A New Energy Direction

Bold Local Solutions to a Global Problem

A Blueprint for Santa Barbara County

Community Environmental Council

fossilfreeby33.org

Santa Barbara County Renewable Energy Blueprint

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Santa Barbara County Renewable Energy Blueprint

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Introduction

Fossil fuels have played a pivotal role in the evolution of modern society – but are also the root cause of many of the most dire problems we face. Without the revolutionary development of technologies that run on fossil fuels, we would very likely still be living in an agricultural economy, with none of the benefits that we enjoy today in terms of transportation, medical advancements, sanitation, entertainment and other improvements to our lifestyle.

But a century of burning fossil fuels has taken its toll, and we can no longer rely on the fossilized energy found in oil, coal and gas to meet our needs. As with all technological advancements, if we are to enjoy their benefits we must also take responsibility for their use. The last decade has provided us with ample information that continued reliance on fossil fuels has very serious implications for our health, our economy, our national security, and the health of the natural systems on which we rely.

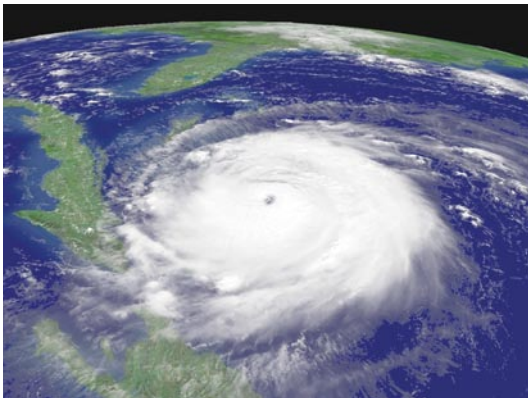
It's not all doom and gloom, however: our detailed economic analysis finds a significant economic benefit in switching to renewable energy in our county. Our consultants project that each person will save over $3,000 per year by 2030 under our "fossil free" scenario. This is equivalent to an annual $1.52 billion savings for our county – a substantial savings by any measure.

Although more and more people are becoming aware of the perils of continued reliance on fossil fuels, it is important that we start by clearly defining the problems we face before moving toward the solutions.

Why do we need to replace fossil fuels?

National Security

About 70 percent of our nation's oil needs are imported — much of this from politically unstable regions in the Middle East.[1] Since the early 1970s, our dependence on foreign oil has more than doubled, making the American economy vulnerable to unfriendly foreign governments, terrorism, blackmail, or other disruptions in supply.



In addition, protecting these resources requires military commitments that are expensive, in terms of both dollars and human life. Our nation's two biggest budget items paid for by income taxes are military expenditures and interest payments on the national debt, which now exceeds $8.5 trillion. From 2000 to 2006, our country swung from enjoying a budget surplus to deficits of $300 to $400 billion each year, with a direct relationship between deficits and military expenditures. Moreover, more than one-quarter of our trade deficit — which exceeded $800 billion in 2006 — consists of oil imports.

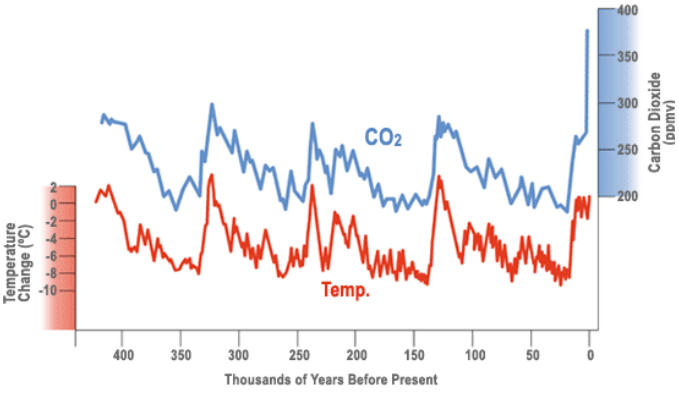
The fact is that most wars throughout history have been fought over resources of one type or another. Under the status quo, we can expect more international conflicts to erupt due to tensions over increasingly scarce supplies of oil and gas. As the Council on Foreign Relations recently stated in a report examining the national security implications of future oil price shocks: "[T]he United States has largely continued to treat 'energy policy' as something that is separate and distinct — substantively and organizationally — from 'foreign policy.' This must change."[2]

Climate Change

When burned, fossil fuels emit into the atmosphere large amounts of carbon dioxide and methane — the two major "greenhouse gases." As these gases accumulate, they act as a blanket, keeping heat in our atmosphere and oceans, leading to potentially catastrophic consequences for our planet and everyone living on it.

We have already been witnessing the effects of increased greenhouse gases for many decades. In the last century, global temperatures have risen an average of about 1.3° F, and twice that in polar zones.[3] This may not seem like a large increase, but on a global basis, this increase is incredibly fast.

Figure 0-1. Atmospheric carbon dioxide levels are far higher now than they have been in the last 650,000 years.[4]



Governor Arnold Schwarzenegger stated at a conference in San Francisco in 2006: "I say the [global warming] debate is over. We know the science. We see the threat, and we know the time for action is now." The Governor then unveiled his plan to return California's greenhouse gas emissions to 80 percent below 1990 levels by 2050.

As greenhouse gases continue to accumulate, we may see more "freak" weather conditions, including longer and more severe heat waves, increased disease, stronger hurricanes, megastorms, floods, droughts, and a sea level rise from between seven and 23 inches by 2100, according to the Intergovernmental Panel on Climate Change.[5] And the effects don't stop at 2100. As the IPCC's recent report confirmed, climate effects will continue for centuries even if we all stopped emitting greenhouse gases today.

While scientists don't always agree on the details, they overwhelmingly agree that we are already witnessing rapid climate change due to human-related greenhouse gas emissions. For example, a survey of peer-reviewed articles on climate change found that, of the 928 articles reviewed, 928 agreed with the view that most of the warming we've witnessed in the last 50 years has been caused by human activities. *Not one article disagreed with this view.*[6]

Early in 2007, the Intergovernmental Panel on Climate Change released its fourth major report, which concluded that the warming we've witnessed over the last half century is "very likely" (90 percent certainty or better) to have been caused by humans burning fossil fuels.[7]

Some effects of increased climate change may include:

Heat-related deaths and illness — According to the U.N. World Meteorological Organization, every one of the 11 hottest years on record has occurred since 1994 (and 2006 was the sixth hottest year).[8] Many scientists expect this trend to continue as long as carbon dioxide and other heat-trapping gases keep collecting in the atmosphere faster than plants and our oceans can absorb them. In California, average summer temperatures are expected to rise between 2.0 and 5.5 °F by the 2030s[9] and 3.0 to 10.5 °F by the end of the century.[10] Heat waves are expected to grow more frequent and more intense — even in cooler

"The world has never faced a problem like [peak oil]. Without massive mitigation at least a decade before the fact, the problem will be pervasive and long lasting." -- Robert Hirsch, author of the Hirsch Report.

coastal climates. Children, the elderly, and those who cannot afford to protect themselves will be at the greatest risk for heat stroke and dehydration.

Drought — Worldwide, regions suffering from serious drought more than doubled in area from the early 1970s to the early 2000s, with much of the change attributed to global warming, according to the National Center for Atmospheric Research.[11] In California, short-term weather patterns notwithstanding, changes in rain patterns and diminishing snowpacks are already being observed. An extended drought could have a devastating effect on food resources, supplies of drinking water, and many industries that require large amounts of water. As precipitation falls more frequently as rain than snow, snowpacks will continue to shrink, "and nearly eliminate skiing and other snow-related recreational activities," according to a recent report by the California Climate Change Center.[12]

"Conventional" oil production is generally defined as crude oil and natural gas liquids, which together comprise the large majority of current oil production. Unconventional oil generally includes heavy oil (much thicker than normal crude), tar sands, oil shale, and deepwater oil. World oil production of all types reached a new high in the final quarter of 2006, but ethanol, biodiesel, and unconventional oil now comprise an increasingly significant part of this total.

Loss of species — As climates change, so do ecosystems. As temperatures increase and sea levels rise, we are already witnessing the transformation of entire ecosystems. Warmer oceans are killing coral reefs at an alarming rate, and glaciers are disappearing, from the Andes to Alaska. Spring now arrives an average of 10 days earlier in some regions, and scientists are observing that certain species of fish, sea turtles, migratory birds, amphibians, and butterflies are altering their reproductive and migratory patterns or dying off altogether. Scientists also predict that if current trends continue, polar bears, one of our most iconic Arctic species, will become extinct within a few generations. Recognizing this fact, the Bush administration began a process in late 2006 to list polar bears as threatened species, citing climate change as the cause.[13]

The City of Portland, Oregon has convened a Peak Oil Task Force to examine local actions for dealing with peak oil. They have not finalized their recommendations as of early 2007, but are the leaders on this issue in the U.S. A great primer on peak oil can be found at the City of Portland's website: http://www.portlandonline.com/osd/index.cfm?c=43027&. More general information on peak oil can be found at the Association for the Study of Peak Oil's website: www.aspo-usa.com.

The end of easily recoverable oil and gas

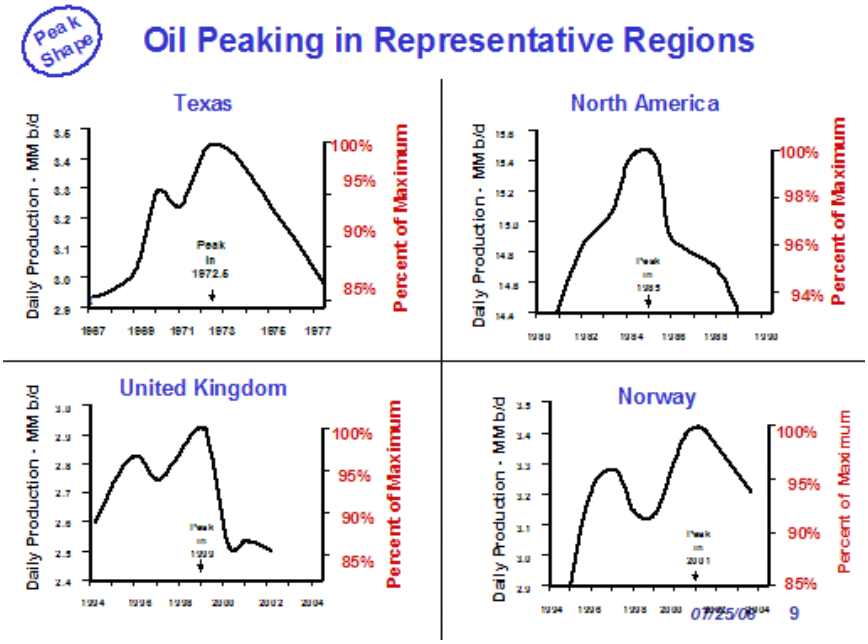
The phrase *peak oil* refers to the high point of global oil production. Once this point is reached, the oil that remains in the ground becomes less and less cost-effective to extract and oil prices climb.

According to the Energy Information Administration, conventional oil production peaked in May 2005. We won't know for some time if this is an all-time peak, but the recent rapid decline in production from many large fields -- such as the North Sea region, Kuwait's Burgan oil field and Mexico's Cantarell oil field (25 percent in 2006 alone) -- suggests it may be. The question now is: Can unconventional oil and biofuels come online fast enough to make up for diminishing conventional oil production? In any case, the debate is no longer about *if* we will hit a global peak for all oil production, but *when*. When we do, we can expect prices to climb well above the high of $78 a barrel reached in 2006 and 2007.

With more and more experts warning that the global oil peak has already been reached or is very near – including the U.S Army Corps of Engineers[14] – the issue of most concern now is the speed at which production will decline once it has peaked. Production peaks in various regions around the world, such as Texas and the United Kingdom, have been quite sharp (Figure 0-1). If global oil production follows a similar curve, we will likely experience severe shocks to every aspect of our society.

