68	21.03	34.08	47.14	73.25
Total (non-hydro)	12.54	19.28	42.22	64.55	86.88	131.54

**2001 figures show capacity existing in 2001.*

4.2 Renewable Generation Costs

For the costs of new renewable generation, we use the input data from EIA's *Annual Energy Outlook, 2004,* shown in Table 4.2. These data are for facilities built in 2003.

Table 4.2 Renewables Cost Inputs in AEO 2004

	Size (MW)	Base Overnight Costs in 2003	Total Overnight Cost in 2003*	Variable O&M	Fixed O&M
Biomass	80	1,615	1,760	3.02	47.40
Landfill Gas	30	1,404	1,502	0.01	101.56
Geothermal	50	2,135	2,240	0.00	80.87
Wind	50	965	1,032	0.00	26.94
Solar Thermal	100	2,520	2,966	0.00	50.47
Photovoltaic	5	3,875	4,476	0.00	10.28

**Total overnight costs include contingency factors.*
Source: Assumptions for AEO 2004, Table 38. All costs are in 2003 dollars.

To generate a trajectory for the capital costs of each renewable technology over the study period, we use a simplified version of the technology learning function in the NEMS model. In this function, a technology's capital costs are primarily a function of the amount of the technology installed over time. This reflects the idea that, as more capacity is installed, manufacturer's and developer's costs are reduced by experience and economies of scale.

In addition to this learning effect, for wind capacity we also include EIA's cost adjustments to reflect wind sites of differing quality. The best wind sites (i.e., most economic) are those with a strong wind resource, located close to transmission lines in

[12] Most Municipal Solid Waste generating capacity in 2001 is incineration, but new generation after 2005 is considered to be from landfill gas.

flat, accessible terrain. As wind turbines are installed on these sites, developers will have to turn to less desirable sites, and their costs will increase. To reflect this dynamic, EIA has placed the total wind resource in each region into categories and applied factors to increase capital costs in certain categories. In the Balanced Case, all of the most attractive U.S. wind sites are developed by about 2019. Therefore, in 2020 and after, we apply EIA's cost factor for the next most attractive wind sites – a 20-percent cost increase.

Table 4.3 shows the capital cost trajectories for selected renewable technologies over the study period. The cost trajectories of the other renewable technologies are virtually the same in the two cases, because they are mature technologies and/or we do not add much more capacity than is added in EIA's reference case.

Table 4.3. Capital Costs of Renewables in the Reference and Balanced Cases

	2003		2020		2025	
Technology	Reference	Balanced	Reference	Balanced	Reference	Balanced
Biomass	$1,760	$1,760	$1,692	$1,690	$1,672	$1,669
Wind	$1,032	$1,032	$1,022	$1,218	$1,019	$1,218
Photovoltaic	$4,476	$4,476	$2,797	$2,567	$2,555	$2,264

All costs are in 2003 dollars/kw. Note that these costs correspond to the "total overnight costs" including contingency factors.

Note that, in both cases, the cost of biomass capacity falls much more slowly than the cost of photovoltaic capacity. This is because the NEMS learning function treats mature technologies differently from immature technologies. The capital costs of more mature technologies decrease slowly as capacity is installed, because additional improvements in technology and economies of scale are harder to achieve. The costs of less well developed technologies, like photovoltaics, fall faster with capacity additions and time. The cost of new wind capacity falls slightly throughout the reference case, due to learning, but it increases in 2020 in the Balanced Case as developers turn to less attractive wind sites.

We assume that the operating and maintenance costs of renewable technologies remain the same throughout the study period in both cases.

We also use the NEMS input assumptions for the cost of biomass fuel over the study period. For biomass fuel costs, NEMS uses thirteen regional biomass supply curves developed by the EIA. These curves take into account a number of sources of biomass, from dedicated feedstocks to wood wastes, and indicate the regional, market-clearing price of biomass at different levels of demand. We have aggregated these supply curves into a national curve, and priced biomass fuel in our scenarios based on this curve. The result is that biomass fuel becomes more expensive in the Balanced Case, because more biomass is demanded in the power generation sector. In the Reference Case, the cost of biomass fuel rises from $1.09/MMBtu in 2003 to $1.27/MMBtu in 2025 (in constant 2003 dollars). In the Balanced Case, it rises from $1.09/MMBtu to $1.60/MMBtu in 2025.

5. The Balanced Case Results

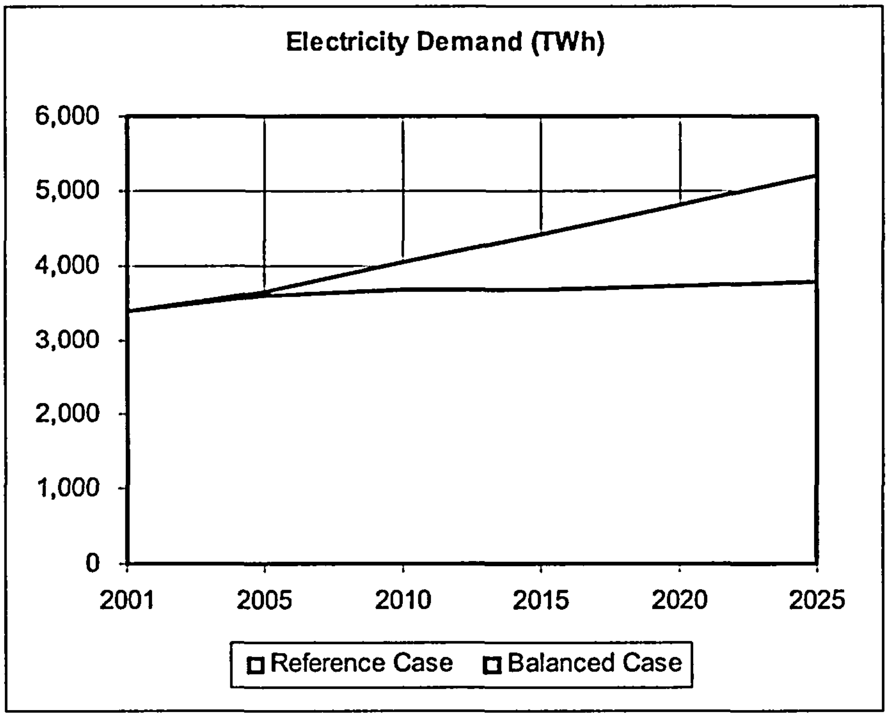
5.1 Electricity Demand and Generation

The AEO 2004 Reference Case has electricity demand growing at an average annual rate of 1.75% between 2005 and 2025, for an overall increase of 41.9%. The proposed balanced plan with an emphasis on energy efficiency results in an average annual rate of growth of 0.23%, with a resulting overall increase of 4.7% over 20 years.

Table 5.1: Electricity Energy Demand Summary Comparison

Electricity Demand (TWh)	2001	2005	2010	2015	2020	2025	From 2005 to 2025 Change	Percent Change	Avg. Ann. Growth Rate
Reference Case	3,386	3,669	4,055	4,429	4,811	5,207	1,537	41.9%	1.75%
Balanced Case	3,386	3,610	3,673	3,692	3,743	3,780	170	4.7%	0.23%

Figure 5.1: Electricity Energy Demand Summary Comparison

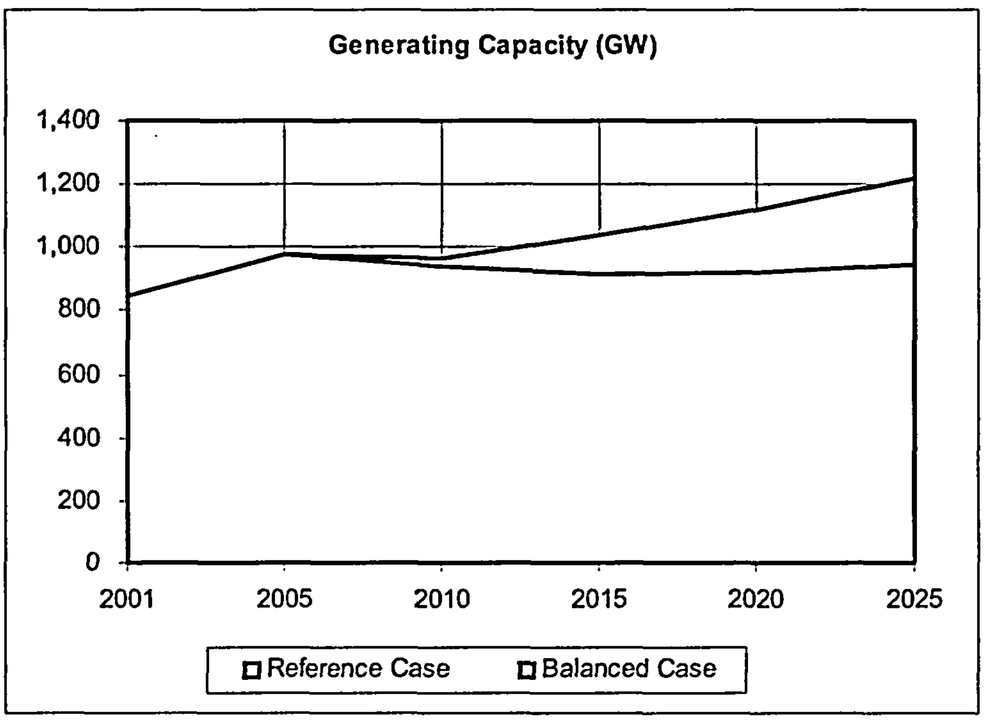


Since the electricity demand increases significantly in the Reference Case, so also do electricity generation and capacity. Because of current excess generating capacity, the overall net increase in capacity is limited to 24.9%. For the Balanced Case, this current surplus means that there is actually a slight decline in total capacity of 2.8% by 2025.

Table 5.2: Electrical Generating Capacity Summary Comparison

Generating Capacity (GW)	2001	2005	2010	2015	2020	2025	From 2005 to 2025 Change	Percent Change	Ann. Avg. Growth Rate
Reference Case	975	965	1,037	1,120	1,217	242	975	24.9%	1.11%
Balanced Case	976	941	916	921	949	(27)	976	-2.8%	-0.14%

Figure 5.2: Electrical Generating Capacity Summary Comparison



Although the total generating capacity needed declines, new capacity is added in the Balanced Case as older capacity is retired. The new capacity is primarily renewable resources replacing coal and other fossil plants. The table below shows that the major differences are the reductions in coal capacity along with a significant increase in renewables. For example, the Reference Case adds 103 GW of new coal capacity, whereas the Balanced Case retires 99 GW of existing coal plants. There is also a small increase in natural gas peaking capacity to complement the intermittent nature of some renewables.

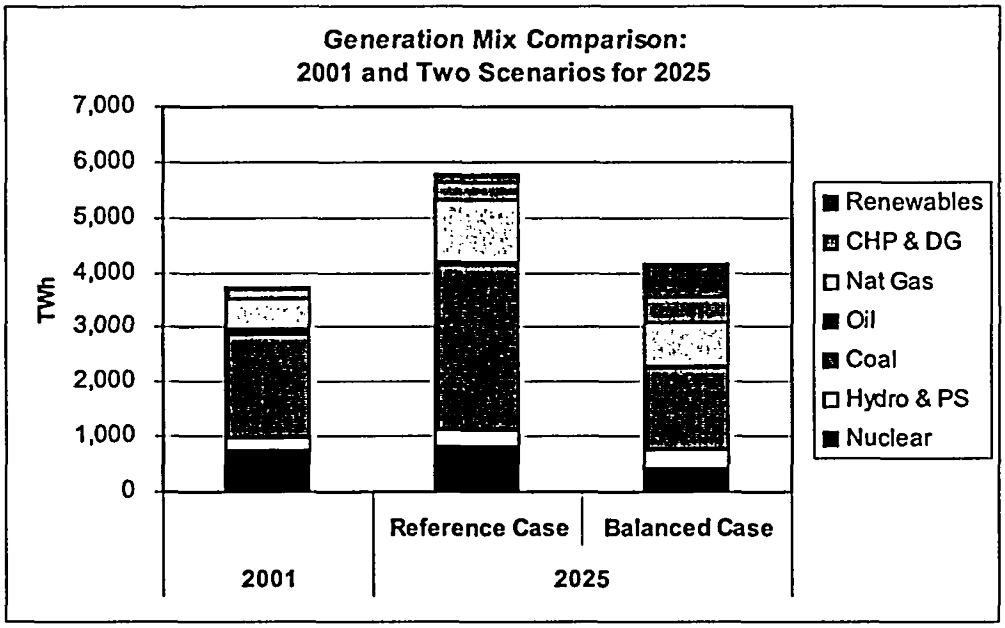
Table 5.3: Generating Capacity Type Comparison

Generating Capacity Changes (GW) 2005 to 2025			
	Reference Case	Balanced Case	Difference
Coal Steam	103.4	-99.0	-202.4
Oil Steam	-9.1	-17.2	-8.0
Nat Gas Steam	-23.2	-65.2	-42.0
Nat Gas Comb Cycle	80.7	-4.2	-84.9
Oil CT	-5.4	-9.0	-3.5
Nat Gas CT	46.2	51.7	5.5
Nuclear Power	2.8	-43.8	-46.7
Pumped Storage/Other	0.0	0.0	0.0
Fuel Cells	0.1	0.1	0.0
Hydro	0.1	0.7	0.6
Renewables (non-hydro)	15.8	111.7	95.9
Distributed Generation[13]	12.3	12.3	0.0
Non-Utility CH&P	18.7	34.8	16.1
Total Capacity Change	242.4	-27.0	-269.4

The figure below shows the generation mix in 2001 and for the two cases in 2025. Note that the generation in the Balanced Case is slightly above 2001 levels but represents a more varied mix of resources both than in either 2001 or in the Reference Case.

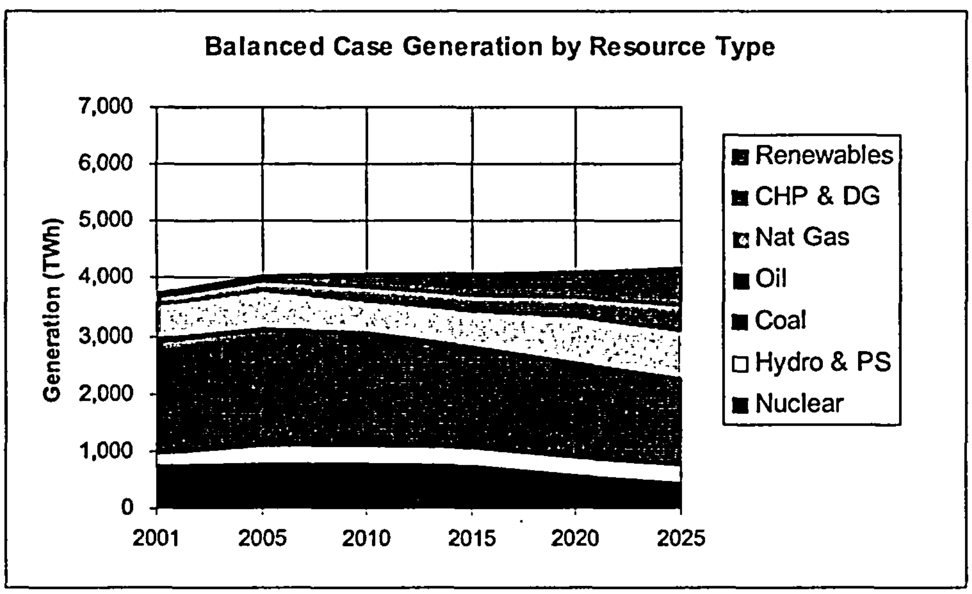
[13] The Balanced Case has additional distributed generation capacity not included in the Reference Case, but that capacity is included in the renewable and CHP categories.

Figure 5.3: Generation Mix Comparison



The figure below shows the generation by resource type in the Balanced Case. Nuclear generation is moderately reduced after 2010. There are substantial reductions in coal generation as renewable and CHP resources come on-line. Natural gas generation, primarily from existing combined-cycle plants, increases slightly. The big increase is for non-hydro renewables, which by 2025 account for 15% of the electricity generation. For a side-by-side comparison with the Reference Case, see Figure 2.1 in Section 2.

Figure 5.4: Balanced Case Generation by Resource Type

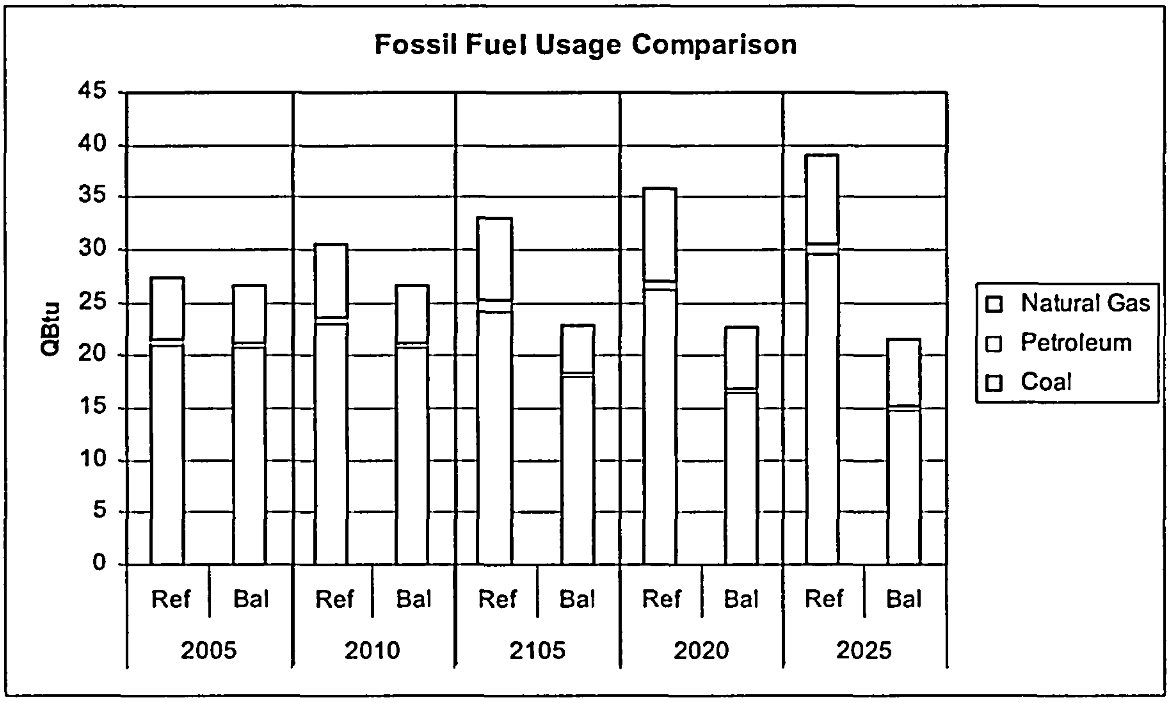


The Balanced Case has a modest increase in natural gas usage compared to current consumption, but a substantial decrease in coal. (Table 5.4 corresponds to Table 2.3 for the Reference case). But there are substantial reductions in consumption of natural gas compared to the Reference Case as shown in the figure below.

Table 5.4: Balanced Case Fossil Fuel Consumption

	Fuel Consumption (QBtu)						% Change
Fuel Type	2001	2005	2010	2015	2020	2025	2001-25
Petroleum	1.25	0.50	0.36	0.35	0.43	0.40	-68.2%
Natural Gas	5.45	5.38	4.26	4.54	5.87	6.21	13.9%
Coal	19.68	20.75	20.35	18.05	16.45	14.88	-24.4%
Total	26.37	26.63	24.96	22.94	22.75	21.49	-18.5%

Figure 5.5: Fossil Fuel Usage Comparison



5.2 Electricity Costs

The economic benefits of the Balanced Case are significant, with reductions in generation and T&D costs that more than offset the costs of the efficiency and renewable programs. By 2025 the Balanced Case is expected to result in $35.8 billion savings for that year, relative to the Reference Case. To give a rough perspective to these numbers, customer electricity costs are approximately $250 billion in 2004 and projected to increase to $367 billion by 2025 (in constant 2003 dollars). Thus the Balanced Case represents a 10% overall direct economic savings in 2025 compared to the Reference Case.

Table 5.5: Cost Impact Summary of the Balanced Case

Annualized Cost Impacts (Billion $)	2005	2010	2015	2020	2025
Variable Generation Costs	-2.7	-13.5	-24.8	-27.1	-31.2
Fixed Generation Costs	1.0	3.2	-0.8	-7.3	-14.2
Transmission & Distribution	0.2	-4.1	-17.9	-25.6	-33.2
Efficiency Programs	1.8	11.5	22.1	32.0	42.8
Annual Net Cost Difference	0.4	-2.9	-21.3	-28.0	-35.8

Notes: Variable Generation Costs include Fuel and Variable O&M; Fixed Generation Costs include the capital cost of new plants and the associated Fixed O&M.

The big reduction compared to the Balanced Case are variable generation costs, which are primarily fuel. There are immediate savings in natural gas and oil generation, which are followed in later years with coal savings as coal capacity (and generation) are reduced. The variable costs for renewables increase slightly as generation increases.

Table 5.6: Variable Generation Cost Differences

Variable Generation Cost (Fuel & VOM) Differences (M$/Year)					
Resource Category	2005	2010	2015	2020	2025
Coal	-290	-3,727	-8,379	-13,296	-20,709
Natural Gas & Oil	-2,708	-11,915	-19,882	-17,002	-14,364
Nuclear	0	-38	-533	-2,201	-3,713
Renewables	176	1,291	2,313	2,745	3,705
CH&P	171	925	1,726	2,623	3,834
Total	-2,650	-13,464	-24,755	-27,132	-31,247

There is a net reduction in the Balanced Case in generation investments with new coal and natural gas capacity additions being greatly reduced after 2010. Renewable capacity investments more than match coal and gas investment savings in the first decade until a balance point is reached about 2015.