As China, India, and other developing economies continue their furious rates of growth, we can expect competition for scarce supplies to grow increasingly fierce. The "Hirsch Report" — a report by SAIC, Inc., for the Department of Energy — found that to mitigate the full impacts of peak oil, the U.S. would have to begin serious planning and start transitioning away from petroleum 20 years *before* the peak. According to this report, if a peak happens within the next 10 years, we will suffer extreme disruptions to our economy because we have not, as a nation, begun to seriously plan for the transition.[15]

Figure 0-2. Shape of oil production curves in various regions.



Air and Water Pollution

Vehicle exhaust plus sunshine equals smog, and California has plenty of all three. Making matters worse, thermal inversions in many parts of the state trap the air and further concentrate pollutants. While our county enjoys cleaner air than its neighbors to the south, we still exceed federal and state allowances for ozone pollution and particulate matter. If we continue to rely on fossil fuels, our air quality will only get worse. Compounding the problem will be the added emissions from our growing population and from other sources, such as marine shipping along our coast.

Smog – which includes ground-level ozone -- is a respiratory irritant that can cause shortness of breath, wheezing, and coughing. Although these symptoms usually disappear once the sufferer is indoors or when the air quality improves, they can cause continued problems for those who are more sensitive, such as children, the elderly, and those with asthma, emphysema, or heart disease. Beyond respiratory problems, burning gasoline and diesel creates particulate matter that is the number-one airborne carcinogen in California, and is associated with heart and respiratory problems among otherwise normally healthy people.[16]

Opportunities in reducing our fossil fuel dependence

Now that we've covered the many downsides to our reliance on fossil fuels, we can discuss the opportunities we face in weaning ourselves from these damaging energy sources.

As discussed in detail in Chapter 8, many high-level analyses have found the cost of mitigating climate change will be minimal compared to the likely costs of adapting to the worst impacts of climate change. The United Kingdom's Treasury recently commissioned a detailed report from Sir Nicholas Stern and his team. The "Stern Review" found that countries around the world will likely see a 5 to 20 percent reduction in annual gross domestic product from climate change – if we don't do anything. Conversely, the costs of mitigating the worst impacts of climate change are likely to cost about one percent of annual GDP.[17]

We are already witnessing a massive national and global effort to bring new technologies on line to replace fossil fuels – such as wind, solar, geothermal, biomass, and wave power. All of these industries promise huge economic benefits for those seeking opportunities. As we transition from a high-carbon economy to a low-carbon economy, the fossil fuel industries (oil, coal and natural gas companies) will certainly suffer, though they will continue to enjoy an economic bonanza for a number of years to come as commodity prices continue to rise. However, if peak oil does arrive within the next decade, it is very likely that low-carbon industries will be the long-term winners.

And with governments around the world awakening to the threats of climate change and energy dependence, the cost of doing business for the traditional fossil fuel industries will certainly rise further as greenhouse gas emissions caps and carbon taxes are implemented.

Our county is already benefiting from the renewable energy boom, with companies like Carpinteria-based Clipper Windpower, Inc., REC Solar, the Solar Energy Company, American Ethanol, Inc., and many others hiring hundreds of people in the last few years. As our county continues to create numerous new renewable energy industry jobs, everyone in the county will benefit from increased tax revenue and business opportunities.

We've completed an economic analysis for our county, finding, as mentioned above that our county as a whole will save over $1.5 billion each year by 2030 in a fossil free future. By 2020, our county will save $418 million each year – equivalent to $830 per person each year. It's clear, then, that there is a good case for switching to energy efficiency and renewable energy in our county based on economics alone, regardless of the many environmental and security benefits that will also accrue.

Endnotes

[1] Energy Information Administration, 2007 Annual Energy Outlook. Online: http://www.eia.doe.gov/oiaf/aeo/index.html.

[2] Council on Foreign Relations. "National Security Consequences of U.S. Oil Dependency," October 2006: pp. 3–4.

[3] IPCC Fourth Assessment Report Summary for Policymakers (2007). Online: http://news.bbc.co.uk/2/shared/bsp/hi/pdfs/02_02_07_climatereport.pdf.

[4] Graphic: www.Architecture2030.org.

[5] Ibid.

[6] Oreskes, Naomi. "Beyond the Ivory Tower: The Scientific Consensus on Climate Change," *Science*, 3 December 2004. Online: http://www.sciencemag.org/cgi/content/full/306/5702/1686.

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[8] Environment News Service, Jan. 3, 2007, online at: http://www.ens-newswire.com/ens/jan2007/2007-01-03-02.asp.

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[10] California Climate Change Center, "Our Changing Climate," (2006), online at: http://www.climatechange.ca.gov/biennial_reports/2006report/index.html.

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[13] Eilperin, Juliet. "U.S. Wants Polar Bears Listed as Threatened," *Washington Post*, 26 December 2006. Online: http://www.washingtonpost.com/wp-dyn/content/article/2006/12/26/AR2006122601034_pf.html.

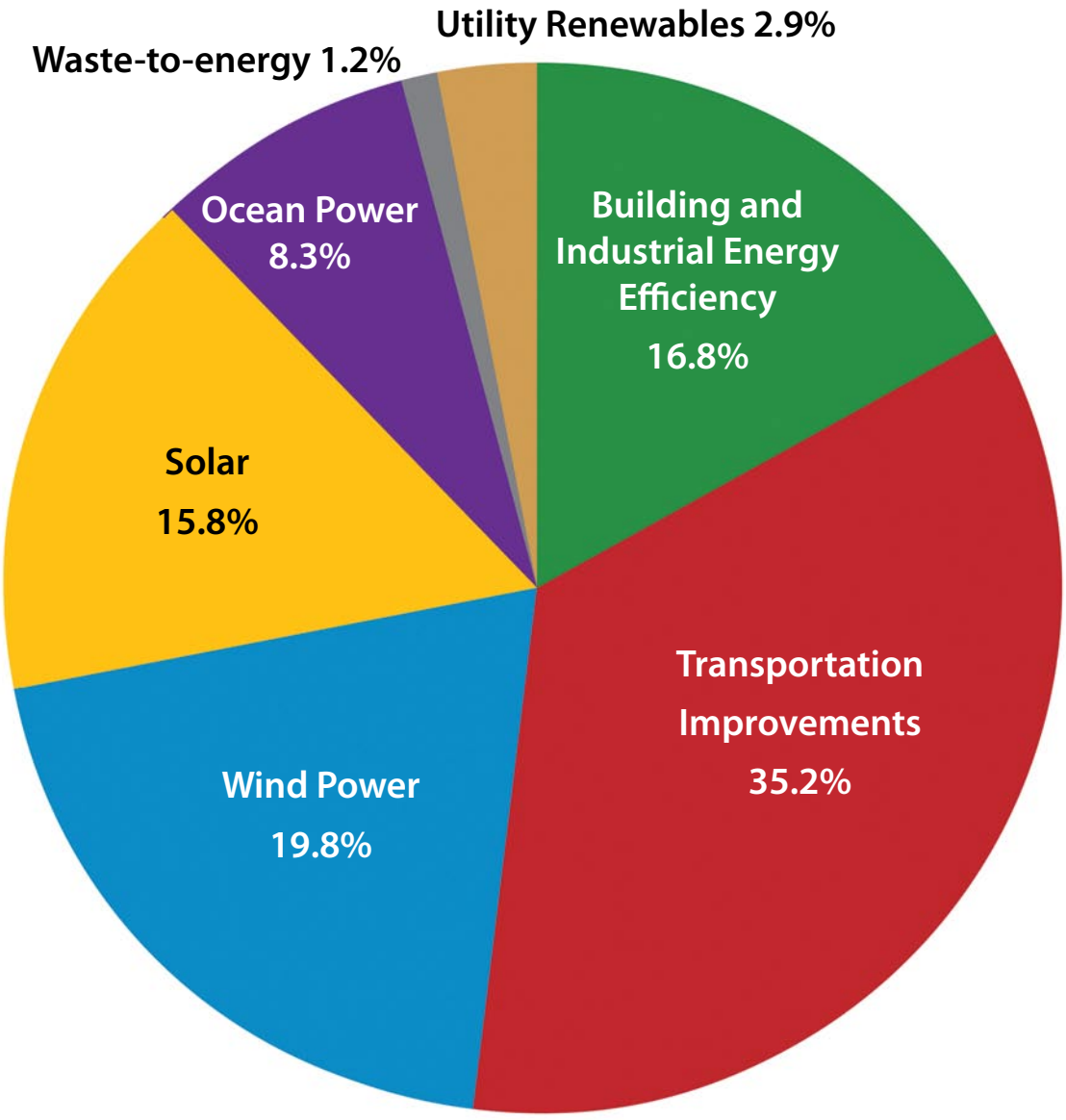
[14] A recent report by the U.S. Army Corps of Engineers, examining energy security for the U.S. Army, states: "World oil production is at or near its peak and current world demand exceeds the supply." ("Energy Trends and Their Implications for U.S. Amry Installations," (Sept. 2005), available at: http://stinet.dtic.mil/cgi-bin/GetTRDoc?AD=A440265&Location=U2&doc=GetTRDoc.pdf.

[15] Hirsch, Robert, et al. "Peaking of World Oil Production: Impacts, Mitigation and Risk Management," SAIC, Inc., February 2005. Online summary: http://www.acus.org/docs/051007-Hirsch_World_Oil_Production.pdf.

[16] Santa Barbara County Air Pollution Control District, online at: http://www.sbcapcd.org/sbc/pollut.htm.

[17] Stern Review. Online: http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm.

Chapter 1 | A New Energy Direction: The Program and Strategy



Pie charts at the beginning of each chapter show the portion of our "fossil free" future that can be met by each technology. The energy flow charts on the next page give a more detailed look at how our energy will be produced and consumed in our county by 2030.

Introduction

Photo: © Mark Bright

Moving away from fossil fuels should be our region's and our nation's top environmental and economic priority. Simply put, we can no longer afford to rely on fossil fuels — oil, coal, and gas — for most of our energy. The key problems stemming from our reliance on fossil fuels, as discussed in the Preface, are climate change, oil and gas depletion ("peak oil"), national security issues arising from having to import foreign oil, and air pollution.

Energy Facts and Figures

- A kilowatt (kW) is a unit of power – or the ability to deliver energy over time. A 3 kW solar photovoltaic installation, for example, will provide much of the power needed for a typical home.
- A kilowatt hour (kWh) is a unit of energy and is enough electricity to run 10 100-watt light bulbs for an hour
- A gigawatt hour (GWh) is one million kilowatt hours
- One kWh is equivalent to 0.03 gallons of automobile gasoline
- Conversely, one gallon of gas is equal to 36.6 kWh

It is now imperative that we quickly transition to a renewable energy economy, and use the remaining recoverable fossil fuels to help make that transition. We should focus vigorously on the cost-effective energy efficiency and renewable energy technologies available today, while at the same time doing what we can to ensure that other promising renewable energy technologies quickly become more cost-effective.

In late 2004, the Community Environmental Council announced its plan to help wean California's Central Coast off fossil fuels (www.fossilfreeby33.org). At that time we faced a public often unaware of the very serious problems caused by our dependence on fossil fuels. Now, many people realize that our unsustainable energy use is at the root of many of our most pressing problems. The climate change and national security implications of our energy use, in particular, have been prominent in news reports and commentary around the country and the globe.

Now that these issues are front and center in the minds of many Americans, what's next?

This Blueprint lays out what should come next for Santa Barbara County. If our recommendations are implemented, we will be well on our way to doing our part to solve the many problems stemming from our use of fossil fuels. The good news is that we'll save a lot of money doing it, as described in detail in Chapter 8.

How Do We Become Fossil Free By '33?