Table 5.7: Investment Differences

Cumulative Generation Investment Differences (B$)					
Resource Category	2005	2010	2015	2020	2025
Coal	0.0	-9.1	-26.3	-74.1	-159.3
Natural Gas & Oil	0.0	-7.2	-37.8	-46.8	-49.7
Nuclear	0.0	0.0	0.0	0.0	0.0
Renewables	5.1	32.6	58.3	82.7	141.2
CH&P	0.6	3.4	6.4	10.0	14.5
Total	5.7	19.6	0.7	-28.1	-53.2

Fixed costs represent primarily the financial costs of the investment capital with a smaller portion (~10%) representing the annual fixed costs of plant operation. Again the avoidance of new coal and natural gas generation after 2010 more than offset the costs associated with the renewable technologies.

Table 5.8: Fixed Generation Costs Differences

Fixed Generation Cost (Capital & FOM) Differences (M$/Year)					
Resource Category	2005	2010	2015	2020	2025
Coal	0	-1,866	-5,393	-15,231	-32,760
Natural Gas & Oil	0	-1,296	-6,765	-8,371	-8,877
Nuclear	0	0	0	0	0
Renewables	907	5,735	10,249	14,539	24,874
CH&P	110	600	1,143	1,782	2,586
Total	1,017	3,173	-767	-7,281	-14,177

Transmission and Distribution (T&D) costs are approximately $95 billion per year presently and are predicted to rise to $127 billion by 2025 in the Reference Case. Much of this increase can be avoided if load growth is reduced. Thus the primary T&D impact of the Balanced Case comes from the fact that load only grows by 4.7% from 2005 to 2025, instead of by 41.9%. Further transmission savings result from CHP and DG resources placed closer to loads. There is also a reduction in interconnection costs since less capacity is added in the later years. To account for the fact that additional transmission lines will be needed for remote wind resources we have also included an additional cost for wind generation.

Table 5.9: T&D Cost Differences

Transmission & Distribution Cost Differences (M$/Year)					
Component	2005	2010	2015	2020	2025
Load Change Impacts	0	-4,928	-17,632	-24,996	-33,089
Plant Interconnect Costs	127	163	-1,489	-2,377	-3,053
Wind Transmission	110	704	1,261	1,790	2,985
Total T&D Differences	236	-4,060	-17,860	-25,583	-33,158

There are several reasons why the cost benefits presented for the Balanced Case are conservative. The Balanced Case does not count any of the following benefits or cost savings:

1. Avoided carbon emission costs.
2. Avoided additional costs for more stringent NOx, mercury and particulate emissions.
3. Fuel price reductions associated with reduced use of fossil fuels (e.g. natural gas).
4. Benefits of reduced price volatility associated with lesser use of fossil fuels.

5. Environmental and health benefits from reduced emissions, land use for generation and transmission, or water use for generation.
6. Environmental benefits associated with less fossil fuel extraction.
7. Jobs and competitive industry benefits associated with the promotion of new renewable technologies.

5.3 Environmental Impacts

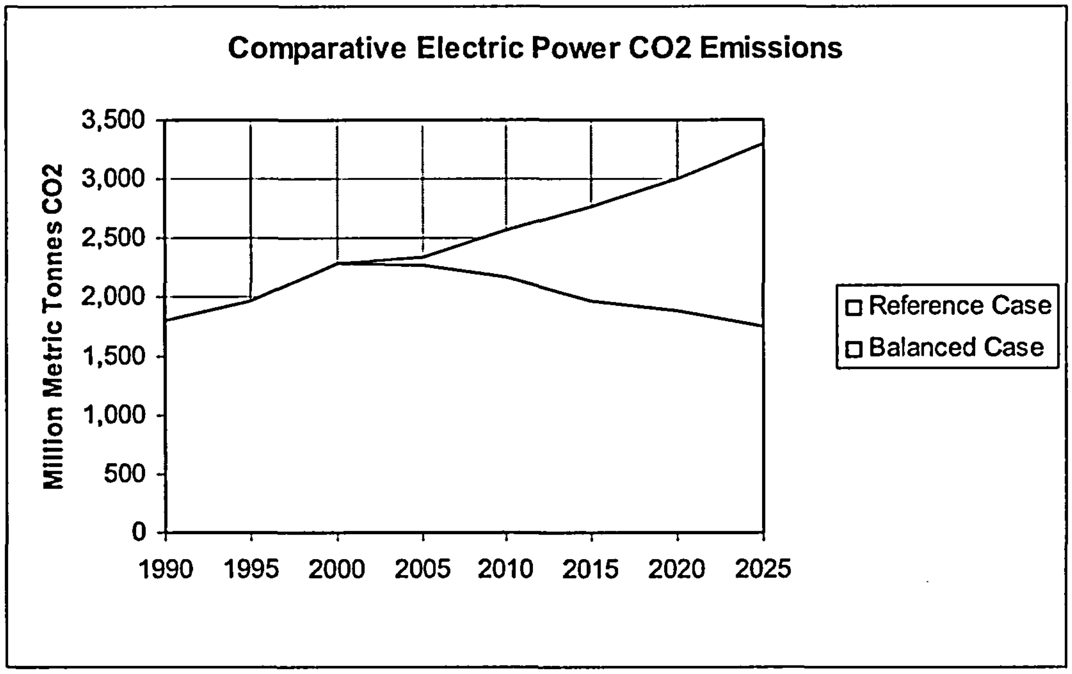
The major environmental impacts of the Balanced Case are the reduction in fossil fuel use along with the associated emissions and their related health impacts. Overall, the Balanced Case reduces CO_2 emissions by over 40% in 2025 compared to the Reference Case. The primary cause of these differences is the nearly equivalent percentage reduction in coal-fired generation, along with a similar reduction in natural gas generation.

Table 5.10: Emission Comparison Summary

Electricity Industry CO_2 Emissions (million metric tonnes)						
	2001	2005	2010	2015	2020	2025
Reference Case	2,227	2,322	2,571	2,760	2,989	3,299
Balanced Case	2,227	2,268	2,160	1,960	1,887	1,756
Difference	0	-54	-411	-800	-1,102	-1,543
Percent Difference	0%	-2.3%	-16.0%	-29.0%	-36.9%	-46.8%

The table and graph below show the long-term trend in CO_2 emissions from electrical generation. The Reference Case emissions are 82% above 1990 CO_2 levels by 2025, whereas the Balanced Case emissions in 2025 are 3% below 1990 emissions, and 23% below 2000 emissions.

Figure 5.6: Comparative CO_2 Emissions



Note: Combined Heat and Power (CHP) emissions are not included in either case.

There are several pending legislative efforts to further reduce mercury and NOx emissions. We were not able to incorporate those calculations within this study. Because of the reduced level of fossil fuel use in the Balanced Case the costs of such controls would be less than for the Reference Case, but we have not calculated nor credited those benefits in this report.

6. Further Research and Analysis

There are a numbers of aspects of this analysis that could be refined and extended. Some of the topics that would be appropriate for further research include the following:

- Analysis on a detailed regional basis.
- Incorporation of innovation and technological change.
- Detailed costing including emission controls and avoided emission control costs in the Balanced Case.
- Detailed simulation of the dispatching of generating resources to meet loads.
- Analysis of the impact of the Balanced Case upon fuel markets and prices.
- Assessment of risks including exposure of the two cases to price volatility, long-term price uncertainty, fuel supply disruptions, and environmental risks.

The results of the broad brush analysis presented here are sufficient, however, to indicate that the business-as-usual course should be changed immediately, and that further research and analysis of "Balanced Cases" would be worthwhile.

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Appendix A – Reference Case Tables

Reference Case Demand by Sector (TWh)	2001	2005	2010	2015	2020	2025
Residential	1,203	1,319	1,428	1,531	1,641	1,747
Commercial/Other	1,197	1,296	1,480	1,653	1,828	2,003
Industrial	964	1,030	1,120	1,216	1,310	1,422
Transportation	22	24	26	29	32	35
Total Sales	3,386	3,669	4,055	4,429	4,811	5,207
Required Generation (TWh)	3,745	4,072	4,483	4,877	5,296	5,733
Required Capacity (GW)	851.7	975.7	965.6	1,038.3	1,120.7	1,218.4

Reference Case Capacity (GW)	2001	2005	2010	2015	2020	2025
Coal Steam	310.6	308.9	310.3	321.5	353.5	412.3
Oil Steam	38.2	36.4	30.0	29.0	28.6	27.3
Nat Gas Steam	96.8	92.4	76.1	73.6	72.5	69.2
Nat Gas Comb Cycle	65.5	154.5	160.0	191.7	217.3	235.2
Oil CT	38.8	38.6	34.9	34.6	33.9	33.1
NG CT	63.2	101.1	101.6	123.4	135.4	147.3
Nuclear Power	98.2	99.8	100.6	102.1	102.6	102.6
Pumped Storage/Other	19.9	20.3	20.3	20.3	20.3	20.3
Fuel Cells	0.0	0.0	0.1	0.1	0.1	0.1
Hydro	78.1	78.6	78.7	78.7	78.7	78.7
Renewables (non-hydro)	12.5	15.6	18.7	22.5	27.2	31.4
Distributed Generation	0.0	0.0	0.5	2.4	7.6	12.4
Non-Utility CH&P	25.9	28.7	33.1	37.3	42.1	47.4
Installed Capacity	847.7	974.9	964.7	1037.4	1119.7	1217.3
Effective Capacity	847.7	974.9	964.7	1037.4	1119.7	1217.3

Reference Case Generation (TWh)	2001	2005	2010	2015	2020	2025
Coal Steam	1,883	2,033	2,235	2,352	2,593	3,008
Oil Steam	102	45	48	93	70	65
Nat Gas Steam	129	57	61	117	88	83
Nat Gas Comb Cycle	398	563	711	808	984	970
Oil CT	17	17	15	15	15	15
NG CT	28	44	44	54	59	65
Nuclear Power	769	791	794	812	816	816
Pumped Storage/Other	(8)	(9)	(9)	(9)	(9)	(9)
Fuel Cells	0	0	0	0	0	0
Hydro	214	303	304	304	305	305
Renewables (non-hydro)	45	76	96	116	138	156
Distributed Generation	0	0	0	1	3	5
Non-Utility CH&P	154	176	207	236	270	305
Total Generation	3,730	4,096	4,507	4,900	5,331	5,784

Reference Case Renewable Capacity (GW)	2001	2005	2010	2015	2020	2025
Geothermal	2.88	2.90	4.01	5.11	6.06	6.84
Municipal Solid Waste	3.38	3.66	3.92	3.92	3.95	3.95
Wood and Other Biomass	1.79	1.89	2.20	2.31	3.04	3.74
Solar Thermal	0.33	0.42	0.43	0.47	0.49	0.52
Solar Photovoltaic	0.02	0.06	0.15	0.24	0.32	0.41
Wind	4.15	6.68	8.01	10.48	13.39	15.99
Renewable (non-hydro)	12.54	15.62	18.73	22.53	27.25	31.44

Reference Case Fossil Generation Emissions	2001	2005	2010	2015	2020	2025
CO_2 (million metric tonnes)	2,227	2,322	2,571	2,760	2,989	3,299
Mercury (tons) *	49.1	50.1	52.2	52.6	53.6	54.4

* Mercury emissions do not incorporate current proposals for more stringent controls.

Appendix B – Balanced Case Tables

Balanced Case Demand by Sector (TWh)	2001	2005	2010	2015	2020	2025
Residential	1,203	1,299	1,306	1,300	1,306	1,303
Commercial/Other	1,197	1,271	1,315	1,331	1,367	1,391
Industrial	964	1,015	1,025	1,032	1,038	1,051
Transportation	22	24	26	29	32	35
Total Sales	3,386	3,610	3,673	3,692	3,743	3,780
Required Generation (TWh)	3,752	4,035	4,081	4,078	4,133	4,175
Required Capacity (GW)	808.1	861.6	876.6	881.2	893.3	902.3

Balanced Case Capacity (GW)	2001	2005	2010	2015	2020	2025
Coal Steam	310.6	305.8	273.8	239.8	221.8	206.8
Oil Steam	38.2	36.4	29.8	27.0	23.3	19.3
Nat Gas Steam	96.8	92.2	74.6	62.4	46.5	27.0
Nat Gas Comb Cycle	65.5	154.5	153.9	151.3	150.8	150.3
Oil CT	38.8	38.6	34.9	34.5	33.2	29.6
NG CT	63.2	101.1	95.1	94.7	122.4	152.8
Nuclear Power	98.2	99.8	100.1	95.4	74.9	55.9
Pumped Storage/Other	19.9	20.3	20.3	20.3	20.3	20.3
Fuel Cells	0.0	0.0	0.1	0.1	0.1	0.1
Hydro	78.1	78.4	78.9	79.0	79.0	79.2
Renewables (non-hydro)	12.5	19.3	42.2	64.6	86.9	130.9
Distributed Generation *	0.0	0.0	0.5	2.4	7.6	12.4
Non-Utility CH&P	25.9	29.4	36.9	44.7	53.6	64.2
Installed Capacity	847.7	975.8	941.1	916.2	920.5	948.8
Effective Capacity	847.7	970.0	927.4	894.3	890.7	903.0

* Note that a portion of the CH&P capacity as well as some renewables such as photovoltaics can be considered as distributed generation.

Balanced Case						
Generation (TWh)	2001	2005	2010	2015	2020	2025
Coal Steam	1,883	2,012	1,972	1,754	1,627	1,509
Oil Steam	102	32	22	23	26	23
Nat Gas Steam	129	40	27	26	26	16
Nat Gas Comb Cycle	398	535	452	508	667	711
Oil CT	17	16	12	14	17	16
NG CT	28	41	33	37	63	85
Nuclear Power	769	791	791	759	596	445
Pumped Storage/Other	(8)	(9)	(9)	(9)	(9)	(9)
Fuel Cells	0	0	0	0	0	0
Hydro	214	303	305	306	306	307
Renewables (non-hydro)	45	96	233	362	451	631
Distributed Generation	0	0	0	1	3	5
Non-Utility CH&P	154	182	238	295	359	435
Total Generation	3,730	4,038	4,077	4,076	4,133	4,174

Balanced Case						
Renewable Capacity (GW)	2001	2005	2010	2015	2020	2025
Geothermal	2.88	3.09	4.18	5.35	6.53	8.88
Municipal Solid Waste	3.38	3.65	3.89	4.03	4.17	4.44
Wood and Other Biomass	1.79	3.38	12.04	19.02	26.01	39.31
Solar Thermal	0.33	0.36	0.49	0.59	0.68	0.87
Solar Photovoltaic	0.02	0.12	0.58	1.48	2.38	4.18
Wind	4.15	8.68	21.03	34.08	47.14	73.25
Renewable (non-hydro)	12.54	19.27	42.21	64.56	86.90	130.93

Balanced Case						
Fossil Generation Emissions	2001	2005	2010	2015	2020	2025
CO2 (million metric tonnes)	2,227	2,268	2,160	1,960	1,887	1,756
Mercury (tons) *	49.1	49.6	46.1	39.3	33.6	27.3

* Mercury emissions do not incorporate current proposals for more stringent controls.

Economics of Offshore Wind Power

by
Bob Sprehe, Energy Economist
and
Bryan Crouch, P.E

Introduction

The December, 2004 Louisiana Energy Topic gave an overview of wind generated electricity and how it relates to Louisiana. It can be downloaded in Adobe PDF format at: http://www.dnr.state.la.us/sec/execdiv/techasmt/newsletters/index.htm. This month's edition focuses on the economics of offshore wind generated electricity. A simple economic analysis will be presented for a nominal 50 MW offshore wind farm after a discussion of the key inputs and assumptions. This economic analysis will present data at three different prices of electricity and three different wind classes. It will also present a breakeven price of electricity for each wind class.

The economics of land-based wind power are fairly well established, but much less so for offshore wind power as no offshore wind farms have actually been built in the U.S., although several have been built in Europe. Wind farms are more expensive to build offshore than onshore. The higher cost is mainly due to costs involved with transmitting the power back to land and because it is generally more expensive to build anything over water than land (something in which Louisiana industries are adept).

Inputs and Assumptions

The economics of an offshore wind farm will vary greatly depending on the specifics of a particular wind farm. As such, this analysis is only meant to show a range of possible scenarios and shed some light on the information used in such an analysis. It is based on the assumptions discussed below and even relatively small changes in these assumptions can lead to very different results.

The cost to install a utility-scale wind farm on land is in the neighborhood of $1000/kW [1]. Estimates for offshore wind farms range from $1500 to $2000/kW [2]. The middle price of $1750/kW was chosen which puts the installation cost at $84,700,000. Operation and maintenance cost for an offshore wind farm should differ little from land wind farms which run about 2% [1] of the original turbine investment. These costs were set at 2% of the installation cost which is more than just the turbine cost, so this figure is somewhat over-estimated. General and administrative costs are an estimate of basic costs needed to run the company that manages the wind farm and were set at 15%. Turbine lifespan was deemed to be 25 years. Land based turbines commonly last 20 years before a major overhaul is needed. Offshore wind turbines are designed to be more rugged due to the harsh marine environment and are subject to less turbulent wind patterns due to the smooth water surface. In reality, offshore wind turbines may last 30 years or more. Finally, a corporate tax rate of 35% was chosen, and the federal 1.8 cents/kWh tax credit was also taken into account. For tax purposes the depreciation would be accelerated.

The biggest assumption that must be made is that of energy production from the wind farm. Energy production from a wind farm is completely dependent on how hard and how often the wind blows. Small changes in wind effect large changes in energy output from a wind turbine. The offshore wind regime is still something of an unknown. To a smaller degree, the selection of a particular wind turbine for a given advertised capacity will determine how much power is produced.

A wind farm consisting of 22, 2.2 MW wind turbines was chosen for a total rated capacity of 48.4 MW. The Danish Wind Industry Association website [1] was consulted to provide a power curve for such a turbine and calculate its annual power production. The annual power production was calculated for wind classes 3, 4, and 5 as defined by the National Renewable Energy Laboratory's wind resource map [3]. Each wind class has a range of values. The average value for each wind class was used. The values were 15.0 mph, 16.3 mph, and 17.4 mph for wind classes 3, 4, and 5 respectively. The energy output is summarized in **Table 1.**

Table 1. Energy Output

Wind Class (mph)	Energy Output per Turbine (kWh/year)	Total Energy Output (kWh/year)
Class 3 (15.0)	4,925,000	108,350,000
Class 4 (16.3)	5,782,000	127,204,000
Class 5 (17.4)	6,531,000	143,682,000

Source: LA DNR Technology Assessment Division

Variables not taken into account here include: ancillary service costs, renewable energy credits, and renewable portfolio standards. Ancillary service costs are the costs associated with integrating wind power into the grid. These costs are estimated to be negligible when wind is a small fraction of the total electricity supply. Renewable portfolio standards and renewable energy credits do not directly affect the cost of wind power, but would alter the economics by placing a higher value on wind power.

Results

The results show that electricity generation from this particular wind farm could break even at 4.2 cents/kWh in a class 5 wind resource; however, the rate of return only begins to become attractive at an electricity price of 8 cents/kWh in a class 5 wind resource. For comparison, the average price of electricity per kWh to Louisiana customers in 2002 was as follows: overall = $0.0599, residential = $0.0710 (range of $0.0271 - $0.0994), commercial = $0.0664, industrial = $0.0442. Securing capital for rates of return at these low levels would appear be a controlling factor in the viability of such a project. The results of the analysis are shown in **Tables 2 - 4** according to wind class.

Table 2. Class 3 Wind

Annual Figures	Electricity Price ($/kWh) 0.04	0.06	0.08	0.056*
Revenue	$4,334,000	$6,501,000	$8,668,000	$ 6,067,600
Operating & maintenance expense	1,694,000	1,694,000	1,694,000	1,694,000
Gross profit	2,640,000	4,807,000	6,974,000	4,373,600
General & administrative expense	650,100	975,150	1,300,200	910,140
Depreciation depletion & amortization	3,388,000	3,388,000	3,388,000	3,388,000
Operating profit	-1,398,100	443,850	2,285,800	75,460
Taxes	0	155,348	800,030	
Production tax credit	1,950,300	1,950,300	1,950,300	
Net taxes	0	0	0	
Net after taxes	-1,398,100	443,850	2,285,800	
Cash flow	1,989,900	3,831,850	5,673,800	
Internal rate of return	-3.73%	0.97%	4.43%	

*Break even

Source: LA DNR Technology Assessment Division

Conclusion

The results of this economic analysis indicate that small changes in any of the variables could make or break a particular project. Such is the current state of wind power in general. The results also indicate that a minimum class 5 wind resource is required for an economically viable wind farm in Louisiana with current technology. Wind turbine capacity will become less expensive as turbine efficiencies improve, and turbine prices will come down as economies of scale materialize. As these happen, wind farms may become viable in less than class 5 wind resources.