In tackling the ambitious goal of weaning our county from fossil fuels, we first need to recognize the magnitude of the task. The main sources of energy we use are gasoline and diesel to run our vehicles, natural gas for heating and cooking, and electricity -- which in California is generated largely by fossil fuels like natural gas and coal (see Fig. 1-1). The main sectors in which we use that energy are buildings, transportation, and industry (see Fig. 1-2).

In 2005, we used in Santa Barbara County about 184 million gallons of gasoline, 28 million gallons of diesel[1], 8.4 million gallons of jet fuel, 525,000 gallons of aviation gasoline, 155 million therms of natural gas, and 2,700 gigawatt hours (GWh) of electricity[2] (see Fig. 1-1). When we combine all of these energy sources and convert them to GWh as a common unit of energy, we find that we used about 15,500 GWh in 2005. If our region continues with business as usual, CEC projects that regional energy demand will

rise to about 21,500 GWh by 2030.

To get an idea of how much energy this is, consider that Santa Barbara County will require the energy equivalent of 590 million gallons of gasoline annually by 2030. Imagine physically pushing your car 25 miles, the distance the average automobile can travel on one gallon of gasoline. By 2030, our county will need the energy required to push your car 25 miles 590 million times over.

Next, let's consider how we use energy in this region. The two biggest sectors are buildings, which account for about 37 percent of our energy needs, and transportation, which accounts for about 48 percent (see Fig. 1-3). A good energy plan for this region, then, needs to focus primarily on reducing the energy used by those two sectors

In identifying the best options for achieving our goals, we have primarily considered two items: the technology's potential for fossil fuel reduction (including its cost-effectiveness) and the potential for local influence on that option. For example, as we will see shortly, our communities may be much more effective in influencing energy used in the building sector (where we can set stringent local building codes and educate and inspire designers and builders), than we would be in influencing the transportation sector (where fuel efficiency standards are set in Washington, D.C. and cars are designed and built in Detroit, Berlin or Tokyo) This is not to say that we can't influence energy use on our roads; to the contrary, there are many ways we can reduce our petroleum demand through local action (discussed in detail in Chapter 3). But at the local level, we have more influence on how energy is used in buildings.

With these factors in mind, CEC determined that the most sustainable and cost-effective alternatives to fossil fuels for our county are:

Energy efficiency and conservation: Chapter 2 focuses on energy efficiency in buildings; Chapter 3 looks at reducing petroleum demand through better land use planning and by increasing energy efficiency in the transportation sector.

Hybrid cars and biofuels: : Chapter 3 discusses the potential for increased hybrid cars sales to reduce petroleum demand. Chapter 3 also examines the potential for biofuels, primarily ethanol and biodiesel (preferably derived from California-grown fuel crops).

Renewable electricity: Chapters 5 through 7 look at the most promising renewable-electricity technologies for our county: wind power, solar power, and ocean power.

Next generation vehicles: Chapter 4 discusses the transition to more efficient vehicles and vehicle fuels, such as plug-in hybrid vehicles, electric-only vehicles and potentially hydrogen fuel cell or hydrogen internal combustion engine vehicles, once they're available and affordable in three to five years.

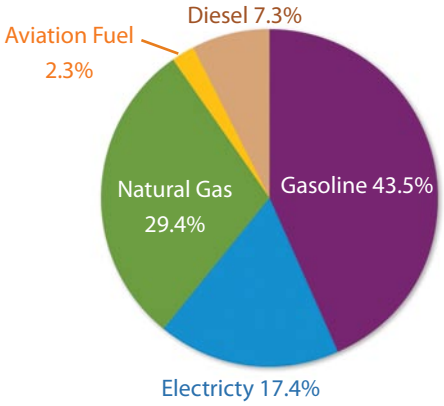


Figure 1-1. Santa Barbara County energy use in 2005 (15,461 gigawatt hours total)[3].

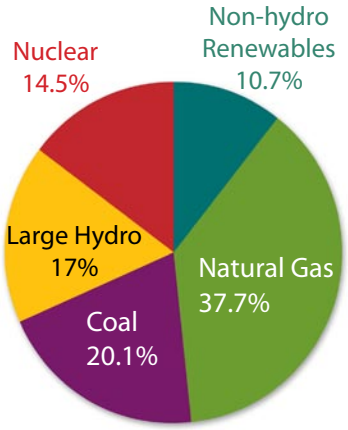


Figure 1-2. California's electricity is generated from the following sources. (Source: California Energy Commission's 2005 Net System Power Calculation.)

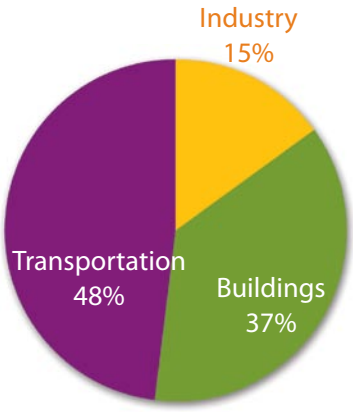


Figure 1-3. Santa Barbara County's energy use by sector (approximate).

Because we have concluded that hydroelectric[4] and geothermal power[5] have limited potential for development in our region over the next five years we have not included them in this Blueprint – though we may include them in later editions. In addition, we do not consider nuclear power to be a sustainable, safe or wise investment for our region (see sidebar for more discussion).

While this Blueprint projects what it would take for our region to replace our fossil fuel and nuclear energy demand over the next two decades, it is likely that we may want to continue to use some small amount of these fuels where it makes economic and environmental sense to do so. Accordingly, we developed our plan to achieve "fossil fuel neutrality," an idea similar to carbon neutrality. Being fossil fuel neutral means that our county will, on a net basis, be fossil free. So even though some fossil fuels will still be used in our county by 2030 (it would be unrealistic to presume otherwise), we will offset that fossil fuel use by renewable electricity exports to neighboring counties.

Energy Efficiency and Conservation

Energy efficiency and conservation are regularly underestimated. The fact is, these two strategies can meet much of our future demand for all types of energy.

The distinction between the two is important. Energy efficiency allows us to do the same things we're doing today while consuming less energy. Conservation saves energy by changing attitudes and behavior to stop wasteful activities. Energy efficient refrigerators, compact fluorescent light bulbs and fuel efficient cars are examples of energy efficiency. Adjusting a refrigerator's settings, turning off lights when not needed, or riding a bike instead of driving are examples of conservation.

When it comes to electricity and natural gas, California is already relatively energy efficient, due in large part to successful state policies. Since the early 1970s, California's per capita electricity and natural gas use have remained level or dropped – while U.S. per capita energy use in these areas has grown significantly.

In the transportation sector, gasoline consumption in the U.S. fell after the introduction of Corporate Average Fuel Economy standards (CAFÉ) in 1975, when gasoline demand was 6.7 million barrels per day.[6] Gas demand didn't return to 1975 levels until 1985, aided by the 1979 oil crisis resulting from the Iranian revolution. Unfortunately, CAFÉ standards have not been significantly strengthened since the early '80s, so demand for oil and gas has continued to rise, slowing down only recently in light of historically high prices since 2005.

What About Nuclear Power?

We have not included nuclear power in our plan for many reasons. First, it is illegal to build new nuclear plants in California. Second, there is still no federal solution for disposing of the radioactive wastes from nuclear power generation, which is why it's illegal to build new nuclear power plants in the state. Third, nuclear power has been very expensive, in California and elsewhere. Fourth, it is not a "carbon neutral" energy source, as is often stated. While greenhouse gases are not emitted during actual power generation, the full life-cycle of a nuclear plant produces significant emissions, including those from exploration for uranium, refining, transportation, construction of the plant, decommissioning, waste storage, etc. — all of which use fossil fuels. Comparable analyses for renewable energy technologies like wind and solar power show much smaller lifecycle emissions. Lastly, nuclear plants are prime targets for terrorism. A major advantage of renewable power is that it generally consists of many relatively small power plants (such as wind turbines), not a single large plant, as is the case with nuclear plants.

We estimate that our county could reduce building and industrial energy use by about 3,100 GWh, or 30 percent, by 2030. In the transportation sector, we could reduce demand by about 5,060 GWh, or almost 50 percent, by 2030. Chapters 3, 4 and 5 show how.

Fortunately when it comes to creating energy efficient buildings, we do not have to reinvent the wheel. A nationwide plan – called the Architecture 2030 Challenge (www.architecture2030.org) — outlines how all buildings in the U.S. could be designed or retrofitted by 2030 to be "carbon neutral" (in other words, to emit zero greenhouse gas emissions on a net basis). In Santa Barbara County, CEC is coordinating a coalition of architects, builders, and nonprofits to implement this challenge. In addition to designers and builders, local agencies and elected officials play a significant role, as they have authority over building design and energy standards, and enforce the state's Title 24 standards for energy use in buildings.

In addition to exploring energy efficiency and conservation in Chapter 2, we also discuss how small wind turbines and solar power can reduce a building's electricity needs in chapters 5 and 6.

With the transportation sector, we also can significantly reduce fossil fuel use through energy efficiency and conservation, but it may be more difficult for us to exert influence locally because we have less local control over transportation and vehicle choices than we do over buildings. First and foremost, however, we can design communities and transportation systems that promote walking, biking, busing, and taking the train. We can create and promote programs to carpool or "car share" -- an exciting new business model that's quickly spreading around the nation, in which drivers rent a car by the hour from convenient locations around town (see Chapter 3). And, when normal driving is necessary, there are many highly-efficient, low-cost smaller cars (which cost about $15,000 and can average up to 35 miles per gallon). Luckily, there are many very positive trends in the transportation sector – such as increasing CAFÉ standards, more hybrid car sales, and biofuels sales increases – that will take us a long way to our goal of a 50 percent reduction in petroleum demand by 2030.

Hybrid Vehicles and Biofuels

EtIn addition to many small, highly-efficient cars, there are more than a dozen hybrid vehicles on the market (which cost more up-front but can get up to 50 miles per gallon and save owners money in the long-term). Hybrid vehicles have an electric motor and a gas engine, allowing greater efficiency with the electric motor providing power at low speeds and complementing the gas engine at higher speeds.

Ethanol and biodiesel -- both biofuels typically derived from plants -- provide excellent opportunities for helping to reduce our regional petroleum demand over the next few years because both the cars and the fuels already exist. The biggest challenges are simply getting the fuels to the market. It is also important to consider the crop sources for these fuels and emphasize fuel crops produced as close as possible to where they're used – to avoid large energy expenditures in transport and other problems associated with some biofuels like corn-based ethanol. There are many controversies associated with ethanol, such as increased food prices, increased burden on agricultural land, increased eutrophication due to fertilizers, and energy balance issues. We deal with these issues in Chapter 3 and conclude that corn-based ethanol offers some benefits over gasoline today, but we need to focus on transitioning quickly to feedstocks other than corn – grown locally. By making this transition, biofuels can contribute substantially to the renewable energy switch.

California is the largest user of ethanol in the country, as every gallon of gasoline sold in the state includes 5.7 percent ethanol to help the gas burn cleaner. President Bush and Governor Schwarzenegger have enacted policies that support increased production of ethanol, so we expect ethanol's recent growth surge to continue for the next few years at least. In addition, there are approximately 300,000 "flex fuel" vehicles on California's roads today that can run on ethanol or gasoline, with more models being offered to consumers each year. But despite the growing market, as of early 2007 only one public fueling station in California -- in San Diego – offered ethanol. CEC is working to address this problem by installing four additional fueling stations on the Central Coast in 2007, as part of a 15-station corridor in Southern California.

Biodiesel faces a similar problem. The fuel exists and can run in any diesel engine generally without alterations (older vehicles may need some minor retrofits), but fueling stations have been slow to make it available. As of early 2007 in Santa Barbara County, only three stations offered biodiesel

blends -- ranging from 20 percent to 100 percent biodiesel. (Again, CEC will be siting new stations as part of a larger corridor to help overcome this barrier.) Also, while diesel engines historically have not been particularly common in California because of the state's strict air pollution laws, a cleaner variety of petroleum diesel (ultra low sulfur diesel) is now available. As a result, we are already seeing an increase in the number of diesel cars on the market. This in itself is a major benefit because diesel engines are 30 percent more efficient than gasoline engines. We can expect biodiesel to become more popular as consumers who are concerned about fossil fuels gravitate toward alternatives. **It's important, however, that diesel car owners check their vehicle manufacturer warranty before relying on blends of biodiesel over 5 percent.**

In the near future, biofuels will also play an important role with hybrid vehicles that are equipped to run on ethanol or diesel, such as the diesel/electric hybrid Jetta due to be released in 2009. As mentioned earlier, when plug-in hybrids begin to emerge on the market, drivers will be able to extend fuel efficiency even further by relying for the first 10 to 30 miles of a trip on the car's battery.

As with all fuels, we must consider the entire lifecycle in getting it to Santa Barbara County.

To address this issue, we must encourage local farmers to grow biofuel feedstocks in our region. For example, switch grass and poplar trees (which are used for ethanol) and jatropha (which is used for biodiesel) can be grown in our region on marginal agricultural land. These crops use less water and can actually build soil because their long roots pull up nutrients from far below the surface. CEC will, during 2007, be analyzing the economics of this business model for local farmers.

In addition to providing local sources of feedstocks, we must make it a priority to attract regionally-based biofuel manufacturers. American Ethanol is building the first biofuel plant for our county in Santa Maria. The plant will initially use Midwest corn for its operations, but the company is also examining the possibility of using cellulosic feedstocks such as switch grass at a later date. In large-scale agricultural operations, cellulosic feedstocks use much less fossil fuel than corn, and thus can more substantially reduce greenhouse gas emissions.

Ethanol can also be made from agricultural waste and municipal solid waste, as described in Chapter 3. Making ethanol from these feedstocks allows us to solve some waste disposal problems and at the same time provide a sustainable source of transportation fuel. Accordingly, CEC will study the feasibility of using these feedstocks even as we examine growing our own feedstocks locally.

Renewable Electricity

While increased energy efficiency and conservation could substantially cut our current demand for energy, and biofuels could provide some of the supply, they are not by themselves enough to wean us off fossil fuels. To truly address the supply side of the equation, we will need to generate more than twice as much electricity as we use currently in our county – and we need to do it with renewable sources instead of the natural gas, coal and nuclear power that are primarily used to generate California's electricity today.

Why will we need so much electricity? For two reasons. First, as mentioned earlier, some of the most promising emerging tech-

nologies that will allow us to transition from fossil fuels are plug-in hybrids and electric vehicles. In other words, we will "electrify" the transportation sector, and by doing so we will vastly increase Santa Barbara County's demand for electricity – from renewable sources. We will also use electricity to substitute for natural gas in home heating and other applications.

Second, we can meet increased electricity demand with a number of renewable energy technologies that are not only sustainable by definition, but also readily available in Santa Barbara County. By using renewable electricity to electrify transportation, we will greatly reduce greenhouse gas emissions and other harmful side effects of petroleum. The steady sunshine, proximity to the ocean and other attributes that make our region so attractive to live in also make it ripe for energy independence. Renewable energy technologies that harness power from the wind, sun and ocean can contribute to regional electricity supplies -- and they won't run out.

But while the State is showing leadership in the area of renewable electricity, to truly generate the amount of energy we will need in this region, this effort must come from within our county. In 2006, only about 11 percent of the power from California's electricity grid came from renewable sources: geothermal, wind, biomass, and solar. (Another 17 percent came from large hydroelectric power, which is not considered renewable under state law because of its environmental impacts.) This hasn't changed much in 2007.

The non-hydro renewable component is expected to increase substantially in the coming decades, as California law requires that utilities generate 20 percent of their electricity from renewables by 2010 and 33 percent by 2020. But with electricity comprising only about one-sixth of Santa Barbara County's total energy use, 33 percent renewable electricity will, in a business-as-usual scenario, constitute only about 5 percent of our total energy demand. Even if we double our electricity supply in that timeframe as we will need to under our plan, only about 11 percent of our total energy needs would be met with renewable electricity from the utilities.

So we need to find other ways to encourage the use and development of renewable electricity above and beyond what state law requires. Wind power offers the most potential today of any renewable energy technology in our region because of its relatively low cost (see Chapter 5). Other types of renewable electricity — such as the various types of solar power, technologies that convert biomass or waste to energy, and ocean power — are also very promising, and are discussed in Chapters 3, 6 and 7.

Promoting renewable energy in our region at such a level will require substantial help from local, state, and federal agencies. Fortunately, a new law, known as Community Choice (AB 117), allows local governments to build or buy as much of their total electricity demand as they want. For this reason, Community Choice will be a key tool for weaning our county off fossil fuels. Essentially, Community Choice gives local governments — not the private utilities, Southern California Edison and PG&E — control over what type of electricity to use. As its name suggests, Community Choice is a way for communities to have more choice over the type of power they receive. (See box for a more in-depth discussion.)

Community Choice: the Closest Thing to a Silver Bullet

To meet our regional goal of getting off fossil fuels, we are going to need to generate over 200 percent of our current electricity demand from renewable sources by 2033. This may seem strange at first glance, but the additional electricity will be required to "electrify" the transportation sector and substitute for natural gas.

Market forces by themselves are very unlikely to achieve this level of renewable energy generation in our county. ***Implementing California's Community Choice law may be the only way for local communities to reach beyond the state's goals,*** which require that utilities provide 20 percent renewable electricity by 2010 and 33 percent by 2020. Community Choice is a powerful tool that should be considered by any community seeking more control over its power supply and more renewable power.

Essentially, Community Choice allows local governments and agencies to choose what power they want to buy or build. The utility, PG&E or Edison in Santa Barbara County, still transmits the electricity over its wires and distributes electricity to customers, but Community Choice gives control over generation to the Community Choice entity (known as an "aggregator"). The utilities are also not impacted economically because they make money on transmission and distribution, not on generation.

There are many uncertainties, however. Community Choice is a relatively new law, and no local governments or agencies in California have yet established a track record in its implementation. King's River Conservation District, in the Fresno region of California, completed its Community Choice implementation plan in January, 2007, becoming the first agency to do so. Many other agencies, including the City and County of San Francisco (which in mid-2007 approved a plan to become an aggregator), Chula Vista, Emeryville, Oakland, Marin County, Santa Monica, and Ventura County, are at some point in the planning stages.

The first step in resolving the uncertainties is to complete a feasibility study, which typically costs from $25,000 to $50,000, though there may be funds available to reduce this cost. Total implementation costs will be much larger, but the long-term benefits will far outweigh the costs – otherwise the local government will not implement Community Choice.

According to Navigant Consulting, which recently studied how Community Choice could benefit 11 local governments in California, these governments could expect to save about 3 percent per year in energy costs while obtaining 40 percent of their power from renewables – essentially doubling the state's 20 percent requirement by 2010. In making these calculations, Navigant was highly conservative in assuming that utility electricity rates will rise by only 2 percent per year in the future, which is considerably below the rate of actual inflation over the last decade. Average electricity rates for Southern California Edison, for example, increased more than 4 percent each year from 1983 to 2006.[7]

In sum, Community Choice is a powerful tool that should be considered by all jurisdictions seeking more control over their power supply and more renewable power – as well as cost savings. More information can be found at the California Public Utilities Commission website: http://www.cpuc.ca.gov/static/hottopics/1energy/archive/r0310003.htm.

Next Generation Vehicles

In the next few years, we can expect new technologies to become available that will improve vehicle efficiency and – perhaps more importantly – allow "electrification" of the transportation sector. In other words, electricity may become the main fuel for transportation, instead of gasoline and diesel.

Most promising of the next generation vehicles are "plug-in hybrid" cars – like today's hybrid cars, but with larger batteries that can be charged from a standard electrical outlet. The larger battery enables drivers to rely on the battery for around-town driving, with the gas engine providing the flexibility needed for longer trips. These cars are not available today, but we expect a number of affordable models to appear in three to five years.

With battery technologies coming down in price, electric-only vehicles also hold promise. The GEM "neighborhood electric vehicle" is available today for $10-12,000 and is suitable for most short trips. The 2008 Tesla Roadster -- a zippy sports car that runs entirely on electric power – has a base price of $92,000 and is slated for production in late 2007. As with most new technologies, it is not a stretch to expect prices to drop by 50 percent or more over the next few years, as this car is sold more widely and economies of scale lead lower manufacturing costs.

Hydrogen vehicles – fuel cell or hydrogen internal combustion engines – hold some long-term promise. Toyota and General Motors have announced plans to offer retail vehicles in 2010 or soon thereafter, but most analysts believe it will be some time later that these vehicles are available to consumers at affordable prices.

The Plan In Brief

A dramatic shift away from fossil fuels can only happen if our region actively pursues the following strategies.

- **Energy efficiency and conservation.** We must aggressively increase our energy efficiency by 30 to 50 percent in the building and transportation sectors, which constitute the large majority of our current and projected energy demand.
- **Hybrid cars and biofuels.** Hybrid cars and biofuels are currently available alternatives to petroleum. Hybrid car sales are booming. Biofuels like biodiesel and ethanol – available soon from cellulosic feedstocks grown in or near our region – can help us reduce petroleum demand immediately.
- **Renewable electricity.** We need to produce large amounts of renewable electricity, such as wind, solar, biomass and ocean power, in or near our region.
- **Next generation vehicles.** We will transition to more efficient vehicles and vehicle fuels, such as plug-in hybrid vehicles, electric-only vehicles and potentially hydrogen fuel cell or hydrogen internal combustion engine vehicles, once they're available and affordable in three to five years.

What Will It Cost?

Our last chapter presents a detailed economic analysis, which we summarize here.

Our consultant's rigorous analysis found that Santa Barbara county residents will in fact save substantially by switching to renewable energy. Due to projections from the UC Santa Barbara Economic Forecast Project that fossil fuel prices in our county and elsewhere will continue to trend upward, energy efficiency and renewable energy will save our county $355 million by 2020 and $1.1 billion by 2030. This is equivalent to annual savings of $700 per person in 2020 and $2,883 per person in 2030.

So we should make the renewable switch purely on economic reasons!

Figure 1-4. Total energy costs business as usual (BAU) versus Fossil Free by '33 (in $millions).[8]

	2020	2030
Business as Usual	$4,181	$6,708
Low Price BAU	$3,802	$5,703
Fossil Free by '33	$3,351	$3,693

Many solutions available today— such as energy efficiency and conservation — cost little or nothing to implement and will show savings immediately. Other options that are available directly to the consumer today – such as existing hybrid vehicles, solar water heaters, and certain building design techniques – require a slight investment that is recovered within a few years through energy savings. Still others -- such as ethanol, biodiesel, solar photovoltaics, small wind turbines, and emerging vehicle technologies like plug-in hybrids and electric-only vehicles – are expected to become more cost-effective for the individual consumer over the next decade. On a larger scale, the technologies needed for large wind farms, concentrating solar power plants, and deepwater offshore wind are also becoming more cost-effective.

Our local results are mirrored in state-wide analyses. A number of reports commissioned by California state agencies have found that meeting California's ambitious goals for reducing greenhouse gases to 1990 levels by 2020 will in all likelihood save money. A report from UC Berkeley, using a sophisticated computer model for energy use and economics, found that reducing carbon dioxide emissions to 1990 levels by 2020 would probably result in $74 billion added to our economy. [9] Other reports have found similarly encouraging results.

That said, we can't afford *not* to rapidly shift from away fossil fuels. Ignoring the problems associated with these fuels and avoiding the solutions is simply too expensive – and too risky – a proposition.