References

1. **Danish Wind Industry Association**
   www.windpower.org
2. **National Wind Coordinating Committee**
   www.nationalwind.org
3. **National Renewable Energy Laboratory**
   http://www.nrel.gov/wind/wind_map.html

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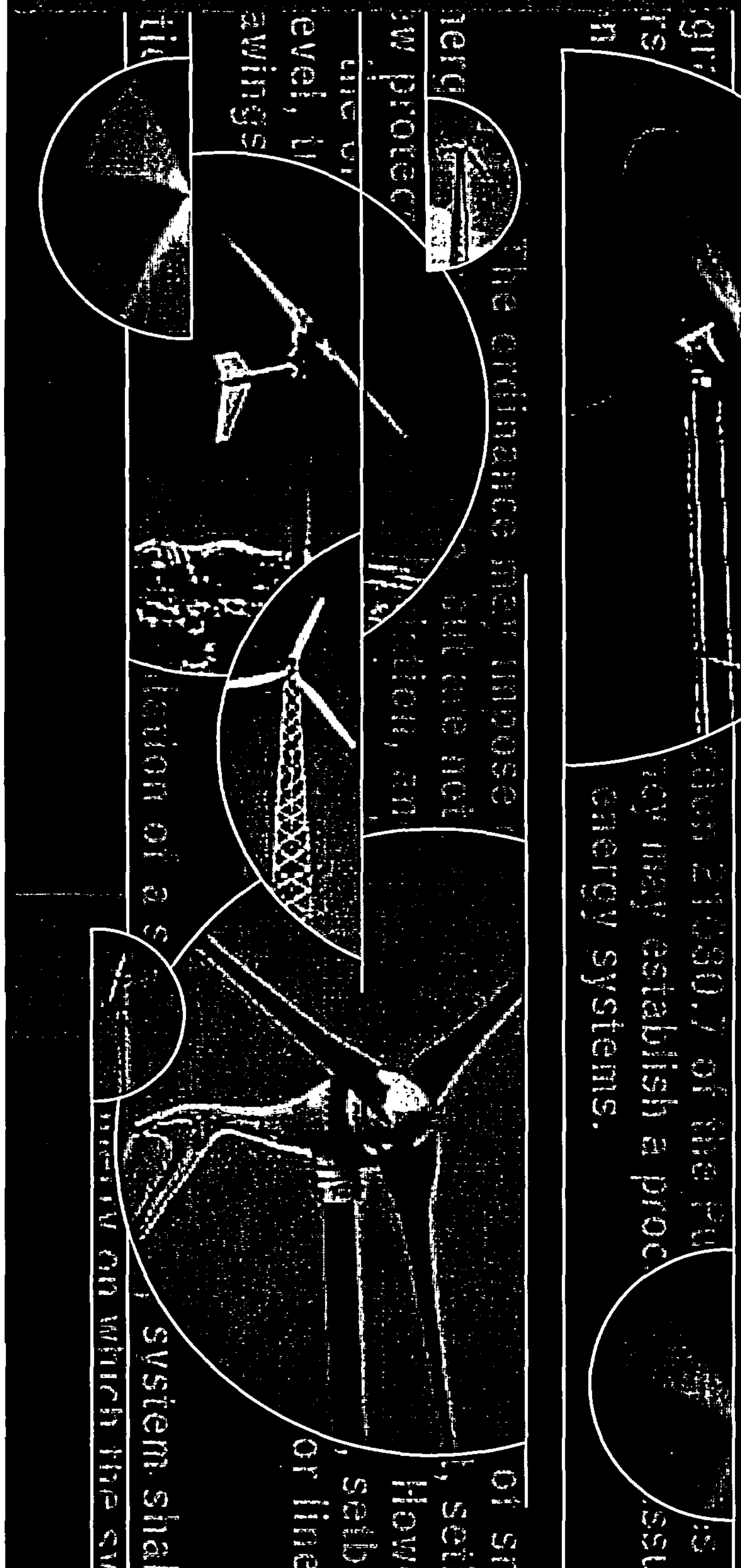


PERMITTING SMALL WIND TURBINES: A HANDBOOK

Learning from the California Experience

CONTENTS

INTRODUCTION

Small Turbines – Large Benefits

Americans today generally associate wind energy with dense arrays of commercial-scale turbines that rise on 200 ft or taller towers, so they are often less familiar with wind turbines scaled for personal use on small acreages. Small (or "residential") wind energy systems typically generate just enough power to meet the demands of a home, farm, or small business. They range from 400 watts to 100 kilowatts or more, and typically consist of a single turbine, while commercial wind farms consist of dozens or even hundreds of megawatt-scale turbines.

But small wind systems are not mere playthings for backyard hobbyists. They can be significant power resources that have proven records of performance, even in locations with modest winds. The success of the commercial wind industry has propelled significant advances in small turbine design, making these systems more reliable, quieter, and safer than those introduced in past decades. And though most of the electricity they produce is used on-site, excess generation from small wind turbines can be fed into distribution lines, strengthening the electric grid.

Small wind systems can be an important component of a power system that's more affordable, secure, and sustainable.

Photo courtesy Kevin Schiebel

Small wind turbines were commonplace on farms and ranches across the Midwestern United States before the advent of rural electrification programs. Wind generators powered lights, radios, and kitchen appliances in far-flung reaches of the country, offering rural families most of the conveniences of modern urban life.

In this new century, small wind turbines are an attractive investment for residents in rural areas looking for relief from high energy costs. Small turbines also contribute a larger public benefit by reducing demand on utility systems now supplied primarily by centralized fossil-fuel plants. In recent years this system has left electricity customers vulnerable to power shortages and sharp price increases. The development of large-scale power plants has become riskier in the turbulent energy market, creating the need for new forms of distributed generation sources to make the system more secure and sustainable. Small wind systems can be an important component of such energy independence.

In 2001, the California Legislature passed landmark legislation, Assembly Bill 1207, to promote small wind turbine installations by standardizing permitting requirements. Other state incentives include a rebate program administered by the California Energy Commission and a state income tax credit for purchasers of small wind systems. The following excerpt from AB 1207 articulates the benefits the state hopes to derive from small wind development:

Distributed small wind energy systems ...enhance the reliability and power quality of the power grid, reduce peak power demands, increase in-state electricity generation, diversify the state's energy supply portfolio, and make the electricity supply market more competitive by promoting consumer choice.[1]

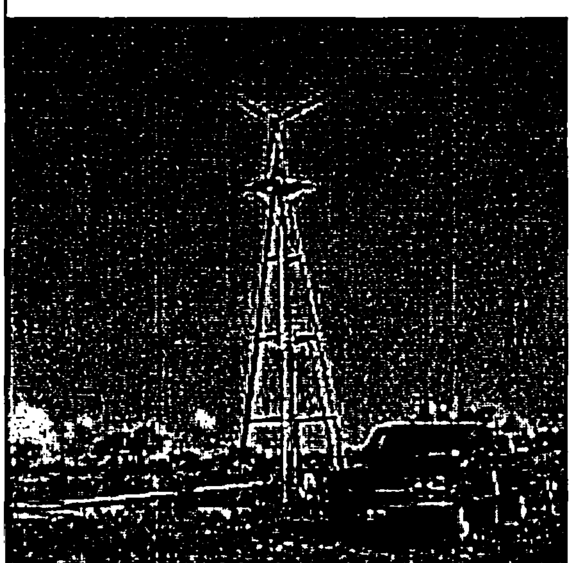


Photo courtesy Southwest Windpower

1. California Government Code, Section 65892.13 (a) (2) www.leginfo.ca.gov/cgi-bin/displaycode?section=gov&group=65001-66000&file=65892.13

Using This Handbook

Public officials and property owners alike will find the information in this handbook useful in determining best practices for siting wind turbines and in understanding the permitting implications of California's new law. The handbook cites key provisions of Assembly Bill 1207 and describes how California counties are complying with the new law. It notes the steps counties have taken (and could take) to streamline the permitting of small wind turbines, using existing installations as examples. Public officials will gain a better understanding of small wind systems, and property owners will learn what to expect in the permitting process.

I. The first section covers site considerations. It lists the factors that determine whether the site is right, where to position the turbine, and what impacts the turbine could have on neighboring properties, wildlife, and safety.

II. The next section describes key provisions of AB 1207, explaining both the letter and the spirit of the law, and illustrates how the law has been applied in specific counties throughout California.

III. The third section provides a model zoning ordinance recommended by the American Wind Energy Association and a list of best practices for permitting small wind turbines both in California and nationwide.

IV. The final section lists a variety of information resources, including publications and web resources offered by the American Wind Energy Association, the California Energy Commission, utilities, and other government agencies and organizations. Small wind turbine manufacturers are also listed.

I. INSTALLING SMALL WIND ENERGY SYSTEMS

Permitting reviews can absorb a significant amount of time and energy from property owners and public officials. Before beginning the process, property owners should be reasonably certain that their site is windy enough to justify the effort. After that, there's more to consider: How difficult will it be to obtain the necessary permit? How do you arrange for a utility line connection? What about safety and impacts on wildlife?

Much of the land mass of the United States gets enough wind to power small wind turbines.

Evaluating the Site

Small wind turbines require lesser wind resources than large commercial turbines, so they are feasible in many more places. Much of the land mass of the United States gets enough wind to power small turbines. Simply put, if a site "feels" windy enough, it is probably worth investigating and determining the estimated pay back. Does the wind blow steadily for sustained periods on a regular basis? Are there large seasonal variations? What are the expected electricity bill savings? Turbine dealers can often help assess a potential site through visual inspection of surrounding terrain.

Property owners in many parts of the country can analyze their hunches with recently updated wind maps that predict wind patterns. County officials also can use wind maps to familiarize themselves with local wind

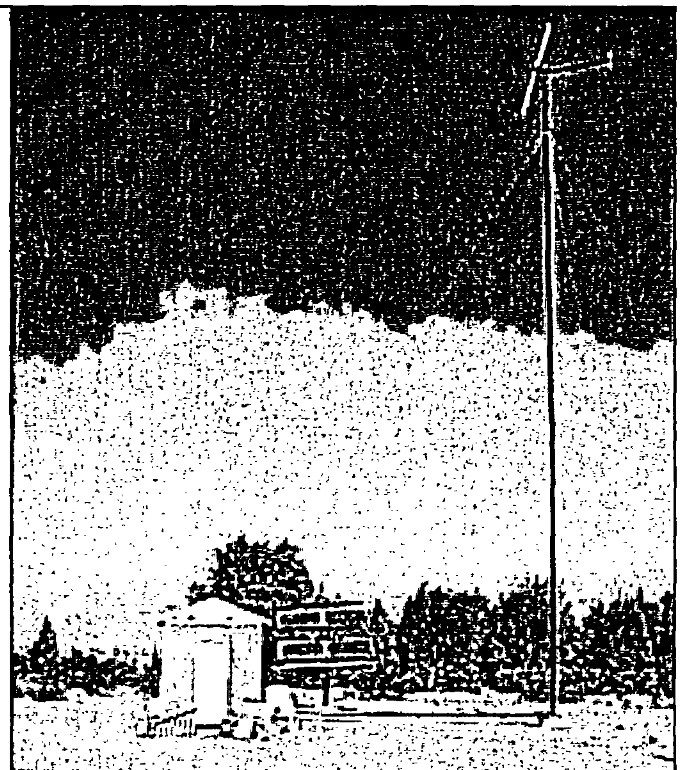


Photo courtesy of Tom Rhamy

Hybrid Solar and Wind Installation Pays Off

Ridgecrest (Kern County) – Tom and Angela Rhamy decided that electricity had become too expensive during the power crisis of 2001, so they bought a combination wind/solar energy system and started generating their own. When conditions are good their meter spins backward, cutting their power bills to half what they used to be.

The Rhamys, who own a 2,000-square foot home and keep an office in the barn behind the house, have joined the ranks of homeowners discovering that small-scale wind systems are a viable alternative to high power bills. They took advantage of state

For more info on the economics of small wind, see: www.awea.org/smallwind/toolbox/INSTALL/financing.asp

incentives designed to encourage the installation of home generating systems, receiving a state tax credit and a rebate from the California Energy Commission that covered half the cost of their machine. Their system went online in May 2002 and should pay for itself within five to seven years.

The Rhamys found plenty of information available from the American Wind Energy Association, *Home Power Magazine*, and state resources such as California's "Green Team" video conferences and the California Energy Commission. Their turbine dealer gave them the information they needed to approach the county building inspector, who approved a permit for the system that same day.

Kern County allows towers up to 80 feet high in most zoning districts, so no special permitting was required. "It was very simple," says Tom Rhamy.

Connecting their generator to the utility's system was also a straightforward process. Southern California Edison sent the Rhamys a blank contract that included a net metering agreement and other interconnection requirements. The Rhamys filled in specific information about their system, and the utility sent a completed contract for them to sign.

Small wind turbine installations are not this easy in all California counties, but the Rhamys' experience shows the widespread acceptance that residential renewable power systems have earned in recent years.

resources and answer inquiries from prospective permit applicants.

The primary map used by the small wind industry in California to predict the performance and economics of a small wind system for potential customers is produced by the California Energy Commission and available online[2] or by calling (916) 654-3902. Also available online is *The Renewable Energy Atlas of The West: A Guide to the Region's Resource Potential*, which allows users to find average wind speeds at specific locations in 11 western states using ZIP codes or geographic coordinates.[3]

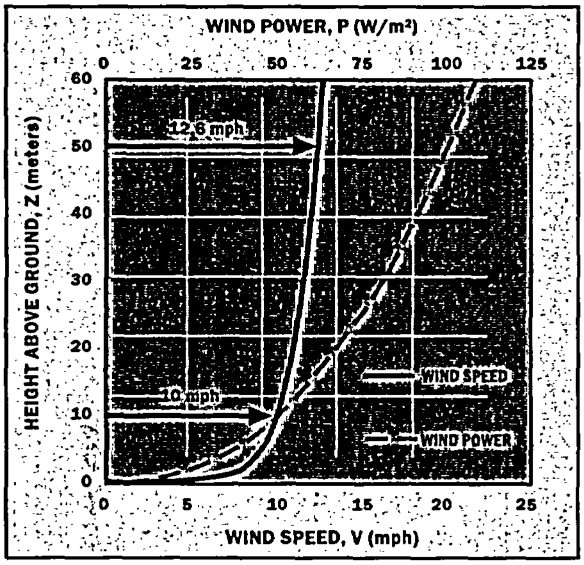
The Department of Energy ranks wind strength according to seven classifications. Class 1 winds are the weakest. Small wind turbines are generally cost-effective when installed in at least Class 2 or Class 3 winds (taller towers, 100 ft or higher, may be necessary in Class 2 winds), or where winds average at least 10 to 12.5 miles per hour (4.4 to 5.6 meters per second) at a height of 33 ft (10 meters) above ground. However, the wind power on a particular site is greatly affected by terrain. The wind may be obstructed by a hill or accelerated by a trough or valley. In complex terrain, small turbine dealers can help determine whether the wind is sheltered or concentrated. In a few cases, the installation of a wind data logging system may be necessary. (See inset next page.)

Positioning the Turbine

Ideally, property owners will place their turbines where wind is least obstructed, which is often the highest point on the site. Wind speed increases with height, and gaining even a small increase in velocity boosts

2. www.energy.ca.gov/maps/wind.html
3. www.EnergyAtlas.org

a turbine's generating potential significantly (see graph below). County officials may have aesthetic concerns about allowing turbines proposed on hills or ridges. However, planners and permitting officials should be aware that restricting the placement of a wind turbine within a site for aesthetic reasons may adversely affect project economics.



Graphic: Texas State Energy Conservation Office

Typical Wind Shear Profile — Speed and power available in the wind increases with increasing elevation. The relationship is commonly referred to as the one seventh power law (a=1/7).

Wind turbines should be elevated so that the bottom tips of their blades pass three times above the tallest upwind barrier, or at least 25-30 feet above any physical wind barriers (trees, buildings, bluffs) within 300-500 feet of the tower or the local treeline, whichever is higher. This is advisable to minimize air turbulence that places stress on mechanical components and reduces turbine performance. (See diagram next page.) Elevating the turbine higher above adjacent obstacles is always better, although one manufacturer suggests that clearance of at least 20 feet may be adequate for "micro" turbines (under 1 kW). *However, optimum tower height is always determined by the terrain and wind resource, not the turbine size.*

In cases where it is impossible to elevate a turbine sufficiently because of local permitting restrictions, planning officials can review their rules to see

Your Best Guess May Not Be Good Enough

Scotts Valley (Santa Cruz County) — Larry Gilliam found out that wind maps are no substitute for on-site wind measurements. A map may show healthy winds over a general area, but topological features significantly affect the strength of the wind blowing across a particular site. "I looked at the maps and thought I was in a Class 2 wind regime," says Gilliam, whose 10-kilowatt turbine hasn't been as productive as he'd hoped. "If I had to do it over again, I would have erected an anemometer."

Still, Gilliam's enthusiasm for wind turbines — inspired by a visit to a wind farm in San Gorgonio Pass — is not diminished. His turbine cut his monthly electric bill from $120 to about $80, and he's confident that the turbine will prove an even better investment over time as energy prices continue to rise.

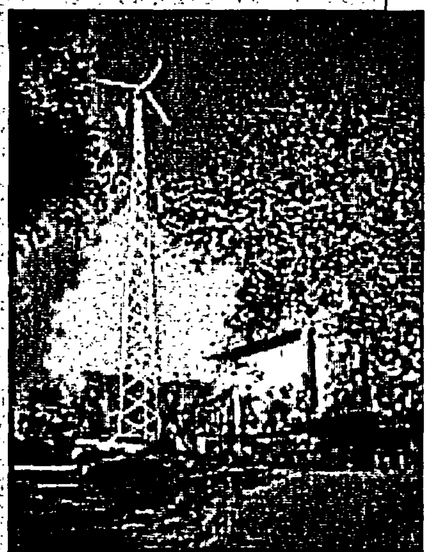
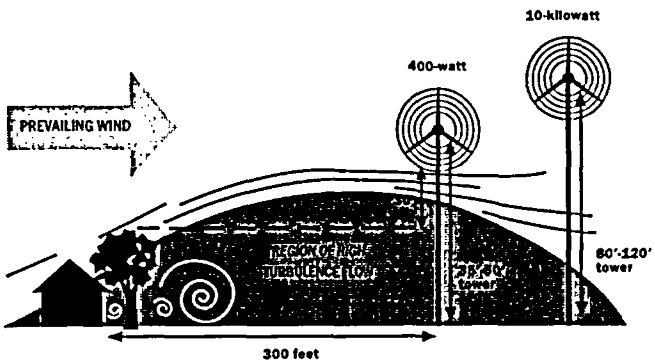


Photo courtesy Bergey Windpower

if they are more restrictive than necessary or allowed by AB 1207 and grant waivers as appropriate. (See "County Staff Make Way for Small Wind," page 27.)



Utility Line Interconnection

Wind turbine owners serviced by distribution lines can derive significant economic advantages by connecting their generators with the utility's system. Federal law (PURPA, 1978) requires that all utilities permit customer-owned generators to interconnect with their systems and compensate them for energy production.

In California and many other states, utilities are also required to provide **net metering** service, which allows turbine owners' electric meters to spin backward when the turbines generate more power than the owners need.[4] *This does not mean that the turbine owner is selling electricity.* Rather, net metering is a trade between the turbine owner and utility. When the turbine owner does not need the power the generator is producing, the energy is essentially banked with the utility. When the customer's demand exceeds the turbine's output, electricity is drawn back from the utility.


Photo courtesy of Chuck Koch

4. California State Public Utilities Code 1995 § 2827, as amended 1998, 2000 & 2201); www.dsireusa.org

Do it Yourself, but be Prepared to Wait

Tracy (San Joaquin County) – Steve and Kathy Nelson, who live five miles from one of the world's largest wind developments at the Altamont Pass, didn't have to worry about tower height restrictions when they put up a small turbine on their rural property. But they learned that it can still take some time and patience to install a turbine, especially if you do it yourself rather than contract with a turbine supplier.

Local permitting officials required two sets of plans for the Nelsons' installation – one from a civil engineer, and another from a structural engineer. Local inspectors were sometimes too busy to sign off on plans right away and asked for revisions. The Nelsons waited three months just for utility staff to approve the interconnection. (Other utility customers, however, have not encountered such lengthy delays.)

Fortunately for the Nelsons, the California Energy Commission had not yet changed the rules of its Emerging Renewables Program to discount the rebate awarded to owner-installed systems. The new rules, which took effect in 2003, now reduce the rebate by 15% for systems not installed professionally. So a prospective turbine owner should carefully consider whether self-installation will save money once the reduced rebate is calculated in.

For the Nelsons, the do-it-yourself ethic did pay off. Their wind turbine has been performing well, reducing monthly bills on their 3,000 square-foot home from nearly $300 to under $100. The Nelsons expect their turbine to pay for itself in six to seven years.

Net metering shortens the payoff period for a wind turbine because it gives retail credit for power generated during low-use periods. Under net metering laws in California and several other states, however, utilities have the right to claim excess generation left over at the end of an annual billing cycle. If a turbine produces more electricity than the customer uses over a 12-month period, the utility does not have to reimburse the customer for that extra power.

For more information on net metering, see www.awea.org/smallwind/

Wind turbines must be connected to the utility system to be eligible for rebates through the California Energy Commission's **Emerging Renewables Program.**[5] Customers of Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), San Diego Gas & Electric Company (SDG&E), and Bear Valley Electric are eligible for rebates that can currently cover up to $2.30/watt toward a wind turbine's installed cost. Rebates apply only to equipment that has been certified by the Energy Commission. Applicants must document and may be asked to justify specific installation expenditures when applying for rebates.

Utilities generally define requirements for connecting to the grid through interconnection agreements. California's three private utilities (PG&E, SCE, and SDG&E) offer simplified interconnection agreements that are consumer friendly. These contracts define turbine specifications, permitting and design requirements, technical requirements for interconnection, conditions under which the turbine is to be disconnected, and legal liability. They also set the rate at which the utility will credit the customer for excess electricity, the billing arrangement, and any administrative fees the customer must pay. The Energy Commission is preparing a document for customer-generators interested in interconnecting to their utility.[6]

Communicating with Neighbors

County planners advise and sometimes require that permit applicants notify their neighbors before proceeding with a project as visible as a wind turbine. Small wind turbine manufacturers also recommend early notification of neighbors. That courtesy will in many cases correct misperceptions and head off full-blown opposition. A letter like the one below can answer most questions people have about small wind turbines.

Dear Neighbor,

You may be interested to learn that I plan to install a small wind energy system on my property at [address]. This modern, non-polluting system will generate electricity solely for my own use, reducing my dependence on the local utility. Any excess generation will be supplied to the utility system, but I will not receive any income from this exchange.

I plan to install a [turbine make and model] that will be mounted on a __-foot tower, set back __ feet from the street and __ feet from the [south/north/east/west] property line. This wind turbine uses a [two/three] -bladed propeller __ feet in diameter and has only __ moving parts. It does not turn until the wind speed reaches at least __ mph. On calm, quiet days the wind turbine will not likely be audible. When the rotor is turning, the sound of the wind passing over the blades will register about __ decibels (dB(A)), at a distance of __ feet, which will barely be audible over other noises caused by the wind.

[Manufacturer] has installed __ [number] of [turbine make and model] in the United States [and overseas]. They have a proven track record of producing energy quietly, cleanly, and safely. If you have any questions about the proposed installation, please feel free to contact me.

Sincerely,

5. Emerging Renewables Program requirements are at: www.consumerenergycenter.org/erprebate
6. For more information see: www.energy.ca.gov/distgen/interconnection/guide_book.html

It also lets the neighbors know that an applicant has properly researched the project. California law limits locally imposed notification requirements to neighbors living within 300 feet of the proposed installation.

Concerns that may arise about small wind turbines are typically about noise and other perceived nuisances, safety, and impacts on views and property values. Often these worries are fueled by neighbors' lack of familiarity with wind systems. Below are some facts that address common issues.

1. Acoustics

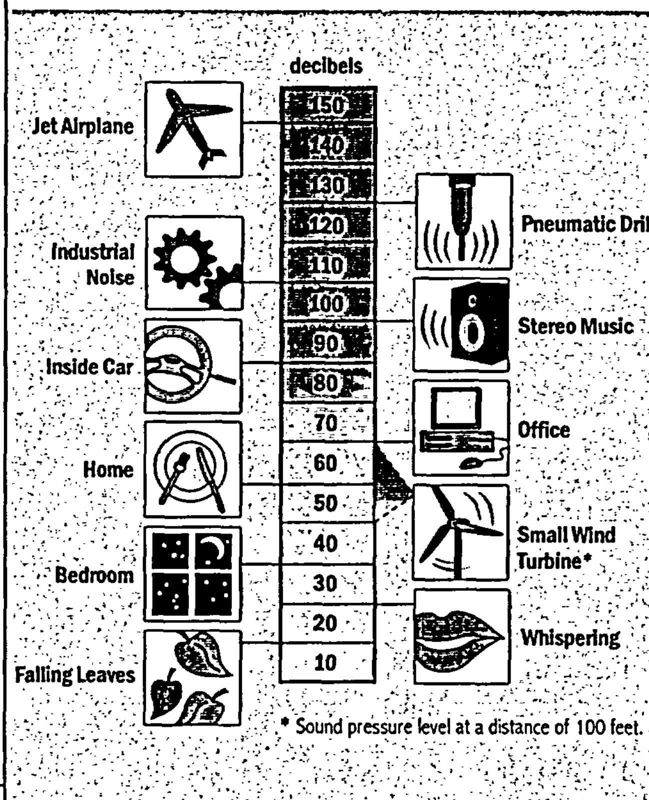
Wind turbines produce two types of noise: one from the equipment inside the nacelle, such as the generator, and the second from the aerodynamic noise of the rotating blades. Most small wind turbines do not have gearboxes or other noisy mechanical systems, and manufacturers have made them quieter through better sound insulation, lower rotor speeds and adjustments to blade geometry.

Although turbine noise increases with wind speed, so does the background noise produced by nearby trees, cars, animals and airplanes. Research has found that the background can be almost as noisy as the wind turbine, and at low wind speeds, will usually mask the wind turbine noise.

In a test conducted by the Clinton (Iowa) Detective Bureau, the noise from a 10-kW Jacobs wind system was measured in winds between 16 and 36 miles per hour. At 50 feet, the decibels measured between 55 dB(A) and 59 dB(A). But the detective, noting that the turbine noise was partially masked by rustling leaves, also took readings from trees that were 300 feet away. The trees registered 60 dB(A) to 62 dB(A). The report concluded that the wind generator produced "inconsequential" noise emissions.[7]

Wind turbine noise is measured in two ways: sound power level is a measure of the acoustic strength of the source – the wind turbine itself, and sound pressure level is a measure of the noise perceived at a particular location. Therefore, a distance from the wind turbine rotor hub must be specified for the sound pressure level to be meaningful. The noise perceived at a receptor location also depends upon the wind speed and the local surroundings. Mathematical models allow estimates of the sound pressure level at any location around the wind turbines.

The acoustic source strength of a wind turbine is measured in dB (decibels) on a logarithmic scale.



http://www.awea.org/faq/noisefaq.html

7. Mick Sagrillo, Windletter Feb/Mar 1997.

Because humans hear higher frequencies better then lower frequencies, an adjusted dB(A) scale is used to replicate this human response. Tests at the National Wind Technology Center[8] show that the sound power level of small wind turbines varies from about 75-100 dB(A). At a distance of 100 feet from the rotor hub, this range corresponds to sound pressure levels (perceived noise) of 40-65 dB(A). A level of 40 dB(A) - about the same as inside an average living room - is generally considered acceptable for neighboring structures. A level of 65 dB(A) - noisier than a loud conversation - may cause an annoyance.

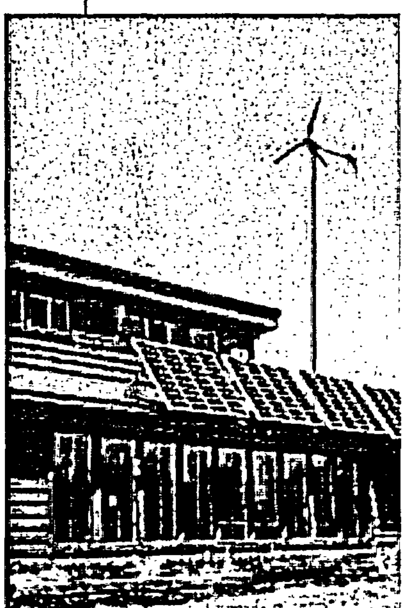


Photo courtesy Southwest Windpower

Noise complaints are rarely lodged against installed small wind turbines. The noise from their blades tends to blend in with the background acoustic vibrations produced in windy conditions.

When responding to neighbors' questions about noise, remember that sound levels decrease at a rate approximately equivalent to the square of the distance from the source. So a noise reading taken 25 feet away from a turbine will fall by a factor of four at 50 feet, by a factor of 16 at 1000 feet, and so on.

2. Aesthetics

Turbines must be mounted on tall towers to achieve their best performance and avoid damaging turbulence, so visibility is unavoidable. This isn't a problem for the many people who find wind turbines aesthetically pleasing. But in response to neighbors who do not, planning officials should consider the relative visual impacts of wind turbines. Communities already accept water towers, billboards, relay towers, and utility lines as part of the landscape. Does a wind turbine constitute a greater intrusion on a neighbor's view than would the addition of a second story to a home or other property improvements that are legally permitted? The right of applicants to generate their own local, clean energy, along with the public benefits spelled out by AB 1207, must be weighed against those who object to turbines on aesthetic grounds. County planners should weigh the potential cost impacts and lost revenue resulting from preventing turbines from being sited in optimal locations, and follow the guidance of Assembly Bill 1207:

> *In light of the state's electricity supply shortage and its existing program to encourage the adoption of small wind energy systems...local agencies [should]...not unreasonably restrict the ability of homeowners, farms, and small business to install small wind energy systems ...It is the policy of the state to promote and encourage the use of small wind energy systems and to limit obstacles to their use.*[9]

Small turbines are not as visibly noticeable as many people imagine. Even in flat, treeless areas it is difficult to pick them out from a quarter of a mile away. Among hills or trees they are even less noticeable. Guyed lattice towers are the least visible from a distance. Turbines and towers can be painted light gray to further minimize visual impacts.

8. Migliore, P., van Dam, J. and Huskey, A, Acoustic Tests of Small Wind Turbines, NREL SR-500-34601, Golden, CO, 2003.
9. California Government Code, Section 65892.13(a) (2)

Photo courtesy Southwest Windpower

3. Property Values

There is no documented evidence that wind turbines — including commercial wind farms — have ever lowered the values of surrounding properties. In fact, the opposite effect has been recorded. A recent study that examined 25,000 property transactions within five miles of wind farms found that values almost always rose faster in those areas than in similar communities without turbines. The report, commissioned by the U.S. Department of Energy, included data from 10 wind installations in seven states.[10]

Vermont turbine owner David Blittersdorf reports that the home next to his sold within one day for the full asking price. His new neighbors later told him that his 10-kW wind turbine was a major factor in the quick sale. "They said they wanted to live in a place where the community cared about the environment. They told me that they too wanted to install a small wind turbine someday," says Blittersdorf.

Wind turbine manufacturer Mike Bergey says that in 20 years of business he's never heard of a customer's wind turbine adversely affecting the value of neighboring real estate. "Our customers have sold their homes and adjacent lots, and they have had direct and nearby neighbors sell their homes. In all but one case the wind turbine was not an issue. In that case, the turbine had been partially installed on the abutting property due to a faulty survey. This situation was resolved amicably," notes Bergey.

Some homebuyers will pay more for a home equipped with a renewable energy system. A California Energy Commission market survey of 300 California homeowners found that half were willing to pay extra for homes with solar panels or wind turbines. The study also found that more than 60% of homeowners preferred to buy a home already equipped with a renewable energy system rather than install it themselves.[11]

4. Electronic Interference

Experimental wind turbines with metal blades put up in the 1970s reportedly "chopped up" television signals, resulting in ghost images on TV screens.

But the rotors on small-scale turbines are not large enough to interfere with TV or telecommunications signals, and their blades are made from wood, fiberglass, and plastic — materials that signals easily pass through.

Small wind turbine generators have never been shown to disrupt telecommunications or radio waves through electromagnetic interference. Jim Green of the U.S. Department of Energy's National Renewable Energy Laboratory reports that in 10 years researching small wind turbines, he has never encountered a problem with electromagnetic interference, nor have other researchers found cause to study them.

In fact, one of the major niche markets for small wind systems is powering remote telecommunications sites. Small wind turbines have been approved by the U.S. Navy for powering military communications.[12]

10. www.REPP.org
11. www.energy.ca.gov/reports/2002-04-03_500-02-016.PDF
12. Mick Sagrillo, "Telecommunication Interference from Home Wind Systems" AWEA Windletter, Volume 22, Issue No. 4 April 2003.

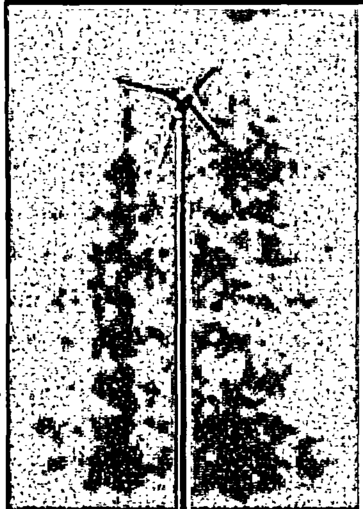


Photo courtesy Southwest Windpower

5. Safety

No public injuries have been attributed to falls from the thousands of unfenced small turbine towers installed over the past 25 years. Turbine towers should be required to have the same access restrictions — such as fencing or warning signs — as similar structures such as ham radio towers. Some turbine tower models currently on the market, primarily for the smallest turbines, are designed to be lowered to the ground for maintenance and repairs and don't have hand- and foot-holds. The small wind industry does not recommend fencing or anti-climbing devices.

Under AB 1207, turbine permit applications are required to include standard drawings and an engineering analysis of the system's tower, showing compliance with national or state building codes and certification by a licensed professional engineer, demonstrating that the system is designed to meet requirements for the most stringent wind (Uniform Building Code wind exposure D), the worst seismic class (Seismic 4), and the weakest soil class (soil strength of not more than 1,000 pounds per sq ft). Applications are also required to include a line drawing of the system's electrical components in sufficient detail to allow determination that the installation conforms to the National Electric Code.

Utility personnel unfamiliar with wind generation may mistakenly worry that turbines are a threat to utility line workers responding to power outages. In the 25 years that utilities have been required to interconnect small wind turbines, not a single liability claim has been filed against a turbine owner over electrical safety. Inverters certified by the California Energy Commission for use with small wind turbine installations are required to comply with UL 1741, which ensures safe operation on an electricity grid, including during utility outages.

Section 2827 of the California Public Utilities Code, most recently amended in 2002 by Assembly Bill 58, establishes standard terms for interconnection:

> *A...wind turbine electrical generating system ...used by an eligible customer-generator shall meet all applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers, and accredited testing laboratories such as Underwriters Laboratories and, where applicable, rules of the Public Utilities Commission regarding safety and reliability. A customer-generator whose ...wind turbine electrical generating system ...meets those standards and rules shall not be required to install additional controls, perform or pay for additional tests, or purchase additional liability insurance.*

6. Avian Risk

Bird collisions with small wind turbines are very rare. Statistically, a sliding glass door is a greater threat to birds than a small, unlighted wind turbine. Smoke-stacks, power lines, and radio and television towers have been associated with far greater numbers of bird fatalities than have even larger-scale wind farms.

Motor vehicles and pollution are responsible for an even higher proportion of total bird deaths. House cats kill an estimated 100 million birds annually.[13]

Wind turbines have been associated with avian impacts primarily because of unique conditions at California's Altamont Pass Wind Development. Habitat for golden eagles and other protected species, Altamont Pass is one of the world's largest, and earliest, commercial wind installations. Much research has been conducted to make wind turbines more "bird safe," including tower design changes and better siting practices. According to a recent report from the Bonneville Power Administration, "Raptor mortality has been absent to very low at all newer generation wind plants studied in the U.S. This and other information ...strongly suggests that the level of raptor mortality observed at Altamont Pass is unique."[14]

Because small wind turbines have small rotor swept areas, are not usually tall enough to interfere with bird migration patterns, and are not often installed in dense enough configurations to create a "windwall" effect, they generally do not cause problems with birds or other wildlife. The California chapter of the National Audubon Society endorsed the passage of AB 1207, stating that the number of bird collisions with small-scale turbines is expected to be "similar to the deaths caused by other stationary objects that birds routinely fly into."[15]

13. National Wind Coordinating Committee (NWCC), Permitting of Wind Energy Facilities: A Handbook, 2nd ed. *www.nationalwind.org*
14. Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments, West, Inc., December 2002
15. Letter from John McCaull, California Audubon, to California Assemblyman John Longville, July 17, 2001.

Who Says Wind Turbines Need Lights? Not the FAA.

Solara Energy President Peter Burcat takes issue with counties that require beacon lights on small wind turbines. An attorney who is also working to obtain a pilot's license, Burcat knows that even the tallest small turbine towers do not reach high enough to trigger Federal Aviation Administration (FAA) lighting requirements.

The FAA doesn't require lights on structures less than 200 feet tall, and prohibits both commercial and small private aircraft pilots from flying lower than 1,000 feet. Pilots cannot drop lower than 500 feet when approaching a runway. The only time a small wind turbine would be affected by FAA regulations is if it were proposed to be sited adjacent to an airport.

Many common structures that are taller than small wind turbines – transmission line poles, for example – are not required to be lit.

California's AB 1207 does, however, require that turbine owners alert crop duster pilots to their installations in certain regions. Section 65892.13(d)(4) stipulates that:

"In the event a small wind energy system is proposed to be sited in an agricultural area that may have aircraft operating at low altitudes, the local agency shall take reasonable steps ...to notify pest control aircraft pilots registered to operate in the county pursuant to Section 11921 of the Food and Agricultural Code."

7. Air Traffic

The height of small wind turbine towers is well below the 200-foot elevation that would require them to be lit under Federal Aviation Administration (FAA) rules. Nor does the FAA require notification of small wind turbine construction[16] unless the proposed tower would be within:

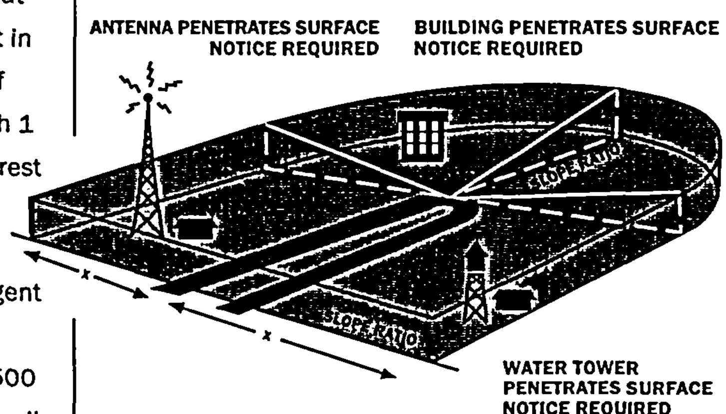
- 20,000 feet of an airport or seaplane base with at least one runway more than 3,200 feet in length and the object would exceed a slope of 100:1 horizontally (100 feet horizontally for each 1 foot vertically) from the nearest point of the nearest runway; or

- 10,000 feet of an airport or seaplane base that does not have a runway more than 3,200 feet in length and the object would exceed a slope of 50:1 horizontally (50 feet horizontally for each 1 foot vertically) from the nearest point of the nearest runway. (See figure to the right.)

The California State Aeronautics Act is less stringent than FAA guidelines, requiring Department of Transportation review for structures exceeding 500 feet, which is four times as high as the tallest small wind turbine tower available.[17]

Some townships in close proximity to Edwards Air Force Base Flight Test Center are subject to a recent California law (SB 1989) that requires the military be notified of small wind energy systems proposed in the zone classified R-2515. R-2515 lies mostly in Los Angeles County, extending slightly into Kern County. The law does not prohibit small wind turbines in R-2515. It requires only that local planning agencies forward applications for small wind turbines to military authorities. The law is intended as a precaution — small wind turbines are not expected to raise problems for the air base.

Object Penetrates Airport / Seaplanes Base Surface



Airports with one runway more than 3,200 ft. X=20,000 ft. Slope ratio 100:1

Airports with no runway over 3,200 ft. X=10,000 ft. Slope ratio 50:1

Graphic: Federal Aviation Administration

16. FAA Advisory Circular AC70/7460-1K
17. State Aeronautics Act, Part 1 Division 9 Section 21656 of California State Public Utilities Code.

Vineyard Gets Good Wind Harvest

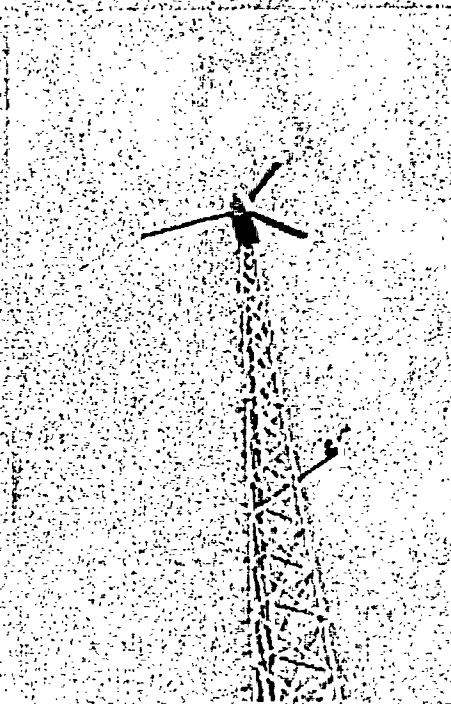


Photo courtesy of Joe Mathewson

Paso Robles (San Luis Obispo County) — Joe Mathewson says permitting staff weren't sure what to expect when he proposed the first small wind turbine in the county, but their ready acceptance of the project made for a smooth installation. "San Luis Obispo County was very friendly toward the application," Mathewson says.

Mathewson had been spending $15,000 annually on electricity to irrigate his 40-acre vineyard. He figured it was time to see if the wind, which blows steadily from afternoon to midnight in the summers, could do some of the work instead. Mathewson's instincts were right: his 10-kilowatt wind generator has cut his power bill from $1,000 to $200 per month during the grape irrigation season. All told, he has cut his annual electricity bill by nearly half.

Mathewson put up the turbine and 100-foot tower himself. The permit cost $400, and the process took only a couple of weeks. He says county planners were primarily interested in the integrity of his tower foundation and electrical connections. Since the turbine was installed in the center of his property, he did not encounter any opposition from neighbors.

He's so impressed with his system that Mathewson has taken to selling small wind turbines on the side. "If you have a consistent wind resource, a suitable location, and want to reduce your electric bill, this is a good way to go," he says.

PERMITTING OF SMALL WIND TURBINES:

A CHECKLIST

A summary of basic steps for obtaining a permit for a small wind turbine in California[18]

1. Contact your county planning department or permitting agency.

- ☐ Find out if small wind energy systems are addressed by local ordinance and, if so, get a copy of the ordinance. (If not, see **2** below.)
- ☐ Learn the relevant permitting procedures.
- ☐ Ask what documents you'll need. Are you required to submit plans from a consulting engineer, or will documentation from the turbine manufacturer or dealer do?

2. Review the applicable standards and restrictions.

In California, if small wind energy systems are not specifically addressed by local ordinances in your area, or if local ordinances have not been brought into compliance with AB 1207, then your small wind turbine is an allowable use, subject to the provisions of the *California Government Code*, Section 65892.13(f), which sets the following restrictions:

- ☐ **Minimum parcel size:** One acre; must be outside an "urbanized" area unless otherwise specified.
- ☐ **Minimum allowable tower height:** Up to 65 feet must be allowed on parcels 1-5 acres; up to 80 feet must be allowed on parcels of five acres or more. Taller towers are not prohibited by state law.
- ☐ **Setback:** No part of the system, including guy wires, may be closer than 30 feet to the property boundary. (The installation must also comply with fire setbacks established by Section 4290 of the Public Resources Code.)
- ☐ **Noise levels:** Must not exceed 60 dB(A) during normal operation, as measured from the closest neighboring inhabited dwelling.
- ☐ **Equipment:** Contact the California Energy Commission for a list of certified small wind turbines[19] and for recognized national certification programs.
- ☐ **Building code compliance:** Standard drawings and an engineering analysis of the tower are required showing compliance with the Uniform Building Code or the California Building Standards Code and certification by a licensed professional engineer. "Wet stamps" are not required.
- ☐ **Electric code compliance:** Requires line drawings of system electrical components showing sufficient detail to determine that installation conforms to the National Electric Code.

18. Many permit requirements are not applicable in certain California counties or outside the state. For recommended practices, see "Do's & Don'ts" and AWEA's model zoning ordinance, pages 27-29.
19. www.consumerenergycenter.org/erprebate/equipment.html

- ☐ **Federal Aviation Administration requirements:** Installations close to airports (within 10,000 to 20,000 feet of runways) may require prior FAA notification. (See "Air Traffic", p. 16.)

- ☐ **Other siting restrictions:** Small wind energy systems may be subject to local restrictions adopted pursuant to state legislation establishing coastal areas, scenic highway corridors, or other specially designated areas.