For example, a recent comprehensive report by Sir Nicholas Stern, working on behalf of the United Kingdom Treasury, found that global climate change would probably cost the world's nations five to 20 percent of their gross domestic product each year over the coming decades. The good news from the Stern report: mitigating the most serious consequences of climate change will probably cost only about one percent of gross domestic product each year. [10]

More importantly, we should look at weaning our region off fossil fuels as a real economic opportunity. With a greenhouse gas emission cap and trade system already being designed in California in 2007 and a national system not too far off, companies achieving significant greenhouse gas emission offsets in the short-term will very likely be able to realize significant earnings from the sale of their emissions allowances in the future. With companies like PG&E, a large California-based utility, part of the Climate Action Protection partnership[11], calling for a federal cap on emissions, companies are starting to see the economic benefit in low-carbon technologies. Companies like PG&E, which are subject to California's more stringent renewable energy and energy efficiency laws, stand to gain substantial economic advantage from a federal cap and trade system.

So when it comes to moving away from fossil fuels, individuals, companies and local governments will be able to be green and save money at the same time.

Endnotes

[1] Gasoline use includes 5.7 percent ethanol in California in 2007. Diesel figures include a small amount of biodiesel used in Santa Barbara County.

[2] Sources: California Energy Commission, California Department of Transportation, Santa Barbara Air Pollution Control District.

[3] Derived from California Energy Commission, Santa Barbara Air Pollution Control District, and Department of Transportation figures.

[4] More than 20 percent of the state's electricity comes from large and small hydroelectric facilities, but we have limited potential in our region due to the lack of significant rivers that could be tapped. Also, because dams both large and small have many negative environmental consequences, we do not generally support new dam construction for power generation. There may be significant potential for power generation in Santa Barbara County through retrofitting existing dams, though we have not yet studied this potential in detail.

[5] Geothermal power is the largest source of renewable energy in California, under the state's definition of renewable energy, which excludes large hydroelectric facilities due to the negative environmental consequences of large dams.

[6] Energy Information Administration, data available online at: http://tonto.eia.doe.gov/dnav/pet/hist/mgfupus1A.htm.

[7] Data on file with the Community Environmental Council.

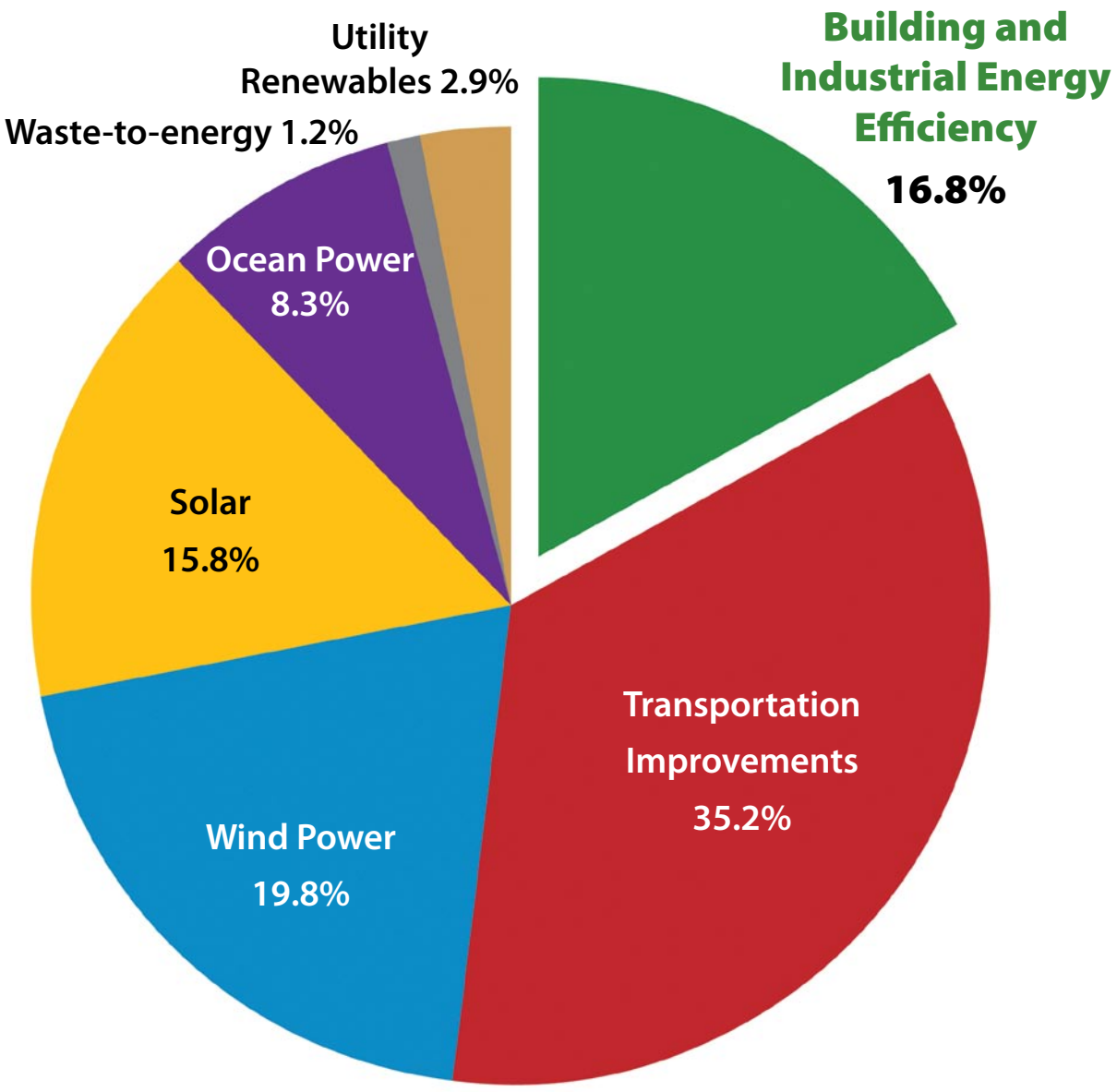
[8] Based on studies completed for CEC by the UC Santa Barbara Economic Forecast Project and Prof. Dan Kammen at UC Berkeley and Prof. Peter Schwartz at CalPoly San Luis Obispo.

[9] David Roland-Holst, UC Berkeley. "Economic Growth and Greenhouse Gas Mitigation in California," August 2006: pg. 3.

[10] Stern Review. Online: http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm.

[11] Climate Action Partnership website: http://www.us-cap.org/.

Chapter 2 | Reducing Energy Use in Buildings



Pros: Conserving and using energy more efficiently is far easier and cheaper than developing new energy sources. California leads the nation in energy efficiency, and local communities can go further by setting more stringent building codes, promoting new technologies and encouraging a shift in behavior.

Cons: Old habits are hard to break, and this is especially true when it comes to using new technologies or doing with less. Also, while most of the technologies we consider here pay for themselves in two to three years, some may take longer. Financing options are limited for homeowners.

Technology readiness: Dozens of energy-efficient building techniques and cost-effective technologies are being implemented today in homes, businesses and government facilities.

Introduction

Conserving and being more efficient with energy are the "no brainers" of energy policy. After all, it is far cheaper and easier to save energy than it is to find new ways to generate it. A good energy plan first emphasizes being smarter and more efficient with existing resources.

Fortunately, we live in a state that lists energy efficiency as the first priority in its own energy plan. In doing so, California has created well-funded programs and opportunities for huge energy savings, and in fact leads the nation in energy-saving measures, with per capita electricity and natural gas use remaining level since the early 1970s. In many cases, our county simply needs to adapt information and programs that already exist. We do not need to re-invent the wheel.

In those cases where we want to push beyond the rest of the state -- perhaps by setting more stringent building standards -- we are fortunate to live in a small community where we have more flexibility to set aggressive goals and where local forces play a key role. Unlike efforts to reduce transportation fuels -- which often rely on state and federal decision-makers -- reducing building energy use is largely in the hands of local architects, builders, government agencies, and the public.

While some technologies will certainly improve over time, for the most part we do not need to wait for the market to catch up as we do with some renewable energy technologies. Energy-efficient appliances, better lighting, smarter building techniques and dozens of other cost-effective technologies are available today. Through these and other measures we could reduce energy use in buildings in our county by 30 percent or more by 2030, from a projected 8,900 gigawatt hours (GWh) down to about 6,200 GWh. With a total of about 21,000 GWh needed by 2030, this would substitute for 12 percent of our projected total energy demand and is equivalent to more than two-thirds of our projected electricity demand in 2030. When we add a 30 percent improvement in efficiency and reduced activity in the industrial sector, we can meet fully 16.8 percent of projected 2030 demand (see pie chart).

Technical Assessment

The distinction between energy efficiency and conservation is important. Energy efficiency allows us to do the same things we're doing today while consuming less energy. Conservation saves energy by changing attitudes and behavior to stop wasteful activities. Energy efficient refrigerators, compact fluorescent light bulbs and fuel efficient cars are examples of energy efficiency. Adjusting a refrigerator's settings, turning off the lights, or carpooling are examples of conservation. This chapter looks at energy efficiency and conservation in buildings, while vehicles are discussed in Chapter 3.

The concepts of conservation and energy efficiency may not be glamorous, but they are incredibly important. California has saved about 40,000 gigawatt hours (GWh) per year through combined programs since the 1970s. That's fully one-seventh of the state's current electricity demand and, at today's average price, equivalent to $4.96 billion saved each year.[1] It's no surprise that energy efficiency remains California's top priority in the state Energy Action Plan.[2]

If we do nothing and continue on with business as usual, our county will need about 8,900 GWh a year by 2030 in the building sector. That includes 2,200 GWh of electricity and 160 million therms of natural gas (equivalent to 4,600 GWh), plus an additional 10 percent of our total energy use by 2030 as "embodied energy" – in other words, the energy used outside of our region to manufacture components in our buildings. (See Figure 2-1.)

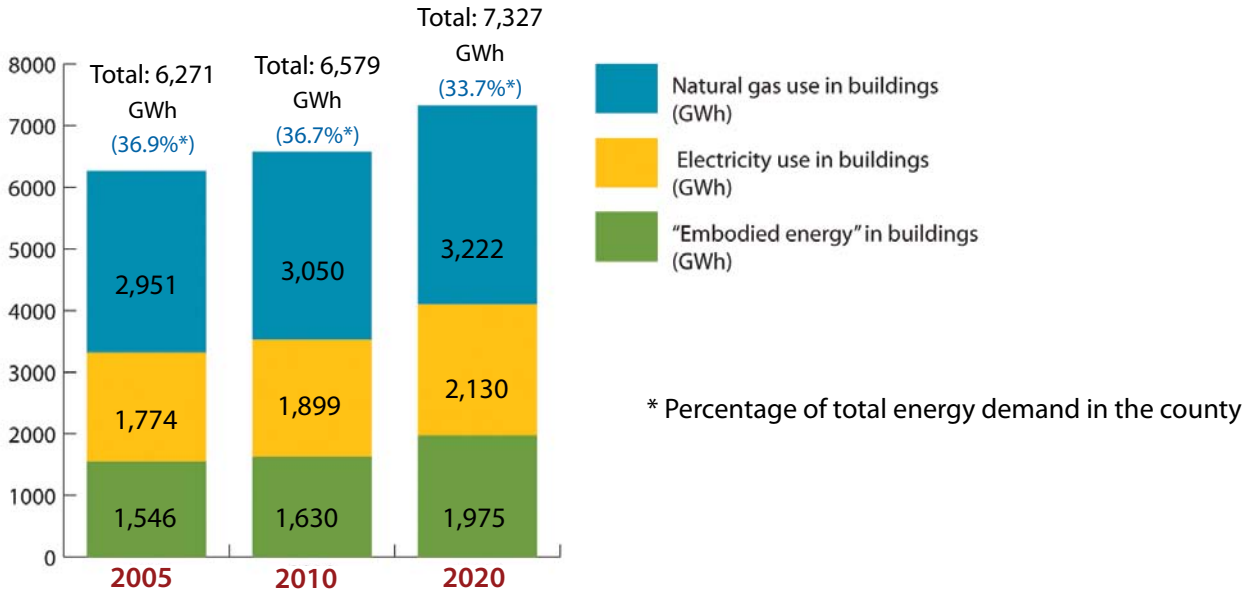


However, if energy efficiency measures were implemented widely in the building sector and energy use was cut by 30 percent, homeowners, businesses and local governments could collectively save about 2,700 GWh a year.[3] That would take demand down to 5,100 GWh — even lower than the 6,200 GWh used in this sector in the county in 2005. At today's utility rates, such a reduction would be equivalent to $210 million a year in savings![4] Imagine what we could do if we were to reinvest those savings into our communities.