3. For California grid-connected systems:

- ☐ **Notify utility:** You may need to show your permitting agency that you have notified the utility of your intent to install an interconnected wind generator.

- ☐ **Reserve an Energy Commission rebate:** Reserve your rebate prior to installation by submitting a Reservation Request Form and required supporting documentation to the Energy Commission.[20] Once your rebate reservation is accepted, you have up to nine months to install your (10 kW or smaller) system.

- ☐ **Interconnection agreement:** The state's investor-owned utilities (SDG&E, PG&E, SCE) have simplified, consumer-friendly interconnection agreements. Utilities are required to process net metering applications within one month.[21]

20. See: www.consumerenergycenter.org/erprebate/forms.html
21. For more information see: www.awea.org/smallwind/california.html

4. Notify your neighbors.

- ☐ Counties may not require notice of an application to install a small wind turbine to property owners beyond 300 feet from the proposed site. (See "Communicating with Neighbors," p. 11.)

5. Comply with permitting requirements.

Permitting requirements, procedures, and fees vary widely among counties.

- ☐ Building permit, use permit, zoning permit, or "plot plan" fees can range from less than $100 to $1600.

- ☐ Other costs for public notification, hearings, or environmental impact studies may range from a few hundred to several thousand dollars.

- ☐ If a particular fee seems excessive or inappropriate for your situation, find out the basis for the fee. You may be able to avoid it or have it reduced. (See "County Staff Make Way for Small Wind," p. 27.)

- ☐ To be eligible for an Energy Commission rebate, your system must be installed by a licensed California contractor possessing an active "A," "B," "C-10," or "C-46" (photovoltaic system) license.

- ☐ Obtain a final inspection sign-off prior to claiming your rebate. Net metering provisions take effect when the permit is obtained or the wind turbine begins operation.

II. PERMITTING SMALL WIND TURBINES UNDER AB 1207

SOME COUNTY COMPARISONS

Photo courtesy Southwest Windpower

The California Legislature's adoption of Assembly Bill 1207 in 2001 sent a clear message to local authorities that "the implementation of consistent statewide standards to achieve the timely and cost-effective installation of small wind energy systems is not a municipal affair...but is instead a matter of statewide concern."[22]

California electricity customers had endured rolling blackouts that year and were facing steep electricity rate hikes. The legislature hoped to clear obstacles to small forms of "distributed generation" that would shore up both the supply and reliability of energy in the state. AB 1207 was written to standardize the small wind permitting process at the local level, removing complications that had frustrated and stymied many potential applicants, requiring local agencies to approve small wind turbine applications by right if specified conditions are met. Similar to existing state law prohibiting "the legislative body of any city or county from enacting an ordinance that prohibits or unreasonably restricts the use of solar energy systems other than for the preservation or protection of the public health and safety," AB 1207 was intended to promote and encourage the use of small wind energy systems and to limit obstacles to their use, declaring that:

> *Small wind energy systems, designed for onsite home, farm, and small commercial use, are recognized by the Legislature and the State Energy Resources Conservation and Development Commission as an excellent technology to help achieve the goals of increased in-state electricity generation, reduced demand on the state electric grid, increased consumer energy independence, and nonpolluting electricity generation.*[23]

As of July 1, 2002, AB 1207 is the default permitting ordinance applied to small wind energy systems in California counties that lack their own ordinance. The law also supersedes specific restrictions contained in existing county ordinances. Although, the provisions of AB 1207 are scheduled to sunset in July 2005, some counties may need additional time to bring local ordinances into compliance with the state goal of encouraging renewable energy, so small wind advocates will likely seek extension.

Key Provisions of AB 1207

AB 1207 allows counties and other local agencies to follow their own processes for permitting small wind energy systems and enforce compatibility and use issues. However, the law limits the restrictions that may

22. California Government Code, Section 65892.13 (a) (5)
23. California Government Code, Section 65892.13 (a) (5)

be imposed on tower height, notification, setbacks, noise level, turbine approval, tower drawings, and engineering analysis. Counties may not enforce restrictions more severe than those established by AB 1207, which include:

- Notice of an application to install a small wind turbine need only be provided to property owners within 300 feet of the property on which the turbine is proposed. (The law allows but does not itself require notification.)

- The allowable height for a small wind turbine tower on a site of one to five acres must be at least 65 feet; on parcels of five acres or more, the allowable height must be at least 80 feet. Counties may allow applicants to exceed these heights, but applicants must demonstrate that the proposed height for a small wind turbine tower is within the range recommended by the turbine manufacturer.

- Setbacks from the property line shall be no farther than the height of the turbine tower, provided they also comply with Section 4290 of the Public Resources Code.

"Small wind turbines are being installed all across the country without the need for a permit or the payment of any fees to local governments. It is in California's best interests to make as simple as possible the installation of a much underutilized technology."

— Joe Guasti, small wind turbine dealer

- Under California law, small wind turbines shall not cause a sound pressure level in excess of 60 dB(A) as measured at the closest neighboring inhabited dwelling. This level, however, may be exceeded during short-term events such as utility outages and severe wind storms.

- The small wind turbine must be certified by the California Energy Commission as qualifying under the Emerging Renewables Program, or by a national program approved by the Energy Commission. Properly certified equipment cannot be excluded by local ordinance.[24]

- The applicant must include standard drawings and an engineering analysis of the turbine tower that demonstrate compliance with the Uniform Building Code or the California Building Standards Code. In addition, the drawings and analysis must

County Reluctance Generates Positive Interest in Wind Turbines

Madera County's resistance to a small wind turbine installation in San Juan Bautista seems to have backfired. County officials sent a letter to neighbors of the proposed 10-kilowatt turbine explaining that they disliked the idea of approving the project, but they had no choice because of the passage of AB 1207. The controversy generated local media attention, and Solara Energy President Peter Burcat, who applied for the permit, says he subsequently received approximately 10 phone calls from local residents interested in installing wind turbines.

24. For a list of these wind turbines, see www.consumerenergycenter.org/erprebate/eligible_smallwind.html

be certified by a professional mechanical, structural, or civil engineer licensed by the State of California.

- The applicant must also include a line drawing of the electrical components of the small wind energy system in sufficient detail to demonstrate compliance with the National Electric Code.

- The small wind turbine must comply with all applicable Federal Aviation Administration requirements, including Subpart B (commencing with Section 77.11) of Part 77 of Title 14 of the Code of Federal Regulations regarding installations close to airports.[25] It must also comply with the State Aeronautics Act (Part 1, commencing with Section 21001 of Division 9 of the Public Utilities Code).[26] Small wind energy systems proposed in zone R-2515, surrounding Edwards Air Force Base, may be subject to the notification requirements of SB 1989. (See p. 17.)

County Responses to AB 1207

Even under AB 1207, the permitting process differs a great deal across counties. Many planning and permitting departments are unfamiliar with the policy rationale behind the new law. In some cases, county staff have not understood that the law trumps all local rules governing height restrictions and other permitting matters for wind turbines unless they are less restrictive than AB 1207.

Some counties have changed their permitting rules as a result of the legislation, but have not necessarily made their processes less cumbersome. Others have not changed their ordinances because of budget constraints or because they have not yet received any wind turbine applications. But some counties in windy regions are becoming increasingly good at accommodating small wind turbines while still protecting the public interest.

Twelve counties (Mendocino, Napa, Santa Cruz, Solano, Kern, Los Angeles, San Bernardino, Sonoma, Riverside, San Diego, San Luis Obispo, and El Dorado) were surveyed for this handbook. Four (Mendocino, Napa, Santa Cruz, and Solano) elected to accept the minimum state standards included in AB 1207. Three others (Kern, Los Angeles, and San Bernardino) modified their local ordinances as a result of AB 1207, and one (Sonoma) adopted a small wind permitting ordinance which it has revised several times to resolve land use issues raised by applicants.

Riverside County simply modified its application criteria to comply with AB 1207 neighbor notification requirements without going through a local public approval process. At the time of interview for this handbook, San Diego and San Luis Obispo counties were still unaware of AB 1207. A representative of the El Dorado planning department said he would welcome a "model ordinance" to help his county conform with AB 1207. (An ordinance recommended by the American Wind Energy Association is included in this handbook. See p. 29.)

Photo courtesy National Center for Appropriate Technology

25. www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_14/14cfr77_00.html
26. www.dot.ca.gov/hq/planning/aeronaut/documents/2003PUC_SAA.pdf

"We are trying to be wind-friendly. We want to promote wind energy in our general plan." –Susan Calladao, Planner, San Luis Obispo County

The next page contains descriptions of permitting processes applied in various counties. For a summary of permitting rules and practices recommended by the authors of this handbook, please see page 31.

In Kern, Solano, and Santa Cruz counties, small wind turbines are permitted "by right" and can only be denied a permit if they violate air safety standards. Turbine installations also require a separate building permit.


Photo courtesy Joe Mathewson

AB 1207 has actually made permitting slightly more difficult and expensive in Kern County. A process that could once be completed over the counter in a single day may now involve public hearings. Kern County added a $325 filing fee to cover additional administration costs for wind turbines on top of the $400 building permit fee. Both permits can be acquired in three to four weeks.

Los Angeles County, by contrast, is one of the most difficult places in the state to get a small wind energy system approved. An ordinance adopted in September 2002 subjects applicants to an expensive conditional use permit review, which generally involves a public hearing. Applicants may qualify for a minor use permit at the discretion of the planning office director if the installation meets established development standards and is opposed by no more than one person.

Will Winds Prevail in L.A. County?

Small wind advocates hope that Los Angeles County will eventually make it easier to site small wind turbines. Acting Chief of Ordinance Study Leonard Erlanger says he believes the few applicants that are trying to get through the county's difficult permitting process will set positive precedents. "As this unfolds, things will be clarified, making it easier for small wind turbine applicants in the future," says Erlanger.

The $800 fee for the first stage of what the county calls a "minor" use permit is a rude surprise for many applicants. But Erlanger says the county reduced the fee for this permit below what it charges for a conditional use permit. Applicants who encounter no neighborhood opposition and avoid public hearings are charged only for the less expensive permit, though the price quickly goes up if hearings are necessary.

Recognizing that applicants "are not real happy" with the performance security the county imposes to cover the eventual removal of a turbine (an event not likely to happen for 20 to 30 years after installation), Erlanger says that "I'd back off on that provision if I had to do it again."

Erlanger says planners could use some guidance from state officials on how best to protect scenic corridors and ensure aviation safety. He says he's receptive to bringing the county's lighting requirements more closely in line with FAA standards, which are less restrictive. The county currently notifies various air safety agencies of small wind turbine applications, and requires a beacon light if any agencies request it.

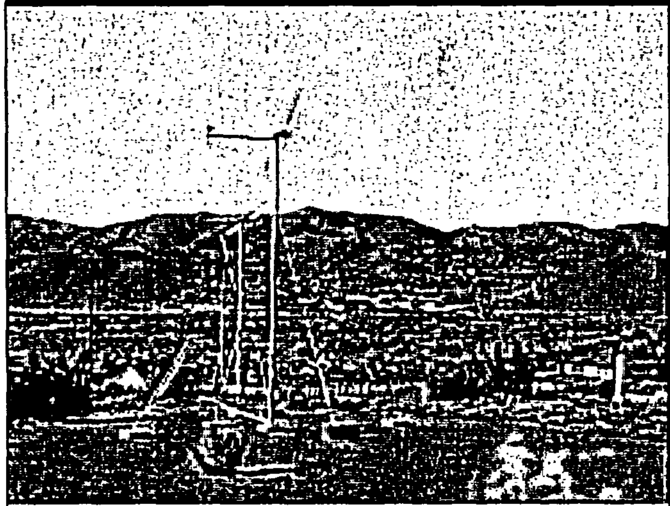


Photo courtesy Daniel Scott

A small wind energy installation must meet the following standards in Los Angeles County:

- Small wind turbines over 50 feet tall may have to install an FAA-approved beacon light. The lighting specified can consume half of the electricity generated by a 1-kW wind turbine.
- Small wind turbines cannot be placed on, or within 100 feet of, a ridgeline. They cannot exceed the height of any nearby ridge by more than 25 feet.
- Small wind turbine owners must pay a performance security to cover the eventual cost of removing the wind turbine. Turbine lifespans range from 20-30 years.
- All wind turbines require fencing even if the site is already enclosed.

Anyone seeking a permit of any kind in Los Angeles County must either obtain an exemption from the California Environmental Quality Act (CEQA) or pay an $800 fee for the first stage of a minor use permit. As a result of these obstacles, few permits have been issued. The small wind industry and local residents are working with Los Angeles County to remedy these problems (See text box previous page.)

Trial and Error in Riverside County

Moreno Valley (Riverside County) – Steve Anderson's determination has not only helped pave the way, but also highlights the pitfalls facing small wind turbine customers. When he first explored the possibility of putting up a small wind turbine two years ago, "county officials didn't have a clue about what I was trying to do," he recalls. Although his wind resource was moderate, California's energy shortage spurred him to invest the time and funds needed. "It took me six months to finalize the county paperwork and comply with all of their documentation and other siting requirements. I went down to their office five or six times, and each time I got a different answer about what I needed to do."

Fortunately for Anderson, the passage of AB 1207 in 2001 required Riverside County to streamline its local codes governing small wind turbines.

The county previously required that wind turbine applicants notify every landowner within a half-mile radius of the site – even absentee landowners. Anderson was preparing to send letters to nearly 50 people when AB 1207 went into effect. Under the new law, which limits notification requirements to neighbors within 300 feet of a proposed wind turbine, Anderson needed only six stamps. (One notification recipient even decided to install a wind turbine himself.)

Anderson admits that a few individuals, particularly the county's head planner, cut him quite a bit of slack. For example, his initial development fee assessment of $10,500 was reduced to $257. His fee assessment to protect the Kangaroo rat, a threatened species in

Photo courtesy Carl Frazier

California, was reduced from $2,500 to $50.

Anderson wound up paying approximately $4,000 in fees to Riverside County, plus another $1,000 for required trenches, topographical maps, signs, and vegetation. Due to low wind resources at the turbine site, his investment is taking longer than he had hoped to pay for itself. He learned that his turbine needs to be elevated higher to reach good sustained winds.

Michael Freitas, senior planner for Riverside County, says Anderson's difficulties resulted from "our inexperience with small wind turbines." In the future, prospective small wind turbine owners may not have to overcome all the siting hurdles Anderson encountered, he says, though the total permitting costs will likely be similar.

The good news, says Freitas, is that there's been little public opposition to small wind turbines in the county. Still, Freitas advises permit seekers to talk to neighbors before proceeding. He also suggests that applicants carefully analyze their wind resource to select the proper tower height and make sure a turbine will repay the time and expense county permits require.

"As this unfolds, things will be clarified, making it easier for small wind turbine applicants in the future."

– Leonard Erlanger, acting Chief of Ordinance Study at Los Angeles County

San Bernardino County responded to AB 1207 by making its turbine tower height limits less restrictive than the state's. Landowners in the desert regions of the eastern and northern portions of the county can now erect turbine towers as high as 120 feet on five acres of land – 40 feet higher than the minimum allowance provided by state law.

In addition, San Bernardino permit applicants may receive a variance allowing a 30% increase in tower height, raising the limit to 156 feet. The county removed a ban on small wind turbines in urbanized areas.

Sonoma County adopted AB 1207 prohibitions against small wind turbines in urbanized areas, but later changed the way it defines those areas, concluding that the designations applied by the U.S. Census Bureau were preventing some residents with suitable sites from putting up turbines. The county deleted the federal designations and now defines urbanized areas according to the reach of city services such as water and sewer connections.

However, the county extended 2,500-foot buffer zones around its urban service areas. Wind turbines taller than 40 feet sited in those zones require a conditional use permit, which is much more expensive ($2,044) than the zoning permit needed outside the buffer ($71). Turbines below 40 feet in height can be installed within urban service areas and buffer zones with a minor use permit.

County Staff Make Way for Small Wind

Oak Hills (San Bernardino County) – Fortunately for Gus Sansone, San Bernardino County staff were willing to negotiate details that could have made the difficult task of permitting his small wind turbine much more expensive. Sansone first teamed up with other small wind enthusiasts to get the county supervisor to lower the permitting fee from $1,200 to $500. Then Sansone had to negotiate with the county assessor, who said his wind turbine would be taxed at its total installed value. Sansone eventually got the county assessment reduced by about half.

a lot of time and effort, but Sansone praises the county staff. "I have to give them a lot of credit. They worked diligently to see that my wind turbine was up and running," he says.

County zoning restrictions limited the height of Sansone's turbine tower to 60 feet, and setback requirements prevented him from putting the tower on high ground near the edge of his lot. (Sansone's property was smaller than the five-acre minimum that would have allowed a tower of 80 feet.) But again, Sansone got a break. He was eventually permitted to extend the tower to 80 feet for a $150 fee. He estimates the additional height is increasing the generation from his 10-kilowatt machine as much as 25%, based on the experience of other local wind turbine owners.

Height restrictions in Santa Cruz County were also an obstacle for Scotts Valley resident Larry Gilliam, but with the help of the county supervisor, Gilliam was able to permit his 80-foot tower through a special wind zoning ordinance Gilliam says was "left over from the last energy crisis."

> "I have to give them a lot of credit. [County staff] worked diligently to see that my wind turbine was up and running."
>
> – Gus Sansone of San Bernardino County

Photo courtesy Bergey Windpower

That ordinance, in fact, stipulated minimum rather than maximum tower heights to make sure small wind turbines generated substantial amounts of electricity.

Both turbine owners are glad they persisted in negotiations with county officials.

For Sansone, the result is a reduction in power bills from $100 per month to $0. "I haven't had to pay an Edison bill at all over the course of an entire year!" he says. His turbine has "accomplished everything I've wanted it to – and then some."

Key compliance issues for small turbines include the following:

- Applicants must submit an architectural or artistic rendering of the proposed turbine.
- Vegetation or other natural features may be required to screen the installation from view.
- The turbine must be painted to blend in with its background.
- Turbines are prohibited on ridge tops.

Although they have adopted stringent regulations, the Sonoma County Board of Supervisors wants to be "wind friendly." A recent ordinance drastically cut permitting fees and removed public notification requirements for zoning permits.

Riverside County imposes no height restrictions on wind turbine towers. AB 1207 greatly simplified the county's notification requirements, but wind turbine permit fees are still quite high.

The county requires a plot plan that costs $1,600. Most applicants also have to pay about $600 for an initial study to determine whether an Environmental Impact Report is required. Applicants make a deposit to cover other application costs — if the county expends more than the deposit, it charges by the hour for staff time until the process is completed. Permitting for installations recently completed in western Riverside County cost up to $5,000. Although county staff have been able to reduce some of the site-specific fees, Riverside remains one of the most costly places to install a wind system in California.

Small Wind and Solar System Prompts Lifestyle Changes

Adreine Jenik was looking for ways to tap the rich natural energy resources around her art studio in 29 Palms, a small community located in the High Desert portion of San Bernardino County. "I noticed that it was pretty sunny out here most of the time. And when it wasn't sunny, there seemed to be quite a bit of wind," says Jenik, an associate professor of Computer & Media Arts at UC-San Diego. She figured a renewable energy system would minimize the environmental impact of her creative getaway.

In 1998, she installed a custom-designed hybrid energy system that combines a 400-watt Southwest Windpower turbine with a 325-watt solar photovoltaic system. It took a year to work out all the technical bugs and get the paperwork straightened out, but now she's satisfied with a system that supplies 100 percent of her electricity. "I paid the price of being an early adopter, but my electricity bills are now zero," she reports.

"What I like the most about my own renewable energy system is that it has made me much more aware of my own energy usage. And that was a very powerful experience," Jenik says. For example, she purchased a new heavily insulated refrigerator and put her water heater on a timer. "I made some major lifestyle changes. Sometimes I just bring a bag of ice instead of turning the refrigerator on if I'm only here for a little while."

Though permitting took some time, there was no opposition to her hybrid wind/solar system from her neighbors. "People pretty much stick to themselves in a community like this," says Jenik. Her "micro" wind turbine tower is less than 35 feet tall, so it didn't present a problem for county permitting authorities. The wind and solar system requires minimal maintenance. So far, Jenik has been able to handle everything by herself, even filling her six batteries with distilled water.

III. AWEA'S RECOMMENDATIONS

Model Zoning Ordinance: Permitted Use Regulation for Small Wind Turbines

Recommended Practices

The American Wind Energy Association offers a Model Zoning Ordinance to help local officials update ordinances governing small wind turbine installations.[27] The following template serves as a starting point that can save planning and permitting staff valuable time. However, states often have unique subsidies or other programs designed to encourage on-site electricity generation, and local ordinances need to be fine-tuned to accommodate both existing state laws and local regulations. A list of practices recommended by the authors of this book are on page 29.

SECTION 1 PURPOSE:

It is the purpose of this regulation to promote the safe, effective, and efficient use of small wind energy systems installed to reduce the on-site consumption of utility supplied electricity.

SECTION 2 FINDINGS:

The [city or county] finds that wind energy is an abundant, renewable, and nonpolluting energy resource and that its conversion to electricity will reduce our dependence on non-renewable energy resources and decrease the air and water pollution that results from the use of conventional energy sources. Distributed small wind energy systems will also enhance the reliability and power quality of the power grid, reduce peak power demands, and help diversify the State's energy supply portfolio. Small wind systems also make the electricity supply market more competitive by promoting customer choice.

The State of ____ has enacted a number of laws and programs to encourage the use of small-scale renewable energy systems including rebates, net metering, property tax exemptions, tax credits, and solar easements [as appropriate]. However, many existing zoning ordinances contain restrictions which, while not intended to discourage the installation of small wind turbines, can substantially increase the time and costs required to obtain necessary construction permits.

Therefore, we find that it is necessary to standardize and streamline the proper issuance of building permits for small wind energy systems so that this clean, renewable energy resource can be utilized in a cost-effective and timely manner.

SECTION 3 DEFINITIONS:

Small Wind Energy System: A wind energy conversion system consisting of a wind turbine, a tower, and associated control or conversion electronics, which has a rated capacity of not more than [100 kW/1 MW] and which is intended primarily to reduce on-site consumption of utility power.

27. Available online at: *www.awea.org/smallwind/documents/modelzo.html*

Tower Height: The height above grade of the fixed portion of the tower, excluding the wind turbine itself.

SECTION 4 PERMITTED USE:

Small wind energy systems shall be a permitted use in all zoning classifications where structures of any sort are allowed, subject to certain requirements as set forth below:

4.1 Tower Height: For property sizes between ½ acre and one acre the tower height shall be limited to [80 ft/150 ft]. For property sizes of one acre or more, there is no limitation on tower height, except as imposed by FAA regulations.

4.2 Set-back: No part of the wind system structure, including guy wire anchors, may extend closer than ten (10) feet to the property boundaries of the installation site.

4.3 Noise: For wind speeds in the range of 0-25 mph, small wind turbines shall not cause a sound pressure level in excess of 60 dB(A), or in excess of 5 dB(A) above the background noise, whichever is greater, as measured at the closest neighboring inhabited dwelling. This level, however, may be exceeded during short-term events such as utility outages and severe wind storms.

4.4 Approved Wind Turbines: Small wind turbines must have been approved under the Emerging Renewables Program of the California Energy Commission or any other small wind certification program recognized by the American Wind Energy Association.

4.5 Compliance with Uniform Building Code: Building permit applications for small wind energy systems shall be accompanied by standard drawings of the wind turbine structure, including the tower, base, and footings. An engineering analysis of the tower showing compliance with the Uniform Building Code and certified by a licensed professional engineer shall also be submitted. This analysis is frequently supplied by the manufacturer. Wet stamps shall not be required.

4.6 Compliance with FAA Regulations: Small wind energy systems must comply with applicable FAA regulations, including any necessary approvals for installations close to airports.

4.7 Compliance with National Electric Code: Building permit applications for small wind energy systems shall be accompanied by a line drawing of the electrical components in sufficient detail to allow for a determination that the manner of installation conforms to the National Electrical Code. This information is frequently supplied by the manufacturer.

4.8 Utility Notification: No small wind energy system shall be installed until evidence has been given that the utility company has been informed of the customer's intent to install an interconnected customer-owned generator. Off-grid systems shall be exempt from this requirement.

Examples of State Zoning and Easement Laws:

See AWEA's online toolbox for links to California, Minnesota, Montana and Nebraska policies:

www.awea.org/smallwind/toolbox/default.asp

Best Practices for Counties

The following recommendations are based on California counties' experiences with small wind turbine installations since the California Energy Commission's Emerging Renewable Program was put in place in 1998. They are lessons learned through counties' responses to AB 1207 and the experiences of pioneering consumers attempting to install wind generators.

Do's and Don'ts

The Do's:

- Remember that small wind turbines reduce the threat of blackouts in your community, contribute to national security, and reduce dependence on polluting forms of electric generation. Small wind turbines are community assets, not toys or hobbies.
- Make sure that your fee structure isn't discouraging potential wind turbine buyers. Ideally, total permitting costs should not exceed two percent of the original capital cost of a small wind turbine.
- Consider following the example of San Bernardino County by allowing turbine towers to exceed the state's minimum height allowances in rural areas.
- Review design integrity of wind turbine towers, with standard drawings and an engineering analysis showing compliance with national or state building codes and certified by a licensed professional engineer.
- Identify a model project to set a high standard for future applicants and to prepare staff to address misconceptions about small wind turbines.
- When in doubt, refer to the language of AB 1207 regarding height restrictions and other rules.

The Don'ts:

- Don't supersede FAA lighting requirements. Small wind turbine towers are usually below heights regulated by the FAA or state aviation law.
- Don't require all small wind turbine applicants to obtain a conditional use permit. Instead, create a permitted use designation with appropriate requirements and restrictions.
- Don't arbitrarily prohibit wind turbines on all ridgelines. Consider the particular merits of individual sites.
- Don't require that all small wind turbines "blend in with their environments." Require such mitigation only when there is a clear public benefit.
- Don't require consumers to post a bond or performance security for removal of small wind turbines. No such obligation is required for any other type of privately financed infrastructure.
- Don't require fencing unless public safety is an issue of particular concern at a given site, or unless similar fencing is required for other similar types of structures (cell phone or amateur radio towers).

IV. REFERENCES AND RESOURCES

Publications and Websites

American Wind Energy Association — Small Wind
http://www.awea.org/smallwind.html
Comprehensive resource on wind energy and energy systems. Includes:

- State-by-state wind energy pages
  www.awea.org/smallwind/index.html
- Small wind toolbox resource for individuals seeking to install a small wind system or for those interested in improving opportunities for small wind energy use.
  www.awea.org/toolbox/default.asp

Buying a Small Wind Electric System — A California Consumer's Guide
Developed for the California Energy Commission by Evergreen Energy LLC and its principals, Tom Starrs and Rob Harmon. (February 2002)
www.energy.ca.gov/renewables/marketing/2002-04-6_WIND_GUIDE.PDF

California Energy Commission — Renewable Energy Program
Renewable energy resources and information for residents of California.
www.consumerenergycenter.org

California Energy Network
Designed to facilitate the installation of wind and solar energy in California, as part of a multi-faceted consumer education program.
www.energybuilder.calenergy.org/

Database of State Incentives for Renewable Energy
Online database compiled by the Interstate Renewable Energy Council.
www.dsireusa.org

Federal Aviation Administration
www2.faa.gov

- Advisory Circular 70/7460-1K, Obstruction Marking and Lighting (2/3/00) (ATA-400)
- Advisory Circular 70/7460-2K, Proposed Construction or Alteration of Objects that May Affect the Navigable Airspace (ATA 411)

Home Power Magazine
The hands-on journal of home-made power.
www.homepower.com

- Issue #90 includes Mick Sagrillo's article "Apples and Oranges: Choosing a Home-Sized Wind Generator."
  www.homepower.com/files/hp90-50.pdf

Iowa Energy Center — Wind Energy Manual
An online manual that walks you through the considerations involved with setting up a small wind system. Written for Iowa residents, but generally applicable.
www.energy.iastate.edu/renewable/wind/wem/wem-01_print.html

Renewable Energy Atlas of the West
Depicts in full color the renewable energy resources of 11 western states, including high-resolution wind maps that are searchable in the online version. Profiles wind, solar, geothermal, and biomass potential. From the Land and Water Fund of the Rockies, Black Graphics, NWSEED, and GreenInfo Network. (July 2002)
www.energyatlas.org

Wind Maps.org
High-resolution maps of wind energy potential in the Pacific Northwest. Resource estimates are accessible to the public through an interactive Geographic Information System (GIS) website.
www.windmaps.org

Wind Power for Farm, Home & Business
Comprehensive review of wind energy from micro wind turbines to megawatt machines, including site selection, installation, and operation. Other books by Paul Gipe include **Wind Energy Basics** and **Wind Energy Comes of Age.**
www.chelseagreen.com

Windustry — Wind Energy Basics
Basic information on wind energy and small wind project resources for rural and urban landowners.
www.windustry.com/basics/default.htm

Agencies and Incentive Programs

California Energy Commission
Renewable Energy Program
1516 Ninth Street, MS-45
Sacramento, CA 95814-5512
Phone: (800) 555-7794 (in California)
or (916) 654-4058 (outside California)
www.energy.ca.gov

- **Emerging Renewables Program**
  The California Energy Commission offers rebates of up to $2.30 per watt of qualified small wind turbines (up to 10 kW) for customers of Southern California Edison, Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Bear Valley Electric. Program funding was extended until at least 2012 by recent legislation.

  E-mail: renewable@energy.state.ca.us
  www.consumerenergycenter.org/erprebate

- **Guidebook for the Emerging Renewables Program**
  Covers all aspects of the rebate program, including eligibility requirements (for consumers and equipment), incentives, application rules, and forms.
  www.consumerenergycenter.org/erprebate/forms

- **List of Certified Small Wind Turbines**
  www.consumerenergycenter.org/erprebate/eligible_smallwind.html

- **List of Registered Small Wind Turbine Dealers**
  www.consumerenergycenter.org/erprebate/retailers.html

U.S. Department of Energy

- **Wind Energy Program**
  Provides information on the latest small wind turbine research, homeowner information, wind energy basics, answers to frequently asked questions, and links to wind publications and organizations.
  www.eere.energy.gov/wind

- **Wind Powering America**
  Compiles state wind maps, small wind consumer's guides, wind workshops, and much more. Visit the "Regional Activities" section to read news articles, press releases, and fact sheets.
  www.eere.energy.gov/windpoweringamerica

Nonprofit Organizations

American Solar Energy Society (ASES)
National organization dedicated to advancing the use of solar energy for the benefit of U.S. citizens and the global environment. ASES promotes the widespread near-term and long-term use of solar energy.
www.ases.org

American Wind Energy Association (AWEA)
Advocating the development of wind energy as a reliable, environmentally superior energy alternative in the United States and around the world.

122 C Street, NW, Suite 380
Washington, DC 20001
Phone: (202) 383-2500
www.awea.org

Golden State Power Cooperative
Helping California communities use the cooperative business model to own and operate their own nonprofit, member-controlled energy co-ops to ensure honest, efficient, affordable and reliable service.

14619 Hamlin Street
Van Nuys, CA 91411
Phone: (818) 988-8690
www.gspower.org

Interstate Renewable Energy Council (IREC)
Dedicated to accelerating the sustainable utilization of renewable energy sources and technologies in and through state and local government and community activities.

P.O. Box 1156
Latham, New York 12110-1156
Phone: (518) 458-6059
www.irecusa.org

Northwest Sustainable Energy for Economic Development (Northwest SEED)
Supports and develops creative programs, policies, and financing approaches to build rural economies and meet the Pacific Northwest's power needs through affordable, renewable energy generation.

119 1st Ave South, Ste. #400
Seattle, WA 98104
Phone: (206) 328-2441
www.nwseed.org

Union of Concerned Scientists
Independent alliance of concerned citizens and scientists committed to building a cleaner, healthier environment and a safer world. UCS analyzes and advocates energy solutions that are sustainable both environmentally and economically, with a focus on supporting policies that let renewables compete successfully.

2 Brattle Square
Cambridge, MA 02138-9105
Phone: (617) 547-5552
www.ucsusa.org

California Utility Companies

Pacific Gas and Electric Company
Phone: (415) 973-2628
www.pge.com

- Net Metering:
  www.pge.com/gen/retail_gen_net_metering.shtml
- Utility Tariff:
  www.pge.com/customer_services/business/tariffs/pdf/ER21.pdf

San Diego Gas & Electric Company
Phone: (858) 650-6166
www.sdge.com/Small_Wind_Electric_Systems

- Net Metering:
  www.sdge.com/net_metering.html
- Utility Tariff:
  www.sdge.com/tm2/pdf/ERULE21.pdf

Southern California Edison Company
Phone: (626) 302-6242 or (626) 302-9680
www.sce.com

- Interconnection Application Form:
  www.sce.com/sc3/002_save_energy/002k_gen_your_own_power/nemfaq.htm
- Utility Tariff:
  www.sce.com/NR/sc3/tm2/pdf/Rule21.pdf

For other utilities in California contact:
The California Public Utility Commission
www.cpuc.ca.gov/

County Planning and Permitting Contacts

For additional county information contact: Willie Beaudet of the California State Association of Counties at (916) 327-7500 x 517

Alameda County Planning Department
James Sorensen, Planning Director
399 Elmhurst Street
Hayward, CA 94544

Alpine County Planning Department
Brian Peters, Director
17300 State Highway 89
Markleeville, CA 96120

Amador County Land Use Agency
Susan C. Grijalva, Chief Planner
500 Argonaut Lane
Jackson, CA 95642-9534

Butte County, Department of Development Services Planning Division
Tom Parillo, Director
7 County Center Drive
Oroville, CA 95965

Calaveras County Community Development
Kim Hansen, Director
891 Mountain Ranch Road
San Andreas, CA 95249

Colusa County Department of Planning and Building
Steven Hackney, Director
220 12th Street
Colusa, CA 95932

Contra Costa County Community Development Department
Dennis M. Barry, Interim Director
651 Pine Street, 4th Floor
North Wing
Martinez, CA 94553

Del Norte County Community Development Department
Ernest Perry, Director
700 5th Street
Crescent City, CA 95531

El Dorado County Planning Department
Conrad B. Montgomery, Director
2850 Fairlane Court
Placerville, CA 95667

Fresno County Public Works and Development Services Department
Carolina Jimenez-Hogg, Director
Planning & Resources
2220 Tulare Street, 8th Floor
Fresno, CA 93721

Glenn County Resource Planning and Development Department
John Benoit, Director
125 South Murdock Street
Willows, CA 95988

Humboldt County Planning
Stephen R. Nielson, Acting Director
3015 H Street
Eureka, CA 95501

Imperial County Planning/ Building Department
Jurg Heuberger, Planning Director
939 Main Street
El Centro, CA 92243

Inyo County Planning Department
Chuck Thistlethwaite, Director
P.O. Drawer L
Independence, CA 93526

Kern County Planning Department
Ted James, Director
2700 M Street, Suite 100
Bakersfield, CA 93301

Kings County Planning Agency
William R. Zumwalt, Director,
Planning and Building Inspection
Kings County Government Center
Hanford, CA 93230

Lake County Community Development Department, Planning Division
Robert Cervantes, Director
255 North Forbes Street
Lakeport, CA 95453

Lassen County Department of Community Development
Robert K. Sorvaag, Director
707 Nevada Street, Suite 500
Susanville, CA 96130

Los Angeles County Department of Regional Planning
James E. Hartl, Director
320 West Temple Street
Los Angeles, CA 90012

Madera County Planning Department
Leonard Garoupa, Director
135 West Yosemite Avenue
Madera, CA 93637-3593

Marin County Community Development Agency, Planning Division
Alex Hinds, Director
3501 Civic Center Drive, Rm 308
San Rafael, CA 94903

Mariposa County Planning Department
Eric Toll, Director
PO Box 2039
Mariposa, CA 95338

Mendocino County Planning & Building Services Department
Raymond Hall, Director
501 Low Gap Road, Rm. 1440
Ukiah, CA 95482

Merced County Association of Governments
Bill Nicholson, Director
369 West 18th Street
Merced, CA 95340

Modoc County Planning
Scott Kessler, Planning Director, AICP
202 West Fourth Street
Alturas, CA 96101

Mono County Planning Department
Scott Burns, Director
PO Box 347
Mammoth Lakes, CA 93546

Monterey County Planning & Building, Inspection Department
William L. Phillips, Director
PO Box 1208
Salinas, CA 93902

Napa County Conservation Development and Planning Department
Charles Wilson, Director
1195 Third Street, Room 210
Napa, CA 94559

Nevada County Planning Department
Mark Tomich, Director
950 Maidu Avenue
Nevada City, CA 95959

Orange County Planning and
Development Services Department
Thomas B. Matthews, Director
PO Box 4048
Santa Ana, CA 92702-4048

Placer County Planning Department
Fred Yeager, Director
11414 B Avenue
Auburn, CA 95603

Plumas County Planning Department
John S. McMorro, Director
520 Main Street, Room 121
Quincy, CA 95971

Riverside County Transportation
and Land Management
Agency/Planning Department
Aleta J. Laurence, Planning Director
PO Box 1409
Riverside, CA 92502-1409

Sacramento County Planning and
Community Development Department
Thomas W. Hutchings, Director
827 7th Street, Room 230
Sacramento, CA 95814

San Benito County Planning Department
Rob Mendiola, Director
3220 Southside Road
Holister, CA 95023

San Bernardino County
Land Use Services Department
Michael E. Hays, Director
385 North Arrowhead Avenue
3rd Floor
San Bernardino, CA 92415-0182

San Diego County Department of
Planning and Land Use
Gary L. Pryor, Director
5201 Ruffin Road, Suite B
San Diego, CA 92123-1666

San Francisco Planning Department
Gerald G. Green
1660 Mission Street
San Francisco, CA 94103

San Joaquin County
Community Development Department
Chet Davisson, Director
1810 East Hazelton Avenue
Stockton, CA 95205

San Luis Obispo County
Department of Planning and Building
Victor Holanda, Director
County Government Center
San Luis Obispo, CA 93408

San Mateo County Environmental
Services Agency,
Planning and Building Division
Terry Burnes, Planning Administrator
590 Hamilton Street, 2nd Floor
Redwood City, CA 94063

Santa Barbara County Planning
and Development
Valentin Alexeef, Director
123 East Anapamu Street
Santa Barbara, CA 93101-2058

Santa Clara County Department of
Planning and Development
Michael M. Lopez, Office Manager
70 West Hedding Street
7th Floor, East Wing
San Jose, CA 95110

Santa Cruz County Planning Department
Alvin James
701 Ocean Street, Room 400
Santa Cruz, CA 95060

Shasta County Department of Resource
Management Planning Division
Russ Mull
Director of Resource Management
1855 Placer Street
Redding, CA 96001

Sierra County Department of Planning
Tim H. Beals, Director
PO Box 530, Downieville, CA 95936

Siskiyou County Planning Department
Richard D. Barnu, Director
PO Box 1085, Yreka, CA 96097-1085

Solano County Department of
Environmental Management
Christopher Monsk
Planning Program Manager
601 Texas Street, Fairfield, CA 94533

Sonoma County Permit & Resource
Management Department
Pete Parkinson, Director
2550 Ventura Avenue
Santa Rosa, CA 95403

Stanislaus County Department of
Planning and Community Development
Ron E. Freitas, Director
1100 H Street
Modesto, CA 95354-2380

Sutter County Community Services
Department, Planning Division
Tom Las, Principal Planner
1160 Civic Center Blvd., Suite E
Yuba City, CA 95993

Tehama County Planning Department
George W. Robson, Director
444 Oak Street, Room 1
Red Bluff, CA 96080

Trinity County Planning Department
John Alan Jelicich, Director
PO Box 2819
Weaverville, CA 96093-2819

Tulare County Resource
Management Agency
George E. Finney, Planning Director
5961 South Mooney Blvd.
Visalia, CA 93277

Tuolumne County Planning Department
Bev Shane, Director
2 South Green Street
Sonora, CA 95370

Ventura County Planning Division,
Resource Management Agency
Keith Turner, Director
800 South Victoria Avenue
Ventura, CA 93009

Yolo County Community
Development Agency
John Bencome, Director
292 West Beamer Street
Woodland, CA 95695

Yuba County Community
Development Department
James P. Manning, Director
938 14th Street
Marysville, CA 95901

Small Wind Turbine Manufacturers and Distributors

Abundant Renewable Energy
(Distributor, African Wind Power generators)
22700 NE Mountain Top Rd.
Newberg, OR 97132
Phone: (503) 538-8292
www.abundantre.com

Aeromax Corporation
(Distributor, Lakota Turbines)
9234 E. Valley Rd., Suite E
Prescott Valley, AZ 86314
Phone: (888) 407-9463
www.aeromaxenergy.com

Atlantic Orient Corporation
P.O. Box 832, 49 Pownal Street
Charlottetown, P.E.I., C1A 7L9
(Prince Edward Island, Canada)
Phone: (902) 368-7171
www.aocwind.net

Bergey Windpower Company*
2001 Priestley Ave.
Norman, OK 73069 USA
Phone: (405) 364-4212
www.bergey.com

Southwest Windpower*
2131 N. First Street
Flagstaff, AZ 86004 USA
Phone: (928) 779-9463
www.windenergy.com

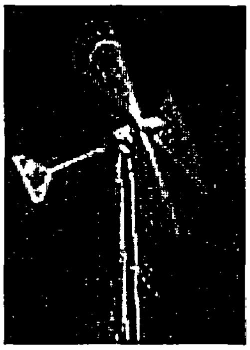
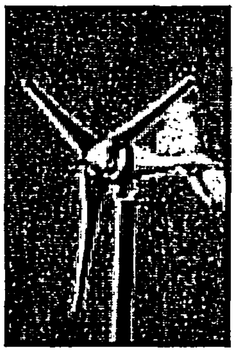


Photo courtesy Bergey Windpower


Courtesy Southwest Windpower


Courtesy Wind Turbine Industries Corp.