Reaching the 30 percent reduction level is one of the core strategies of this Energy Blueprint and will require working on several different fronts. First, we need to encourage and educate homeowners and business owners to convert to some new technologies and make easy adjustments to their habits. Second, we need to create incentives – in some cases by using existing state or utility programs – to help building owners make more significant changes to appliances, equipment or the building itself. And third, we need to work with our local officials to enact more stringent building standards and provide additional incentives.

In 2005, buildings used about 37 percent of our county's total energy demand. This is considerably less than the national average of 48 percent[5] because we need less energy to heat and cool buildings in our region's relatively temperate climate.

Figure 2-1. Building energy use in Santa Barbara County (in GWh).[6] (Derived from California Energy Commission and Department of Transportation data.)



* Percentage of total energy demand in the county

Figure 2-2. Residential Energy End Use in California (Source: Itron 2006)

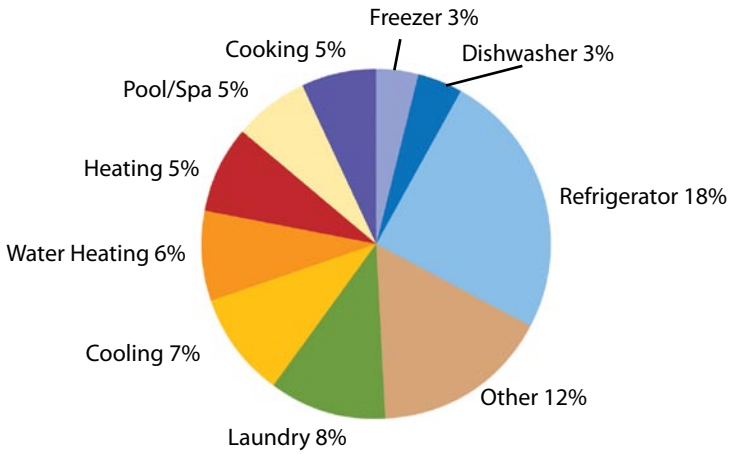


Figure 2-3. The top ten most cost-effective energy efficiency measures for residential buildings.[8]

Measure	Cost per kWh	Estimated potential energy savings in Santa Barbara County	Estimated potential cost savings in Santa Barbara County
High efficiency tube fluorescent	1.7 cents/kWh	4 GWh	$0.5 million
Double pane windows	2.3 cents/kWh	11 GWh	$1.6 million
High efficiency pool pump and motor	2.9 cents/kWh	13 GWh	$1.9 million
Compact fluorescent lightbulbs	3.6 cents/kWh	72 GWh	$10.8 million
High efficiency clothes washer	4.3 cents/kWh	7 GWh	$1.1 million
High efficiency freezer	6.4 cents/kWh	2 GWh	$0.3 million
Refrigerator, early replacement	6.5 cents/kWh	47 GWh	$7.1 million
Heat pump space heater	8.5 cents/kWh	5 GWh	$0.7 million
High efficiency refrigerator	12 cents/kWh	12 GWh	$1.8 million
Heat pump water heater	14.3 cents/kWh	7 GWh	$1.0 million
Total		**180 GWh**	**$26.8 million**

Reducing energy use in residential buildings

In Santa Barbara County, where about 37 percent of our regional energy is used by buildings, more than half of that amount is used in our homes. Even with the South Coast's temperate climate, most residential energy is used for heating and cooling air, heating water, lighting, and running large appliances. (See Figure 2-2.)

It is not surprising, then, that the most cost-effective alternatives – with the potential for saving the most energy – would address these uses. The recommendations in Figure 2-3 are based on a report commissioned by CEC assessing the potential for energy efficiency in our county, based on today's residential electricity costs of 15 cents per kilowatt hour (kWh).[7]

Our consultant's figures were derived from a statewide report completed by Itron, Inc., which assumes that where energy efficiency measures are cost-effective, they will be implemented instead of more costly alternatives.

Other energy efficiency options that were considered "marginally cost-effective" include wall insulation, ceiling insulation and programmable thermostats, which cost about 21 to 22 cents per kWh today. However, when we consider that residential

Energy Star appliances saved Americans $12.6 billion in 2005 alone and avoided greenhouse gas emissions equivalent to about 23 million cars.[11] The Energy Star website, www.energystar.gov, has significant content regarding energy efficiency for homeowners and businesses.[12]

electricity costs have sharply increased in recent years, these measures may prove cost-effective in the near future.

In addition to energy efficiency measures -- which require an up-front investment -- energy conservation measures are free -- requiring only a change in habit. To reach the goal of reducing energy use in buildings by 30 percent by 2020, we will need to actively encourage residents to conserve energy at home through measures such as these:[9]

- **Turn the water heater thermostat down to 120°F.**
- **Set heating thermostats at 68°F in winter when you're home, and down to 55°F when you go to bed or when you're away. (Programmable thermostats do this automatically.)**
- **Close heating vents in unused rooms – no need to heat rooms you don't use.**
- **Close windows and drapes during sunny summer days and after sunset in the winter.**
- **Turn the lights off when you leave a room.**
- **Use energy-saving settings on washing machines, clothes dryers, dishwashers, and refrigerators.**
- **Clean your refrigerator's condenser coils once a year.**
- **Air-dry your clothes where feasible – this also helps extend the life of your clothes.**
- **Don't waste water, hot or cold, inside or outside your home. Water takes energy – and costs money – to get to you.**
- **Repair leaky faucets and toilets (5 percent of water "use" is leakage). Again, you can save money and energy by conserving water.**

Replacing ten 60 watt incandescent bulbs with compact fluorescent light bulbs can save a homeowner or renter about $140 per year in electricity savings.[10]

Figure 2-4: Potential electricity savings by commercial and governmental building end use.[13]

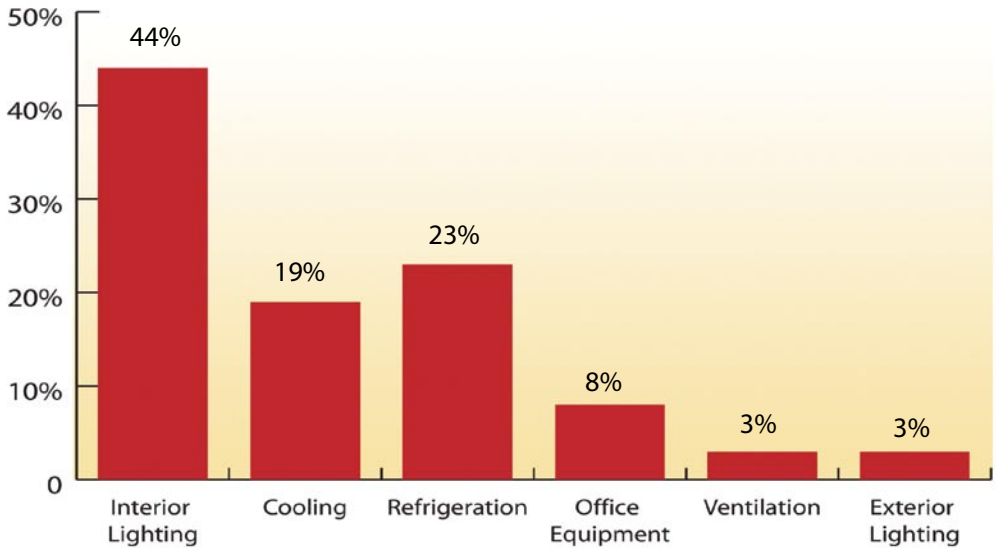


Figure 2-5. The top ten most cost-effective energy efficiency measures for commercial buildings.[14]

Measure	Cost per kWh	Estimated potential energy savings in Santa Barbara County	Estimated potential cost savings in Santa Barbara County
T8/electronic ballast with reflectors	0.7 cents/kWh	11 GWh	$1.8 million
High efficiency chillers	1.7 cents/kWh	5 GWh	$0.8 million
Refrigerator covers	2.1 cents/kWh	4 GWh	$0.6 million
Compact fluorescent lightbulbs	2.5 cents/kWh	8 GWh	$1.3 million
Refrigerator compressors and motors	3.2 cents/kWh	13 GWh	$2.2 million
Ventilation variable speed drivers	3.4 cents/kWh	5 GWh	$0.8 million
Occupancy sensors	4.8 cents/kWh	12 GWh	$1.9 million
T8/electronic ballast	5.9 cents/kWh	28 GWh	$4.5 million
High efficiency direct expansion air conditioner	6.6 cents/kWh	5 GWh	$0.8 million
Office equipment power management	9 cents/kWh	11 GWh	$1.8 million
Totals		**103 GWh**	**$16.5 million**

Reducing energy use in commercial buildings

Of the total energy used by buildings in our region, about 40 percent is used in commercial, industrial and government buildings. In these sectors, interior lighting and refrigeration are the areas with the most savings potential (Figure 2-4).

Energy-saving options for business are even more varied than for homeowners because of the additional equipment that businesses require. The recommendations in Figure 2-5 show the most cost-effective options, based on today's commercial electricity costs (a little higher than residential rates, which were about 15 cents per kWh in early 2007). Other measures that were considered in our analysis to be "marginally cost-effective," at 24 to 26.5 cents per kWh, included cool roofs (highly reflective roofing materials), perimeter dimming and metal halide lamps. However, this does not mean that these additional measures lack merit. There may be other reasons why a building owner may want to proceed with them, such as a desire to implement the best green building practices, or to prepare in advance for future increases in energy costs.

If all of the above costs-effective measures are installed in the residential building sector (180 GWh) and commercial building sector (103 GWh), we would be well on our way to reducing total building energy use in our county by 30 percent by 2030. Unfortunately, reducing residential energy use is a tougher nut to crack. While many companies provide no-cost upgrades for businesses and local governments – and then share in the cost savings – none do this for residential buildings. Outreach to homeowners and renters is, therefore, essential in alerting people to the potential cost-effective energy savings available to them.

The Role of Local Government

In addition to employing many of the techniques and technologies identified for businesses (see Figure 2-5), our local governments can go a step further and set an example for the private sector. The Leadership in Energy and Environmental Design (LEED) program, designed by the U.S. Green Building Council, provides a rigorous set of standards for new and existing buildings to have the least impact on their environment. In Santa Barbara County, we currently have only three LEED certified buildings – two at UC Santa Barbara and one in Santa Maria – but many more are being planned. UC Santa Barbara announced in early 2007 that it would be remodeling 25 large buildings on campus to meet the LEED "Existing Building" standard. This is a tremendous example for others in our communities.

In addition to setting their own house in order by building the most environmentally friendly buildings, local governments have substantial influence over energy efficiency standards in all buildings within their jurisdiction. In fact, as mentioned earlier, this is one area where local leaders can truly impact the process for moving our region away from fossil fuels. When it comes to building and retrofitting more efficient buildings in Santa Barbara County, we do not need to wait for new legislation or for new technologies to be developed. We have everything we need right now.

One of the biggest tools at our disposal is California's existing energy efficiency standard (Title 24), which can be tightened through local ordinances. We also have the benefit of existing partnerships. A nationwide grassroots effort aimed at architects and builders – the 2030 Architecture Challenge – has gained considerable momentum in our region, and an existing coalition of south county local governments – the South Coast Energy Efficiency Partnership – is already collectively promoting energy efficiency.