Point Power Systems
843 Sevely Drive
Mountain View, CA 94041 USA
Phone: (616) 304-3374
www.abrivo.com

Wind Turbine Industries Corporation*
(manufacturer, Jacobs® Wind Energy Systems)
16801 Industrial Circle S.E.
Prior Lake, MN 55372
Phone: (952) 447-6064
www.windturbine.net

Solar Wind Works
(distributor, Proven Wind Turbines)
16713 Greenlee Road
Truckee, CA 96161
Phone: (530) 582-4503
www.solarwindworks.com

* manufacturer of California Energy Commission certified wind turbines

CALIFORNIA ENERGY COMMISSION
ANNUAL WIND SPEED at
30 METER ELEVATION
Legend
Wind Resource
Mean Speed
MPH m/s
< 10.1 < 4.5
10.1 - 11.2 4.5 - 5.0
11.2 - 12.3 5.0 - 5.5
12.3 - 13.4 5.5 - 6.0
13.4 - 14.5 6.0 - 6.5
14.5 - 15.7 6.5 - 7.0
15.7 - 16.8 7.0 - 7.5
16.8 - 17.9 7.5 - 8.0
17.9 - 19.0 8.0 - 8.5
> 19.0 > 8.5
50 0 50 100

CALIFORNIA WIND POTENTIAL BY COUNTY

Based on 2002 California Energy Commission Wind Map Data

COUNTY	ACRES IN WIND CLASS 2-7*	% OF COUNTY IN WIND CLASS 2-7	ACRES WITH PRIME SMALL WIND DEVELOPMENT POTENTIAL**
San Bernardino	7,075,745	55%	610,514
Kern	1,588,973	30%	253,198
Imperial	1,082,929	38%	181,088
Riverside	2,144,764	46%	170,398
Los Angeles	1,038,075	40%	142,800
Solano	428,505	75%	120,651
Inyo	2,108,495	32%	112,311
San Diego	807,947	30%	62,026
Siskiyou	552,615	14%	24,937
Ventura	445,338	37%	22,312
Alameda	61,480	13%	15,545
Santa Barbara	514,992	29%	12,024
Lassen	474,358	16%	10,035
Mono	566,010	28%	9,268
Mendocino	189,666	8%	7,987
Modoc	398,353	15%	5,867
Contra Costa	97,774	20%	5,631
Shasta	341,459	14%	4,996
Humboldt	315,672	14%	4,607
Plumas	174,705	10%	4,110
Del Norte	145,231	22%	3,872
Marin	101,352	30%	3,767
San Joaquin	64,952	7%	3,526
San Luis Obispo	171,523	8%	2,881
Sierra	97,198	16%	2,137
Tehama	413,119	22%	2,135
Lake	67,725	8%	1,887
Sonoma	91,282	9%	1,782
Alpine	133,647	28%	1,677
Yolo	433,990	66%	1,577
Monterey	214,720	10%	1,544
Orange	99,737	20%	1,459
Butte	207,861	19%	761
Trinity	132,566	6%	740
Colusa	104,854	14%	635
Merced	90,180	7%	616
El Dorado	69,247	6%	579
Nevada	37,211	6%	494
San Benito	44,056	5%	447
Tulare	159,285	5%	443
Napa	34,977	7%	437
Placer	61,108	6%	425
Sutter	72,014	18%	292
Fresno	130,694	3%	267
San Mateo	61,647	21%	225
Santa Clara	14,704	2%	217
Stanislaus	28,750	3%	175
Glenn	170,009	20%	116
Kings	7,184	1%	108
Tuolumne	108,706	7%	91
Amador	7,621	2%	83
Calaveras	8,540	1%	69
Mader	35,731	3%	57
Santa Cruz	13,600	5%	7
San Francisco	12,900	43%	2
Sacramento	102,566	16%	-
Mariposa	7,091	1%	-
Yuba	726	-	-
TOTAL	24,029,276	24%	1,815,826

* At least 11.5 mph at 30 meters above ground

** At least 13.3 mph at 30 meters above ground (wind classes 3-7); urban areas, water bodies, protected land and <20% slopes are excluded

CALIFORNIA WINDIEST ZIP CODES BY REGION

Based on 2002 California Energy Commission Wind Map Data

Northern California

TOP ZIP CODES BY WIND DENSITY*

95538	95958	95551	96035	95917	95974	96078	96090
96094	96021	96092	95913	95564	95970	95589	95536
95963	96067	95943	95938	95558	96112	96071	96104
96038	95920	95982	95531				

TOP ZIP CODES BY PRIME SMALL WIND DEVELOPMENT ACREAGE**

94571	94585	95620	95687	94550
94514	94512	95468	95376	93514
95459	94533	93517	96107	96120
93546	94923	95457	94971	95694
94952	94929	95443	94510	93635

Central California

TOP ZIP CODES BY WIND DENSITY*

94535	94512	94966	94083	94104	94105	94123	94128
95625	95639	95680	94929	95697	94030	94571	95615
95612	95618	95641	94108	94133	94066	95690	95620
94923	95776	94005	95687	94107	94080	94937	94109
94971	94130	95698	94129	94510	95695	95616	95694
94940	94134	94585	94514	95837	94111	94565	95645
94965	94533	95937	94121	95931	94127	94525	94038
94103	94115	94014	95627	94124	94018	95688	94561
94015	94592	94131	95832	94555	95691	94924	95424
96107	94010	95950	95606	95912	95957	94521	95242
94117	94941	94112	94118	93517	95468	95450	94591
94019	93529	95721	96120				

TOP ZIP CODES BY PRIME SMALL WIND DEVELOPMENT ACREAGE**

96094	96064	95531	96065	96134
95536	96112	95543	96101	96130
96108	96054	95587	96013	96056
96115	95549	96114	96069	96104
96109	95987			

Southern California

TOP ZIP CODES BY WIND DENSITY*

93062	93021	92335	92377	91326	91330	91752	92323
92366	92398	93020	93042	93044	92336	92327	92316
91304	93502	92258	91310	91948	92509	91311	92378
91739	93551	92241	93534	92337	91324	93501	92240
93536	92376	91351	93528	92808	91362	93063	91905
93065	93532	92230	92501	92222	91307	91344	93554
92602	92282	91350	92285	92862	92223	92807	92259
93542	92365	93519	91384	92308	93243	92329	93505
93527	92267	93066	92284	92340	92252	93043	93560
91962	92312	93510	93504	92310	91325	91321	92203
92886	91934	92322	92326	92276	92304	91340	93552
93550	92338	92364	90265	92066	92278	91360	92887
92311	91760	92356	92220	93033	93012	92869	92345
91342	92283	92555	92239	91931	92262	92280	91301
92505	92610	92277	93437	92536	92004	92823	91320
93950	92036	93283	93555	92341	92676	92407	93041
93545	92332	93429	91306	92618	92392	93255	92371
92709	92404	92256	91709	92363	92561	91761	91331
91720	92539	91759	91963	93561	92582	91906	93436
92405	92314	91710	90704	92325	91980	92307	92620
92384	93117	93035	93960	92317	91381	93015	90272
91916	91343	92320	92352	92391	92339	93518	92242
92065	93516	92385	93240	91042	92782	93040	91361
92328	93434	91303	92070	92867	93543	93441	93953
92368							

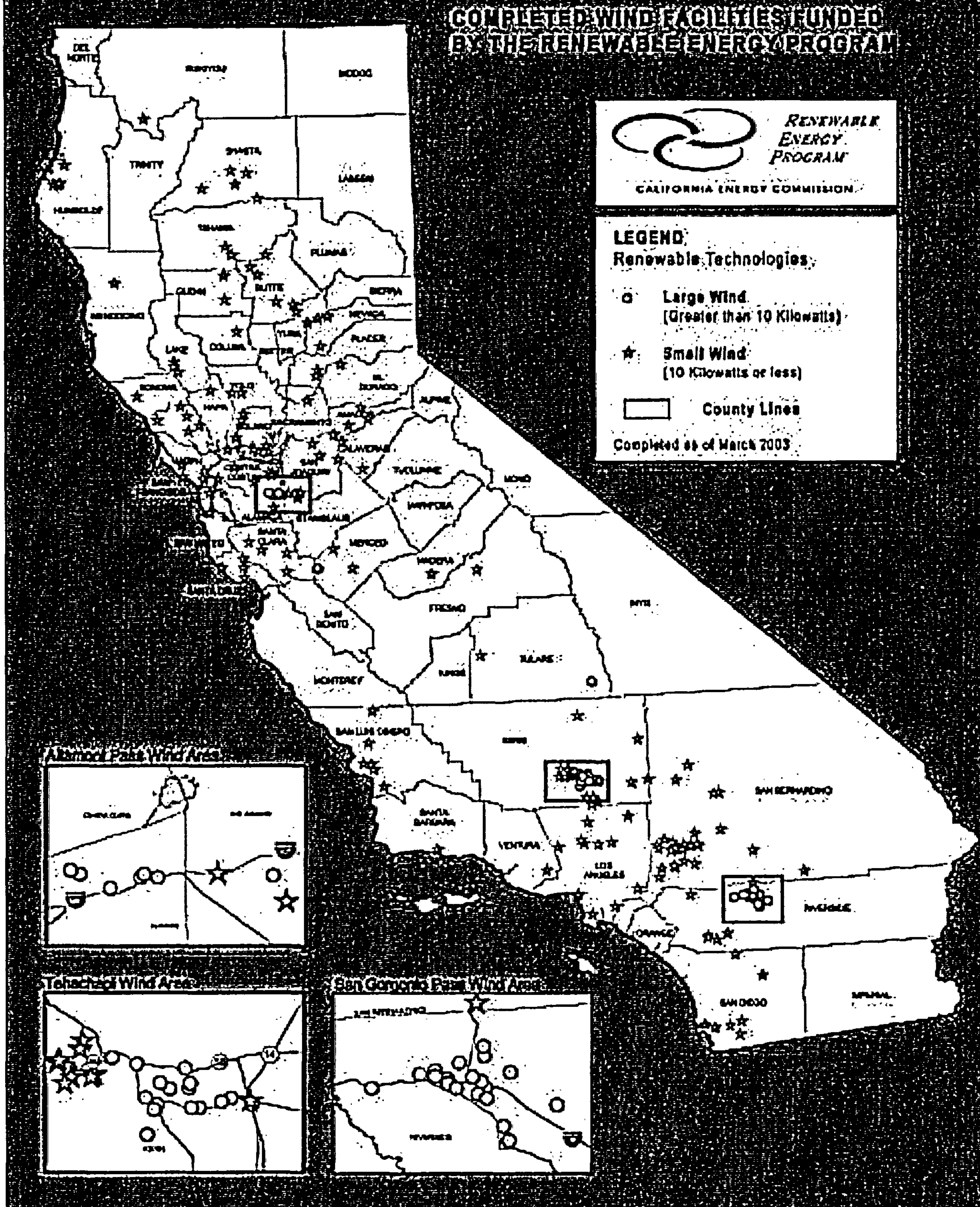
TOP ZIP CODES BY PRIME SMALL WIND DEVELOPMENT ACREAGE**

92283	93536	93555	92365	92310
93501	92239	92363	92364	93560
92338	92304	93545	92332	91905
92278	92277	92285	92384	93527
92259	92311	93519	92241	92240
92004	92223	93021	93505	92220
91350	92230	93551	93436	92407
92327	92280	93550	91384	91962
93243	92356	92308	93561	92274
91906	92066	92262	92070	92555
92582	91720	93518	91934	93203
92036	92282	91752	93283	92377
92314	92267	93437	92336	93065
93066	93510	91739	91351	92561
92284	92509	92536	93532	92065
93452	93225	93063	92371	92242
92316	92539	92376	93552	92307
91342	92276	93920	92252	92544
93429	92309	90704	92086	91710
92320	91311	93255	93453	92347
93117	92258	91948	93020	92323
92366				

* 30% or more of land in Wind Class 2-7 (at least 11.5 mph at 30 meters above ground)

** At least 500 acres or at least 10% of land in Wind Class 3-7 (at least 13.3 mph at 30 meters above ground); urban areas, water bodies, protected land and <20% slopes are excluded

CALIFORNIA ENERGY COMMISSION



SMALL WIND ENERGY INSTALLATIONS BY COUNTY

196 small wind turbines have been installed in 40 of California's 58 counties under the Emerging Renewables Program, for a total of 862.1 kW installed capacity as of March 31, 2003.

Source: California Energy Commission

Pacific Gas and Electric Company

TOTAL NUMBER OF UNITS COMPLETED: 108

TOTAL INSTALLED CAPACITY (kW): 373.4 kW

COUNTY	INSTALLED CAPACITY (Watts)	CITY	ZIP CODE	DATE COMPLETED
Alameda	10070			
	630	Albany	94706	16-Aug-02
	9440	Livermore	94550	27-Nov-02
Amador	11331.36			
	472	Sutter Creek	95685	08-Nov-01
	453.12	Pioneer	95666	27-Nov-01
	453.12	Ione	95640	10-Jan-02
	453.12	Ione	95640	18-Jan-02
	9500	Fiddletown	95629	28-Aug-02
Butte	14457.5			
	855	Chico	95926	11-Jun-99
	2850	Oroville	95965	07-Mazr-02
	2820	Cohassett	95926	13-May-02
	2850	Oroville	95966	28-Jun-02
	2232.5	Chico	95973	25-Nov-02
	2850	Bangor	95914	26-Dec-02
Calaveras	12380			
	2880	Copperopolis	95228	08-Jun-01
	9500	Burson	95225	31-Jan-03
Colusa	2820			
	2820	Colusa	95932	04-Sep-02
Contra Costa	24010			
	9600	Brentwood	94513	28-Jun-00
	9200	Clayton		14-Jan-02
	470	Brentwood	94513	25-Feb-02
	4740	Brentwood	94513	05-Feb-03
El Dorado	3384			
	3384	Greenwood	95635	20-Nov-00
Fresno	443			
	443	Tollhouse	93667	15-May-00
Glenn	9943.68			
	443.68	Willows	95988	08-Aug-01
	9500	Orland	95963	14-Nov-01
Humboldt	38762			
	846	Freshwater	95503	25-Sep-00
	9200	Ferndale	95536	10-Dec-01
	9200	Ferndale	95536	21-Dec-01
	9200	Ferndale	95536	21-Dec-01
	9200	Alton	95540	26-Dec-01
	1116	Fortuna	95540	18-Oct-02
Lake	3167			
	887	Kelseyville	95451	18-Dec-00
	1140	Kelseyville	95451	27-Nov-01
	1140	Kelseyville	95451	27-Nov-01
Madera	3988			
	1756	Raymond	93653	26-Jul-02
	2232	Madera	93638	04-Sep-02
Marin	1344.8			
	448.4	Lagunitas	94938	11-Jul-01
	448.4	Bolinas	94924	06-Nov-01
	448	Tiburon	94920	04-Mar-02
Mendocino	1888			
	1440	Laytonville	95454	09-Mar-99
	448	Albion	95410	21-Dec-99
Merced	1779.4			
	1331	Gustine	95322	25-Jul-01
	448.4	Los Banos	93635	22-Feb-02
Napa	897			
	897	Pope Valley	94567	12-Jun-00
Nevada	4223.68			
	443.68	Nevada City	95959	11-Oct-01
	960	North San Juan	95960	30-Sep-02
	2820	Grass Valley	95949	27-Nov-02
Placer	4176.48			
	1920	Auburn	95603	07-Dec-99
	1812.48	Loomis	95650	15-Jan-02
	444	Newcastle	95658	13-Aug-02
Sacramento	472			
	472	Rancho Cordova	95670	16-May-01
San Francisco	443.68			
	443.68	San Francisco	94107	08-Nov-01

COUNTY	INSTALLED CAPACITY (Watts)	CITY	ZIP CODE	DATE COMPLETED
San Joaquin	14885.18			
	9500	Tracy	95304	11-Oct-01
	897	Lodi	95240	10-Dec-01
	1812.48	Tracy	95304	21-Feb-02
	2232	Linden	95236	02-May-02
	443.7	Acampo	95220	12-Aug-02
San Luis Obispo	31898			
	285	Arroyo Grande	93420	10-Mar-99
	9200	San Luis Obispo	93401	01-Nov-01
	4013	Atascadero	93422	23-May-02
	9200	Paso Robles	93451	30-May-02
	9200	San Luis Obispo	93405	20-Feb-03
San Mateo	2724			
	972	Pacifica	94044	20-Jan-00
	897	Burlingame	94010	22-Jan-02
	855	Pacifica	94044	24-Jan-02
Santa Barbara	1116			
	1116	Santa Ynez	93463	01-Aug-02
Santa Clara	11245			
	887	San Jose	95117	25-Jan-01
	1359	San Jose	95123	10-Jan-02
	2850	Gilroy	95020	14-Jan-02
	2242	Morgan Hill	95037	28-Jun-02
	2151	Morgan Hill	95037	28-Jun-02
	1756	Morgan Hill	95037	22-Jul-02
Santa Cruz	11235.12			
	376	Los Gatos	95033	22-Sep-00
	453.12	Davenport	95017	11-Oct-01
	9500	Santa Cruz	95066	06-Nov-01
	906	Santa Cruz	95060	29-Nov-01
Shasta	20415			
	887	Whitmore	96096	08-Jun-01
	9200	Redding	96001	25-Feb-02
	9200	Bela Vista	96008	18-Dec-02
	1128	Redding	96062	23-Jan-03
Siskiyou	9200			
	9200	Corning	96031	01-Nov-02
Solano	58764			
	9600	Rio Vista	94571	20-Jan-00
	10000	Birds Landing	94512	16-Aug-00
	9200	Suisun	94585	23-Oct-01
	9200	Suisun	94585	01-Nov-01
	9600	Suisun	94585	02-Nov-01
	9600	Vallejo	94591	15-Nov-01
	448	Martinez	94533	30-Apr-02
	1116	Vacaville	95688	19-Jul-02

COUNTY	INSTALLED CAPACITY (Watts)	CITY	ZIP CODE	DATE COMPLETED
Sonoma	26667.4			
	453	Santa Rosa	95404	01-Nov-99
	2880	Occidental	95465	13-Aug-01
	2054.4	Penngrove	94951	27-Aug-01
	9200	Glen Ellen	95442	05-Aug-02
	9200	Casadero	95421	14-Aug-02
	2880	Santa Rosa	95404	09-Oct-02
Tehama	14250			
	5760	Corning	96021	08-Nov-01
	2850	Gerber	96035	16-Nov-01
	2850	Corning	96021	02-May-02
	2790	Manton	96059	06-Sep-02
Yolo	15703.8			
	9600	Winters	95694	01-Nov-99
	4320	Esparto	95627	07-Nov-00
	896.8	Capay	95607	25-Nov-02
	887	Capay	95607	19-Feb-03
Yuba	5277.8			
	331	Oregon House	95962	28-Jun-02
	878	Oregon House	95962	27-Sep-02
	836.8	Oregon House	95962	30-Sep-02
	897	Oregon House	95962	03-Oct-02
	448	Oregon House	95962	06-Dec-02
	887	Oregon House	95962	13-Feb-03

Southern California Electric

TOTAL NUMBER OF UNITS COMPLETED: 83

TOTAL INSTALLED CAPACITY (kW): 479.3 kW

COUNTY	INSTALLED CAPACITY (Watts)	CITY	ZIP CODE	DATE COMPLETED
Kern	140965			
	2880	Rosamond	93560	29-Oct-99
	1410	Tehachapi	93561	01-Nov-99
	7200	Tehachapi	93561	01-Nov-99
	7200	Tehachapi	93561	01-Nov-99
	9500	Tehachapi	93561	18-Apr-00
	9600	South Lake	93240	01-Jun-00
	10000	Tehachapi	93561	02-Aug-00
	384	Rosamond	93560	02-Aug-00
	9500	Tehachapi	93561	05-Mar-01
	9500	Tehachapi	93561	05-Mar-01
	453	North Edwards	93523	17-Jul-01
	448	Tehachapi	93561	25-Jul-01
	9200	Tehachapi	93561	13-Sep-01
	9200	Rosamond	93560	25-Sep-01

COUNTY	INSTALLED CAPACITY (Watts)	CITY	ZIP CODE	DATE COMPLETED
Kern Continued...				
	9200	Tehachapi	93561	27-Nov-01
	9200	Willow Springs	93561	23-Jan-02
	9200	Rosamond	93560	24-Jan-02
	2850	Boron	93516	01-Jul-02
	2820	Ridgecrest	93555	13-Aug-02
	2820	Mojave	93501	04-Dec-02
	9200	Tehachapi	93561	13-Feb-03
	9200	Tehachapi	93561	25-Mar-03
Los Angeles	30750.42			
	1410	Pomona	91768	03-Jun-99
	960	Castaic	91384	09-Aug-01
	1992.72	Norwalk	90650	04-Sep-01
	2850	Lancaster	93536	27-Dec-01
	2850	Sauges	91350	17-Jan-02
	444	Lancaster	93535	16-Jul-02
	443.7	Torrance	90501	01-Aug-02
	2850	Agua Dulce	91350	05-Aug-02
	2850	Acton	93510	27-Aug-02
	5640	Palmdale	93550	19-Dec-02
	5640	Palmdale	93550	19-Dec-02
	2820	Palmdale	93550	21-Jan-03
Riverside	27270			
	3625	Riverside	92509	07-Dec-99
	940	Winchester	92596	18-Apr-00
	960	Winchester	92596	09-May-00
	2395	Temecula	92592	03-Apr-02
	950	Hemet	92545	23-May-02
	9200	Moreno Valley	92557	03-Jan-03
	9200	Moreno Valley	92557	04-Feb-03
San Bernardino	266601			
	897	Alta Loma	91737	21-Dec-99
	897	Hesperia	92345	21-Dec-99
	270	29 Palms	92277	15-Nov-00
	887	Apple Valley	92307	24-May-01
	443	Johnson Valley	92285	30-May-01
	9200	San Bernardino	92407	13-Sep-01
	9500	Oak Hills	92345	13-Sep-01
	9500	Apple Valley	92308	11-Oct-01
	2880	Phelan	92371	11-Oct-01
	9200	Victorville	92392	01-Nov-01
	9500	Hesperia	92345	01-Nov-01
	9200	Phelan	92371	14-Nov-01
	855	Lake Arrowhead	92352	27-Dec-01
	9200	Apple Valley	92308	16-Jan-02
	425	Morongo Valley	92256	14-Feb-02
	9200	Hesperia	92340	15-Feb-02
	9200	Oak Hills	92345	27-Feb-02
	9200	Devore	92407	01-Mar-02
	9200	Hesperia	92345	15-Mar-02
	9200	Phelan	92371	15-Mar-02

COUNTY	INSTALLED CAPACITY (Watts)	CITY	ZIP CODE	DATE COMPLETED
San Bernardino Continued...				
	9200	Barstow	92311	15-Mar-02
	9200	Apple Valley	92308	15-Mar-02
	9200	Hesperia	92345	22-Jul-02
	5700	Barstow	92311	16-Aug-02
	897	Victorville	92392	03-Sep-02
	9200	Apple Valley	92308	17-Sep-02
	9200	Phelan	92371	30-Oct-02
	9200	Phelan	92371	03-Jan-03
	2850	San Bernardino	92407	09-Jan-03
	9200	Apple Valley	92308	15-Jan-03
	9500	Lucerne Valley	92358	04-Feb-03
	9200	Apple Valley	92308	05-Feb-03
	9200	Lucern Valley	92356	05-Feb-03
	9200	Hinkley	92347	11-Feb-03
	9200	Oak Hills	92345	13-Feb-03
	9200	Phelan	92371	19-Feb-03
	9200	Hesperia	92340	21-Feb-03
	9200	Yermo	92398	13-Mar-03
San Diego	2850			
	2850	Ranchita	92066	09-Aug-01
Santa Barbara	9200			
	9200	Goleta	93117	30-Oct-02
Tulare	453.12			
	453.12	Tulare	93274	16-Jan-02
Ventura	1166.9			
	1166.9	Simi Valley	93065	20-Mar-02

San Diego Gas & Electric Company

TOTAL NUMBER OF UNITS COMPLETED: 5

TOTAL INSTALLED CAPACITY (kW): 9.4 kW

COUNTY	INSTALLED CAPACITY (Watts)	CITY	ZIP CODE	DATE COMPLETED
San Diego	9418.8			
	444	El Cajon	92019	22-Sep-00
	2850	Warner Springs	92086	28-Nov-00
	2850	El Cajon	92019	24-May-01
	424.8	San Diego	92111	30-Nov-01
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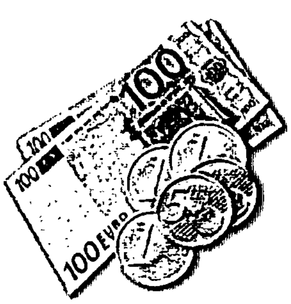
COSTS COMPARED

WIND HAS PLENTY IN RESERVE IN COMPETITIVE COST STAKES



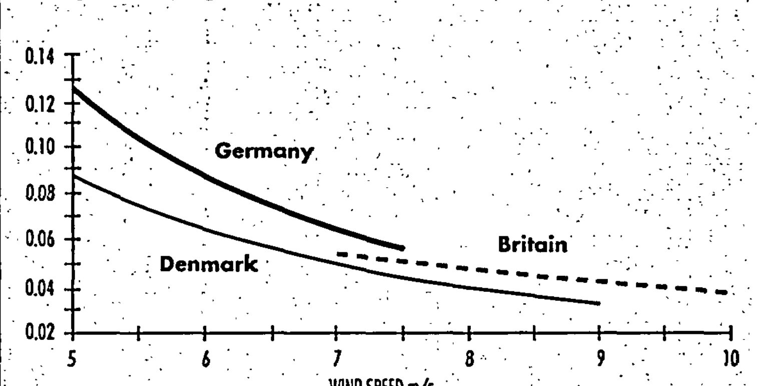
Wind has an impressive track record in delivering price reductions. Plant costs have steadily fallen while productivity has risen—and there is no sign of the momentum slowing. But conventional power plant are getting cheaper and more efficient too. And fuel prices are falling. Can wind keep up? In this article we reveal that the rate of fall in the price of wind is faster than that for competing technologies. Wind energy—so far—has the edge

DAVID MILBORROW
Windpower Monthly Technical Consultant

Every doubling of global wind energy capacity is being accompanied by a 15% reduction in cost. Since world capacity has doubled every three years in the past decade, the downward trend in wind turbine costs is no less than stunning. According to learning curve theory, a reduction in cost of 8-10% for each doubling of manufacturing volume would have been reasonable. What is actually being achieved is well in excess of these expectations.

Alongside the fall in machine costs, the productivity of new turbines has also increased—from around 1300 kWh for each kilowatt of capacity installed in 1983, to over 2000 kWh/kW in 1996. With machine prices falling and energy productivity rising, the cost of producing a wind driven kilowatt hour has fallen rapidly: prices have dropped by a factor of three and energy productivity has increased by 50%, meaning that wind energy prices have fallen by a factor of about 4.5.

The impact of institutional factors 1
Same product, three prices



Capital cost. €850/kW, O&M €17/kW/year+€0.003/kWh

So much for the good news. The bad news is that the competition is also getting cheaper. Similar cost mechanisms are at work in the conventional generation sector. Plant costs are falling and efficiency is rising. Moreover, fuel prices have steadily decreased over the years. The installed costs of combined cycle gas turbines have fallen by about a third in the past eight years and the price of coal delivered to American utilities fell by 40% in the ten years to 1996. Gloomy predictions of fuel shortages are rarely heard these days, so the downward trend in fuel prices looks set to continue. So too, therefore, are generation costs from the conventional thermal sources of electricity. The price of industrial electricity sold in the United States fell by one-third in just ten years, between 1985 and 1995. There is every expectation that these trends will continue, albeit at a slower rate.

THE CRUX OF THE MATTER

The crucial question is whether wind energy can maintain its current high speed progress along the learning curve, thereby firmly securing its newly won status as one of the cheapest technologies around for generating electricity—given enough wind. Before answering that question, the complications of establishing a fair basis for comparing the price of electricity from all the front-runners need to be understood and a method of comparison established.

Most other direct comparisons of the prices of wind and thermal plant do not take embedded generation into consideration. To swim with the stream this analysis also deliberately neglects to account for the benefits of using an energy source, such as wind, which is delivered much closer to the point of use than electricity generated in a large power station. Like-for-like comparisons should really be made taking into account the benefits of embedded generation. Although these vary widely (WINDPOWER

Monthly, April 1998), broadly speaking they bring a price advantage to wind up to about €0.004/kWh.

No single price can be assigned to electricity from any source, wind being no exception. Prices depend on many factors, especially on plant size and location, partly because plant and fuel costs vary across borders and partly because of differing institutional frameworks. Denmark and Germany might be next door neighbours, but that does not mean that electricity prices, or even wind prices, are the same. Indeed, while wind appears to be cheaper than thermal plant in Denmark, that does not necessarily mean it will also be cheaper in the United States or Great Britain, even at sites with the same wind resource.

THE INSTITUTIONAL FACTORS

Wind prices vary not only with wind speed, but also with institutional factors, which is why the same product ends up with three different prices in Germany, Britain and Denmark (figure 1). Denmark's public sector utilities often calculate wind energy prices assuming an interest rate of 6%, net of inflation (the "real" interest rate) and that capital costs can be written off over the life of the plant, say 20 years. Thus the Danish price, €0.093/kWh in low winds, dropping to €0.038/kWh at an 8.5 m/s site, is consistently cheaper than for Britain and Germany.

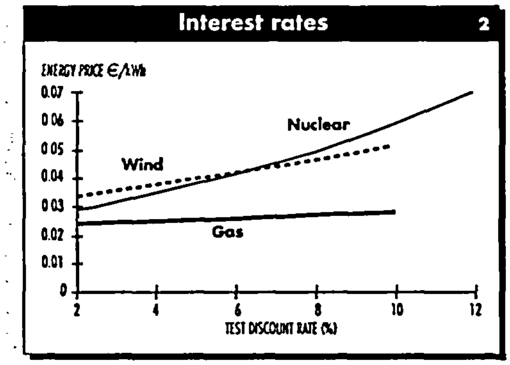
Prices in Britain are slightly higher because the contracts for premium payments run for a shorter period—15 years—and the private sector developers use interest rates from about 8% upwards. So a project on a 7 m/s site—even if it costs the same to build—will need €0.054/kWh in Britain, compared with €0.0472/kWh in Denmark, to achieve an acceptable rate of return. High wind speeds in Britain, however, mean that prices fall to around €0.038/kWh on a 10 m/s site.

In Germany, most wind installations are funded by private developers who obtain money from the Deutsche Ausgleichsbank, with a loan period of ten years. What's more, the loan is typically for only 80% of the total cost. The remaining 20% is "equity" and most equity investors expect higher rates of return and 10% upwards is usual. The net result is that German wind energy prices appear to be significantly higher than those in Denmark. So a wind farm, again on a 7 m/s site, will need about €0.064/kWh in Germany, 35% more than in Denmark. Moreover, the lower wind speeds in Germany, meaning less energygenerated per kilowatt, widens the apparent discrepancy even further; most wind plant operate with wind speeds around 6 m/s, and the corresponding energy price is around €0.085/kWh.

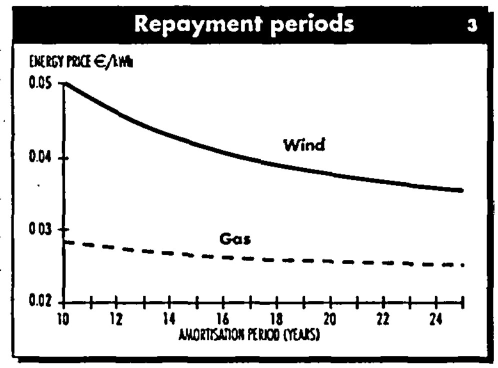
When the price of wind is such a clearly variable quantity, it is hardly surprising that the price of electricity from thermal and nuclear sources is just as difficult to pin down, especially when thermal plant costs are influenced by fuel prices too. For this article, data is drawn from a series of recognised sources. Making comparisons between all the sources is complicated, in particular, by interest rates. These have a decisive influence, especially on capital intensive technologies like wind and nuclear compared with gas, the cheapest of the thermal sources, where the cost of fuel is the overriding price element. Wind is more sensitive to interest rates than gas, but less sensitive than nuclear (figure 2). The price of electricity from gas fired plant is only slightly sensitive to interest rates, simply because the capital cost of the plant does not figure prominently in the price calculation. Wind, along with nuclear, is capital intensive because the bulk of its price is dictated by the capital payments.

It all adds to the cost

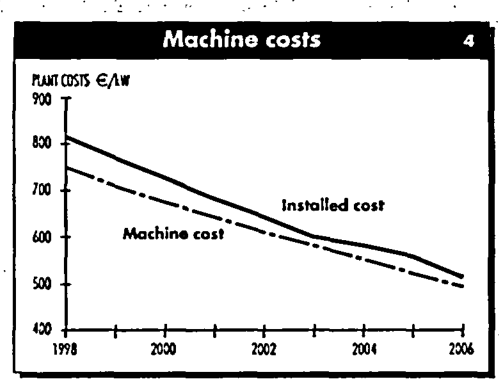
Factors influencing wind's market price



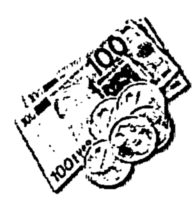
Nuclear: €1980/kW, build time six years, O&M €0.012/kWh; Wind: €850/kW, build six months, O&M €17/kW/year + €0.003/kWh; Gas: €400/kW, build one year, gas price €0.007/kWh, O&M €0.004/kWh



Based on 8% test discount rate in each case

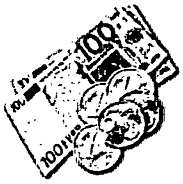


SOURCE: Installed costs: Renewable Energy Policy Project, USA



THE RISK FACTOR

To muddy the waters still further, banks and other financial institutions in the private sector often set interest rates to match the perceived risk of a project. The higher the risk, the higher the test discount rate. Gas turbine technology is proven and regarded as low-risk and a real interest rate around 8% might be considered appropriate. Wind is now coming into this category. Nuclear, on the other hand, tends to be regarded as higher risk. In a major energy sector review, the British government recently suggested a test discount rate for nuclear of around 11%.



Capital repayment periods also have an important influence on the cost of generation. The less time in which to repay a loan, the higher the cost, with the "capital intensive" technologies most sensitive to shortened repayment periods (figure 3). Risk is also an influencing factor here. High risk technologies tend to make banks nervous so they reduce the risk by requiring the finance to be repaid over a shorter period. Early wind projects in the UK secured loans for just ten years. Today 12 to 15 years is more common. No nuclear plant would ever be built if short repayment periods were coupled with high discount rates, so the compromise is to use a moderately long repayment period but a high test discount rate.

Capital repayment periods are decided in different ways. If premium prices for wind energy only last for a fixed period—15 years is quite common—this fixes the term. Similarly, the term of bank loans may dictate the period. If these constraints are absent, private developers may choose periods up to, say, 20 years, if projects are be-

FAIR WORLD PRICE COMPARISONS

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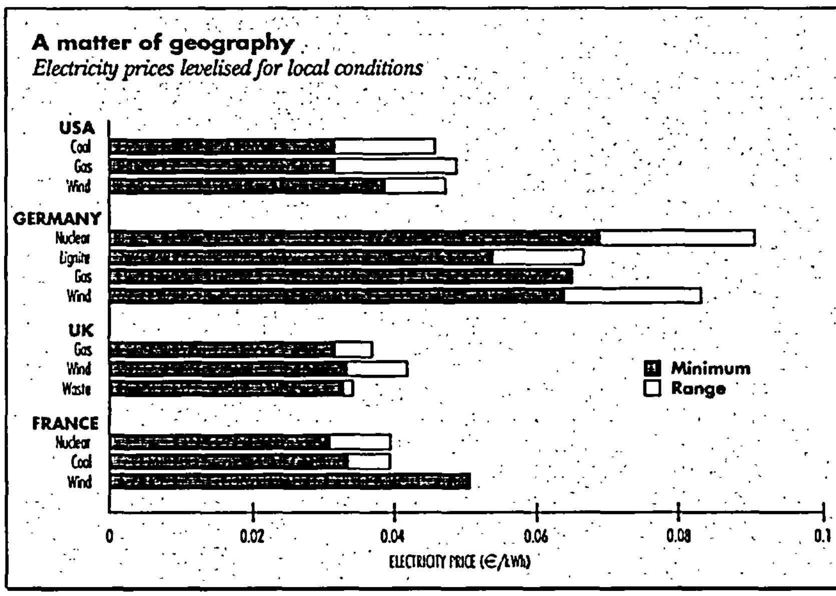
Today's price of electricity from any one fuel source is entirely dependent on the structure of national markets and the strength of the various influencing factors. Comparisons of the price of wind in the United States, Germany, Britain and France—countries representing a wide variety of market infrastructures and stages of maturity—have to be made using a range of prices for each technology.



Most significant in this comparison is the revelation that wind power in Germany is cheap at the price when energy price estimates for thermal plant are calculated on the same basis. In good wind speeds, wind is about the same price as nuclear and around 10-25% dearer than coal. German coal, however, is heavily subsidised by taxpayers and the real price is markedly higher, by about €0.02/kWh. This makes coal fired generation prices roughly equal with those of wind on good wind speed sites.

Using the same electricity price calculations for all sources, wind comes in at around €0.15/kWh at wind speeds of 5 m/s, falling to around €0.08/kWh at 7 m/s; expected prices in 2000 for German nuclear are about €0.07-0.09/kWh and for the fossil fuel sources about €0.055, according to international levels of plant and fuel costs, and €0.07/kWh, according to the RWI Economics Institute in Essen. The comparison uses the same ten year amortisation period applicable to wind for the nuclear and fossil fuel price calculations.

The actual price paid in Germany for output from wind plant is fixed by government at a premium level of €0.085/kWh. Wind turbine operation becomes viable at wind speeds down to around 5.5 m/s due to tax breaks.

France is the only country where nuclear is claimed to be the cheapest generating source. The government uses an 8% discount rate for its price calculations—considered low for nuclear by other countries—with depreciation over the life of the plant. On this basis nuclear comes in at €0.036/kWh, coal at €0.043/kWh and gas at €0.042/kWh. The average wind price, from the latest round of the French EOLE wind program, in which contracts run for 15 years and interest rates are decided by the developer based on the returns required from the project by its investors, is slightly dearer at €0.05/kWh. If wind prices were based on depreciation over 20 years, the gap would be even smaller.

Wind is at its cheapest in Britain in this four country comparison, with current contract prices under the Non Fossil Fuel Obligation (NFFO) starting at €0.033/kWh and rising to €0.042/kWh. For the sake of comparison, the NFFO price range for another new technology, electricity from waste, is €0.033-€0.034/kWh. These plant may not be built for anything up to five years, suggesting the prices are projections for early in the next century. They compare with the government's quoted price for gas of €0.032-0.037/kWh.

In America, coal and gas are running neck and neck in the price stakes, according to Department of Energy publications, with prices starting at roughly $0.037/kWh (€0.032/kWh), about the same as those in Britain. Wind, according to an analysis by the National Wind Co-ordinating Committee, an NGO grouping of utilities, utility commisions, wind equipment suppliers and others, is about 20% more expensive at around €0.038/kWh ($0.045/kWh). Depreciation periods and interest rates are broadly similar in the calculations for all types of US plant.

ing financed from internal funds, but this is unlikely. It is mainly public sector utilities that use "plant lifetime" as the yardstick for capital repayments.

IN COMPARISON

Adopt a common set of theoretical interest rates and accept that depreciation periods are equal to plant life times and the basis for comparing differing power production technologies is laid. This procedure is used by the International Energy Agency (IEA). The prices which result are not real—and may not be relevant in any national framework—but they make fair comparisons possible.

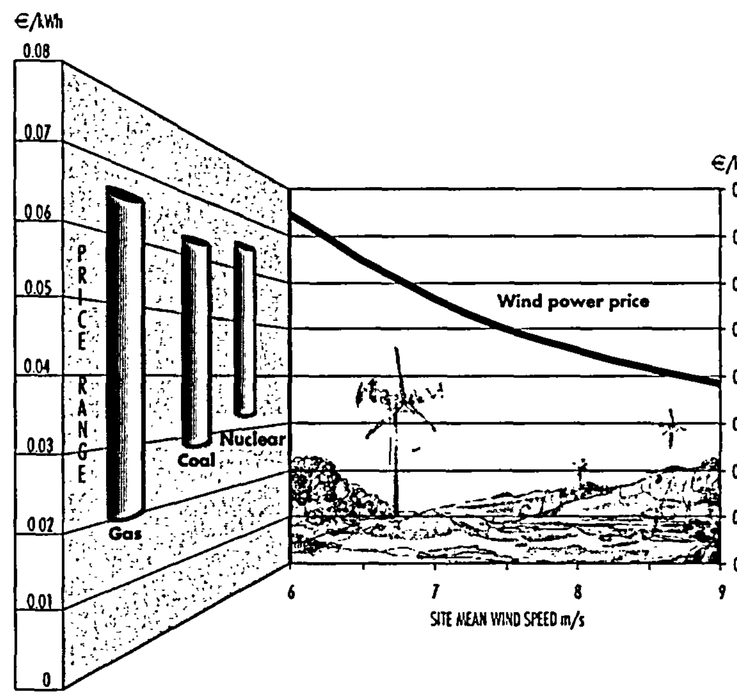
Assuming a fixed set of interest rates and depreciation periods, wind speed now becomes the key factor in determining whether or not wind is competitive with gas, coal and nuclear, since wind energy prices vary with wind speed. The comparison is encouraging. At wind speeds over 6.5 m/s, wind energy falls within the price range of all the thermal technologies. Mid-range costs for the thermal technologies are around €0.05/kWh, which corresponds to the price of wind energy price at wind speeds of 7.5 m/s (figure 5).

For a real world picture of the competitiveness of wind, a closer look needs to be taken at particular national situations. Finding a clear cut analysis of prices from thermal plant can be tricky, though. Just as for wind energy, prices vary with plant size and location and with estimates from varying sources. In America the Centre for Economic Development—a think tank backed by the coal industry—has produced studies showing that coal is the cheapest electricity generating option in the US. Other analyses, however, indicate that gas is the cheapest option—as it is in most of the rest of the world.

Since precise prices do not exist, comparison using a range of electricity prices from all four energy sources is the best option (see box). It is also perfectly realistic as the exact costs will vary from plant to plant even within a single state. Just as with the IEA procedure, wind again emerges as a close competitor to most of the other generating options, with the possible exception of gas, whether in the United States, Germany, France or the UK.

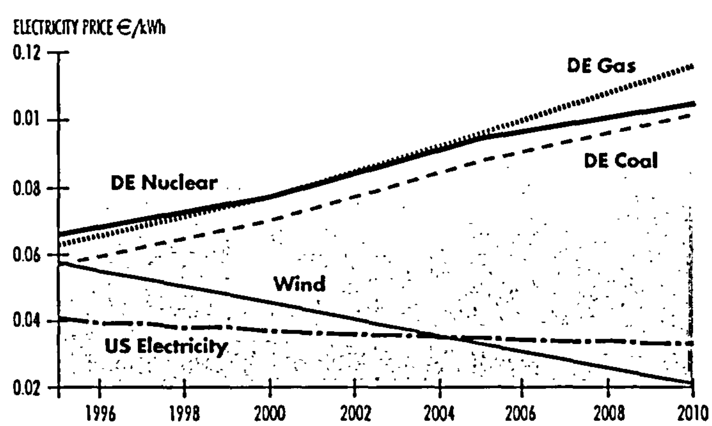
Plotting wind's competitive position today 5

Thermal plant price ranges and wind prices at differing wind speeds



Note who occupies the bottom line 6

Electricity price trends projected

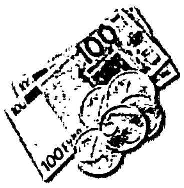


WIND'S ACID TEST

Looking to the future, forecasts of electricity prices from thermal sources of generation cannot be as accurate as those for wind. Future movements of fuel prices need to be taken into account—and these can be influenced by political factors beyond economic control. Recent trends show fuel prices—and subsequently electricity prices—on the way down. Some current forecasts, however, firmly hold that prices will eventually rise, while others are equally firm that prices will drop.

The RWI Economics Institute in Essen, Germany, suggests the price of coal fired generation in the country may rise from its 1995 level of €0.057/kWh to just over €0.1/kWh by 2010. That makes wind look very secure. In the US, however, the Department of Energy is predicting a significant reduction in the price of coal. As coal is highly likely to remain the mainstay for electricity generation, electricity prices in the US are expected to move steadily downwards. The US Department of Energy reckons the cost of coal may fall by 24% by 2020, which corresponds to a reduction in the cost of electricity of about $0.0035/kWh (€0.003/kWh). The final cost of electricity sold to industrial consumers is projected to fall by a similar amount, 27%.

That wind's price target is getting ever smaller to hit is no reason for undue pessimism. There is nothing to suggest that wind power capacity will not continue to double every three years or so, accompanied each time by a 15% reduction in wind turbine manufacturing cost. The scope for reduction remains considerable.



In this scenario, machine costs will continue to drop every three years from today's €750/kW, to €609/kW in 2002, and €496/kW in 2006. The projection fits well with a similar forecast for installed wind turbine costs completed by the Renewable Energy Policy Project (REPP), an American renewables think tank, which explores technical and policy issues (figure 4). REPP's costs are for completed projects, thus making them slightly higher than basic plant costs, and start at €812/kW in 1998, falling to €513/kW by 2006. A third projection, for electricity prices rather than plant costs, comes from Danish consultants BTM Consult. It suggests a 30% reduction may not be realised until around 2009. But the downward trend in all three cases is indisputable.

Here looms the question for which this article is providing an answer. Can wind stay competitive with the very lowest prices being quoted anywhere for thermal energy sources? This really is wind's acid test. The answer? Yes, it can. In a projection to 2006, the rate of fall of wind energy's cost is significantly steeper than that for all the thermal technologies (figure 6). Reason for optimism in the wind camp, indeed, though not for complacency.