Going Beyond State Law

Under California's Title 24 regulations, all new buildings in California must meet minimum energy efficiency standards.[15] However, while California has the most stringent efficiency standards in the U.S., Title 24 is not enough to reduce our fossil fuel use to the level we need.

Some communities have enacted ordinances that go beyond Title 24. For example, the City of Palm Desert enacted an ordinance in 2006 requiring all new buildings to exceed Title 24 by 10 to 15 percent. Santa Monica also requires builders to achieve 10 to 15 percent above Title 24 requirements.[16] Other cities and counties that have passed ordinances requiring similar standards include Marin County, Los Altos Hills, and Mill Valley.[17]

In addition, some communities have chosen to encourage or require additional energy efficiency improvements even when Title 24 is not triggered. For example, San Francisco and Berkeley have enacted "time of sale" improved energy efficiency requirements. Under this requirement, each time a residential or commercial building is sold or renovated, the owner must obtain a certificate of compliance from the city demonstrating that the "energy conservation measures" have been completed.[18] Between 2003 to 2005, Berkeley's program resulted in inspections of more than 1,400 units, with 92 percent complying after inspection.[19]

The cost of compliance with such ordinances is always a concern, so implementing an ordinance like this in jurisdictions in our county should always be done carefully – ensuring that compliance can be cost-effective and not overly burdensome to architects, builders, businesses or homeowners.

In 2006, CEC, The Sustainability Project, the local chapter of the American Institute of Architects and the Santa Barbara Contractors Association co-sponsored a public lecture with Ed Mazria, a nationally recognized architect and creator of the 2030 Challenge. Mazria's talk galvanized the community and inspired the creation of a local Architecture 2030 Coalition, with architects, builders and consultants as members. After the event, Mayor Marty Blum of the City of Santa Barbara requested that the coalition provide a plan to the City for meeting the 2030 Challenge. The coalition is also working with the County of Santa Barbara to improve the energy efficiency of its buildings and buildings in the county's jurisdiction and will work with other local jurisdictions in the future.

The Architecture 2030 Challenge

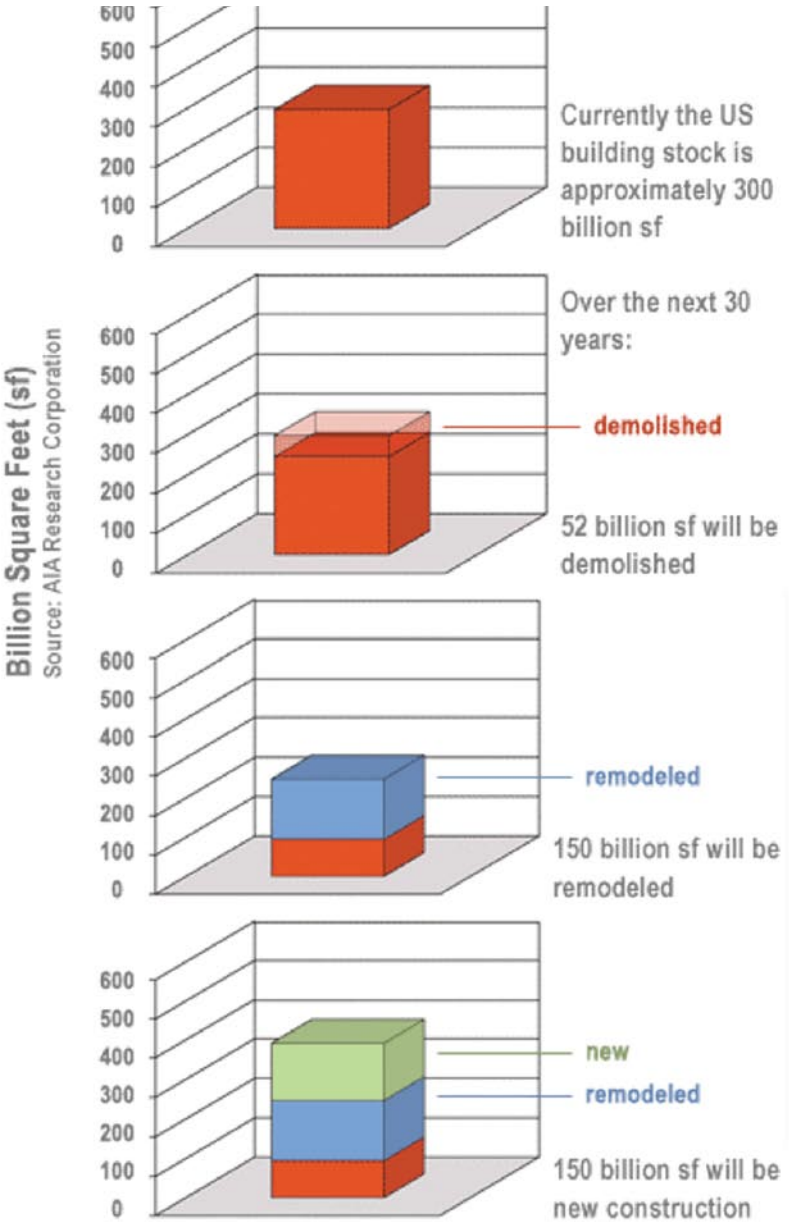
A national effort known as the Architecture 2030 Challenge (www.architecture2030.org) made a splash in our county in 2007. The 2030 Challenge, motivated by concerns about climate change and resource depletion, seeks to improve energy efficiency and outlines how we can design or retrofit all U.S. buildings so that they are "carbon neutral" — in other words, buildings will emit no greenhouse gases such as carbon dioxide and methane, on a net basis – in 2030. As one of the largest sources of greenhouse gas emissions in our county, energy use in buildings is an obvious target for reduction. It is also a sector that can easily incorporate many existing, cost-effective energy efficiency improvements (see Figures 2-3 and 2-5).

Having been adopted by the American Institute of Architects and the U.S. Green Building Council, the challenge has received significant national support and is now gaining momentum in our region. CEC is chairing a coalition of architects, builders and non-profits in Santa Barbara County to implement the 2030 Challenge locally. One of the group's first successes was when the City of Santa Barbara voted in early 2007 to accept the goals of the challenge and directed staff to change city ordinances to achieve the challenge's goals.

Along the way to its ultimate 2030 target of carbon neutrality, the challenge calls for a 60 percent reduction in fossil fuel energy use in buildings by 2010 and 80 percent by 2020. This may seem ambitious – and is in fact much more aggressive than our projection in this Blueprint to reduce building energy use by 30 percent by 2030. However, numerous studies and real world experience have found that a 60 percent reduction in fossil fuel energy use (compared to national averages for similar building types) could be achieved in Santa Barbara County at a cost savings to builders.[20]

Achieving "carbon neutrality" for buildings by 2030 is not as daunting a task as it may seem when we consider that in addition to new construction, many buildings will be demolished or remodeled by 2030 (see Figure 2-4). This is particularly important in the southern part of the County, where the rate of new building is slower than the rate of remodels. Both new buildings and remodels can incorporate strong energy efficiency measures to move toward carbon neutrality, requiring much less changes to existing building stock as one may think.

Figure 2-6. National building stock turnover by 2030.[21]



Built Green Santa Barbara

Built Green Santa Barbara is a voluntary program developed by the Santa Barbara Contractors Association that encourages builders to construct more sustainable homes and other buildings. The program is self-certifying and ranges from one star projects up to three star projects, indicating the highest sustainability rating. In 2006, the City of Santa Barbara incorporated Built Green into its permitting process by offering expedited permitting procedures as incentives to those who go through the program. As of early 2007, 16 projects had been certified in Santa Barbara County as Built Green projects. In addition, Built Green Santa Barbara is a member of the 2030 Challenge Coalition chaired by CEC. More information can be found at www.builtgreensb.org.

If all buildings in Santa Barbara County were in fact carbon neutral by 2030, as per the Architecture 2030 Challenge, we would likely see a reduction in energy use in our county's buildings by 50 percent or more – at least 20 percent more than we project in this chapter as achievable by 2030.

Can We Do With Less?

Despite California's leadership in energy-efficiency and its influence on the rest of the nation, collectively U.S. residents use far more electricity than anywhere else in the world.[22] In fact, our nation uses about two-thirds more electricity than China, the country in the #2 slot, with four times the population of the U.S.

While inventing and installing more efficient technologies are extremely important, many people believe that conservation is, in fact, both a personal virtue and sufficient basis for a sound, comprehensive energy policy. As the twin threats of climate change and "peak oil" become more apparent, we hope more of us will voluntarily adopt conservation measures by choosing smaller houses, using our cars less, and making other personal sacrifices to live more within our means.

Government Partnerships

Dozens of technologies and programs that could significantly reduce energy use in our region are available to residential and commercial energy customers today, but most of us don't know abut them. This is why representatives from Southern California Edison, the County of Santa Barbara and the cities of Carpinteria, Goleta and Santa Barbara have started to regularly meet to share information about making their communities more energy efficient. CEC serves as consultant to this group, known as the South Coast Energy Efficiency Partnership

Part of the group's task is to introduce the community to emerging technologies that might need a nudge in order to gain acceptance. In 2006, the partnership held a lamp exchange at the County fairgrounds, in which more than 1,000 people exchanged 3,900 inefficient halogen and incandescent lamps for new, efficient fluorescent lamps. During another exchange over the holiday season, nearly 1,000 people swapped strands of inefficient holiday lights for more efficient lights that use LED technology. These and all partnership programs are funded by a small "public goods charge" that utility customers pay on their bill each month.

Over the next two years, the partnership will offer more opportunities to address some of the biggest energy-using features of our homes and businesses, such as programs for turning in old refrigerators or converting to T-8 ballasts in small and medium-sized businesses. For updates on these programs, visit www.southcoastenergywise.org.

Additionally, as we are successful in building renewable energy facilities, on a large-scale and small-scale, in our county, we will do much to help buildings become carbon neutral. As we move closer to 100 percent carbon neutral electricity in our county, buildings in our county will of course use more and more carbon neutral electricity.

Overcoming Barriers to Energy Efficiency & Conservation

Cost of Installing or Upgrading to New Technologies

Even though many energy efficiency measures are cost-effective – meaning they pay for themselves in a short period of time – the up-front cost can still be prohibitive. Compact fluorescent light bulbs, for example, can cost significantly more than incandescent bulbs, and Energy Star appliances can be more expensive than their less-efficient counterparts. On a much larger scale, changing out a restaurant's refrigeration system or a building's 30-year-old boiler can be a huge investment.

This is why it is particularly important to promote rebates and other programs offered by our region's three utilities: Southern California Edison, Pacific Gas & Electric, and Southern California Gas. Dozens of programs offering everything from lighting assistance for small businesses, rebates for energy-efficient home appliances, and even low-energy vending machines for schools are funded by a small fee that we all pay on our utility bills. This "public goods charge" is administered by the state Public Utilities Commission and the utilities to create programs that are designed to help our region lower its energy use.

For larger entities such as hospitals, schools, government agencies or large businesses, "energy service companies," also known as ESCOs, will audit the facilities and provide energy efficiency improvements at no charge. As the company or agency saves on utility bills, the ESCO receives its compensation by sharing in those savings – a true "win win" situation. (See page x for more information.) Unfortunately, home owners and small businesses do not have a similar option. However, some lending institutions offer "energy efficiency mortgages" to homeowners to pay for retrofits.[23]

Lack of Immediate Feedback on Energy Consumption

From 1999 to 2006, total electricity costs increased by more than 50 percent, and natural gas costs more than doubled. As prices increase, consumers tend to become more efficient in their energy use and reduce consumption. However, when they don't immediately see the increase or are not reminded of it on a regular basis, their response time will be delayed and they will continue with their existing behavior.

Energy use in the transportation sector is much more transparent: gasoline prices go up and consumption goes down in a fairly consistent relationship. In addition to feeling the increase when they fill the tank, some drivers with new gauges in their cars can track the amount of fuel they are using in real time. This allows them to make an even closer connection between their behavior and their fuel efficiency; the difference in efficiency between 55 and 75 mph becomes very obvious.

In the building sector, however, very few homes and businesses display their electricity or natural gas meters where users can see them. New "smart meters" can change that, allowing customers to see the prices they are being charged on a real time basis. This real time information can help reduce overall demand for electricity and shift consumption to off-peak times such as at night and on weekends. Smart meters will soon be available to utility customers in PG&E and Southern California Edison service areas, along with "time of use" pricing options that allow customers to pay less overall by reducing use during peak demand periods.

Lack of Time, Information or Expertise

Most homeowners, businesses and local governments aren't aware of the wide array of cost-effective options available to reduce energy use and costs. In some cases, energy-saving programs aren't well advertised; in other cases, they are simply confusing. Transitioning to new technologies can also be time consuming to research, install or learn to operate. As with all new technologies, there can be a natural tendency to stick with what we know.

These hurdles can be magnified when under the staffing pressures of a business, school, or government facility. Someone within the institution may be interested in energy efficiency measures and conservation, but may simply lack the time or knowledge to follow through. For larger facilities, Energy Service Companies (ESCOs) can help by providing information and actually installing upgrades. Service representatives from the utilities can also help. For both commercial and residential energy users, the South Coast Energy Efficiency Partnership (www.southcoastenergywise.org) and CEC (www.cecsb.org) are working to provide information on energy-saving programs.

The Action Plan

Energy efficiency and conservation are the foundation of our region's energy blueprint. In our action plan, we focus on the following areas: individuals, businesses, local governments, and CEC.

What can individuals do?

1. Conserve energy.

As discussed, conservation measures are no-cost changes that can lead to serious savings – in energy and dollars. Setting computers to power saver mode, turning off lights when not needed, setting washing machines to warm water instead of hot water, are all examples of conservation. Also, turning off appliances and electronics when on vacation can save energy and money.

2. Get a home energy audit.

Our utilities offer free online energy audits that can help you identify how to save energy.

Southern California Edison serves Santa Barbara County from Gaviota south to Carpinteria. It offers two online audits – one that that takes about 5 minutes and requires very little information, and one that takes about 15 minutes and provides a more comprehensive analysis of your energy use and costs based on your billing history. (For this you will need your Edison service account number.) The surveys are available at: https://websafe.kemainc.com/websitesce/.

PG&E serves Santa Barbara from Gaviota north to Santa Maria. To conduct its online audit you will need to set up an account at: http://www.pge.com/energysurvey/.

3. Install cost-effective energy efficiency improvements.

High efficiency fluorescent lights (including CFLs), double pane windows, and high efficiency pool pumps cost less than one fourth of the retail cost of electricity, on a per kWh basis, and are the most cost-effective measures for homeowners. High efficiency appliances such as Energy Star refrigerators, freezers, washing machines, and water heaters are also cost-effective. Your home energy audit may identify additional measures.

What can businesses do?

1. Conserve energy.

As with homeowners, much energy can be saved through no cost conservation measures such as turning off lights when not used, turning off computers when not used, setting power options on computers and other equipment to "power saver" mode, etc. Essentially, employees, managers, and building managers could save significant energy and dollars for a company by being more conscious of energy use and conserving where possible.

2. Get an energy audit for your business.

Businesses can typically obtain even more specialized energy audits. Facilities located in Santa Barbara County south of Gaviota are Southern California Edison customers; north of Gaviota are PG&E customers.

A site visit audit can be obtained by calling Edison at (626) 812-7682. Edison's online commercial energy audit is available at: http://www.energyguide.com/energysmartsbe/sbemasterframe.asp?referid=91&bid=sce&sid=447.

A site visit audit can be obtained by calling PG&E at (800) 468-4743, option 3, and asking for an integrated energy audit. PG&E's online commercial energy audit is available at: http://www.pge.com/biz/energy_tools_resources/energy_audit/index.html.

3. Talk to an "energy service company" about no-cost energy efficiency improvements.

"Energy service companies," also known as ESCOs, audit business facilities and provide energy efficiency improvements at no charge to the business. The business saves on utility bills and the ESCO receives compensation by sharing in those savings.

For more information on ESCOs, visit the National Association of ESCOs website at www.naesco.com. This website offers a search tool to locate an ESCO that would be appropriate for the described task: http://www.naesco.org/providers/default.aspx.

4. Implement "flex time" or telecommuting options for employees.

Flex time and telecommuting policies allow employees to travel less for work and be more efficient in how they use energy. In addition to being one less car on the road, telecommuters can save employers the energy needed to operate an office or facility by allowing employees to stay at home to work or to not work at all on certain days. Many local businesses and agencies offer these options to their employers, as do some city and county governments. For information on flex time programs in our region, visit www.flexworksb.com

5. Build LEED certified buildings.

Leadership in Energy and Environmental Design (LEED) is a program of the U.S. Green Building Council that certifies buildings as models of good environmental stewardship (www.usgbc.org). LEED certified buildings are highly energy efficient, use less water, generate less waste and have less impact on land use than normal buildings. Businesses should consider LEED certification – at as high a level as is feasible – as well as Built Green certification, a local program designed to provide builders in the City of Santa Barbara with incentives to "build green" More information on Built Green can be found at www.builtgreensb.org.

What can local governments do?

1. Adopt the same options recommended for the business sector

Options for local governments include options 1 through 5 for businesses above. A very good first step for local governments is to ensure that all new government building construction and remodels are LEED certified. We recommend LEED Silver or better. If local governments lead the way with their own buildings, they are likely to face less opposition in imposing additional energy efficiency requirements on the private sector, as detailed below.

2. Incorporate aggressive energy efficiency goals into the General Plan

Similarly, local governments should incorporate aggressive energy efficiency goals and/or the Architecture 2030 Challenge into their General Plan process. The City of Santa Barbara City Council voted in early 2007 to consider incorporating the Challenge into their General Plan update. The County of Marin went further by meshing their own Fossil Free by '33 program (modeled directly after our program here in Santa Barbara County) goals with their general plan.[24] General Plans provide long-term direction to cities and counties and represent the most far-reaching manner in which local governments can incorporate energy efficiency into their work.

3. Adopt building standards that go beyond Title 24.

In line with the Architecture 2030 Challenge, local governments should consider adopting ordinances for all buildings within their jurisdiction to exceed the State's Title 24 standards for energy efficiency. These state standards are due to be updated in 2008 and 2011, and it is likely that they will become more stringent at those times.

If local governments enact ordinances to go beyond Title 24, as many local governments have over the last two years, it is possible that Title 24 will be upgraded in 2008 or 2011 to match the local requirements. As mentioned earlier, the City of Palm Desert is the most recent agency to enact this type of ordinance.[25] These ordinances allow local governments to be ahead of the curve on energy efficiency, but not be so far ahead that unduly burdensome requirements are imposed on builders.

4. Adopt a "time of sale" energy efficiency upgrade standard.

Building standards generally only address new buildings or remodels, so time of sale standards are another means of increasing building energy efficiency. As discussed earlier, the City of Berkeley has adopted a time of sale energy efficiency ordinance that requires sellers to install a number of energy savings measures before sale.[26] These measures are not overly strict, so while they do impose some additional cost on sellers, the costs need not be burdensome if a similar ordinance was enacted by jurisdictions in Santa Barbara County.

5. Create a North County Energy Efficiency Partnership

Utility customers pay a small "public goods charge" each month as part of their utility bill, which is used to fund rebates to consumers for energy-efficient products such as compact fluorescent light bulbs, programs for turning in old refrigerators, etc. The fund is also used to provide incentives to the utilities to focus on energy efficiency improvements as a means of reducing demand.

In the southern half of the county, the South Coast Energy Efficiency Partnership creates opportunities for the utility – Southern California Edison – to reduce energy use by working with community leaders (see page x.) We urge all North County jurisdictions to work with PG&E on a similar partnership, which is being negotiated as of early 2007.

What Will CEC Do?

1. Continue to work with local governments to implement the Architecture 2030 Challenge

CEC will continue to work with the City of Santa Barbara, the County of Santa Barbara and other local governments in implementing the 2030 Challenge. While the City of Santa Barbara took the key first step in early 2007, much remains to be done. Our coalition will continue to provide information to the City and other local governments regarding the costs of compliance and other key issues.

2. Continue to work with the South Coast Energy Efficiency Partnership

CEC will remain as the contractor to SCEEP during 2007, working on such programs as the Small Business Direct Install program, which provides up to $5,000 in free energy efficiency upgrades to qualifying businesses. Visit www.southcoastenergywise.org for more information. Additionally, CEC will work with PG&E and North County cities, should the opportunity arise, to begin a North County Energy Efficiency Partnership.

3. Work with churches, school and other non-profits to improve energy efficiency

CEC began a new effort in early 2007 to reach out to churches, schools and other non-profits (all entities that don't pay taxes and thus can't take advantage of tax credits for energy efficiency or renewables) to improve their energy efficiency and to install solar panels. Essentially, CEC is attempting to fill a market gap left by Energy Service Companies, which often find this sector unattractive for their business model. Many building managers are unaware of the many rebates and other incentives available for energy efficiency and renewables, so much of our work will be alerting these entities to incentives. We will also help complete building energy audits and identify the most cost-effective measures for improving energy efficiency.

Endnotes

[1] 40,000 GWh equals 40,000,000,000 kWh. The state-wide average cost of one kWh was about $0.124 in 2005, according to the California Energy Commission, so 0.124 x 40,000,000,000 = $4.96 billion.

[2] Available at http://www.energy.ca.gov/energy_action_plan/index.html.

[3] We assume a 20 percent reduction in projected energy demand by 2020 for all buildings: 0.25 x [3,650 GWh electricity demand in 2020 + 7,070 GWh natural gas demand by 2020] = 2,144 GWh saved.

[4] 1,400 GWh x 15 cents per kWh = $210 million.

[5] Architecture 2030 Challenge, www.architecture2030.org.

[6] Source: Community Environmental Council, with data from the California Energy Commission and California Department of Transportation.

[7] CEC commissioned a technical report on energy efficiency, from KJK Associates, to help complete this chapter. The consultant report is available online at www.fossilfreeby33.org.

[8] These figures are from our technical report on energy efficiency, available online at www.fossilfreeby33.org.

[9] Rocky Mountain Institute, "Energy Efficiency: First Things First," http://rmi.org/sitepages/pid195.php.

[10] Assuming 6 hours a day of operation, with 70 percent savings for CFLs.

[11] 2005 Energy Star Annual Report. Online: http://www.energystar.gov/ia/news/downloads/annual_report2005.pdf.

[12] Energy Star website: https://estar6.energystar.gov/index.cfm?c=home.index.

[13] These figures are from our technical report on energy efficiency, available online at www.fossilfreeby33.org.

[14] Id.

[15] Title 24 is part of the California Code of Regulations and is available online at http://www.dsa.dgs.ca.gov/CodeChanges/title24.htm.

[16] City of Santa Monica website: http://www.greenbuildings.santa-monica.org/introduction/introperformanceordinance.html.

[17] A full list is available at the California Energy Commission's website: http://www.energy.ca.gov/title24/2005standards/ordinances_exceeding_2005_building_standards.html.

[18] Berkeley's residential energy efficiency ordinance is available at http://www.ci.berkeley.ca.us/bmc/berkeley%5Fmunicipal%5Fcode/title%5F19/16/index.html.

[19] California Energy Commission, "Options for Energy Efficiency in Existing Buildings," (Dec., 2005), page 10.

[20] Cite.

[21] 2030 Challenge website: www.architecture2030.org.

[22] Nationmaster.com: http://www.nationmaster.com/graph/ene_ele_con-energy-electricity-consumption.

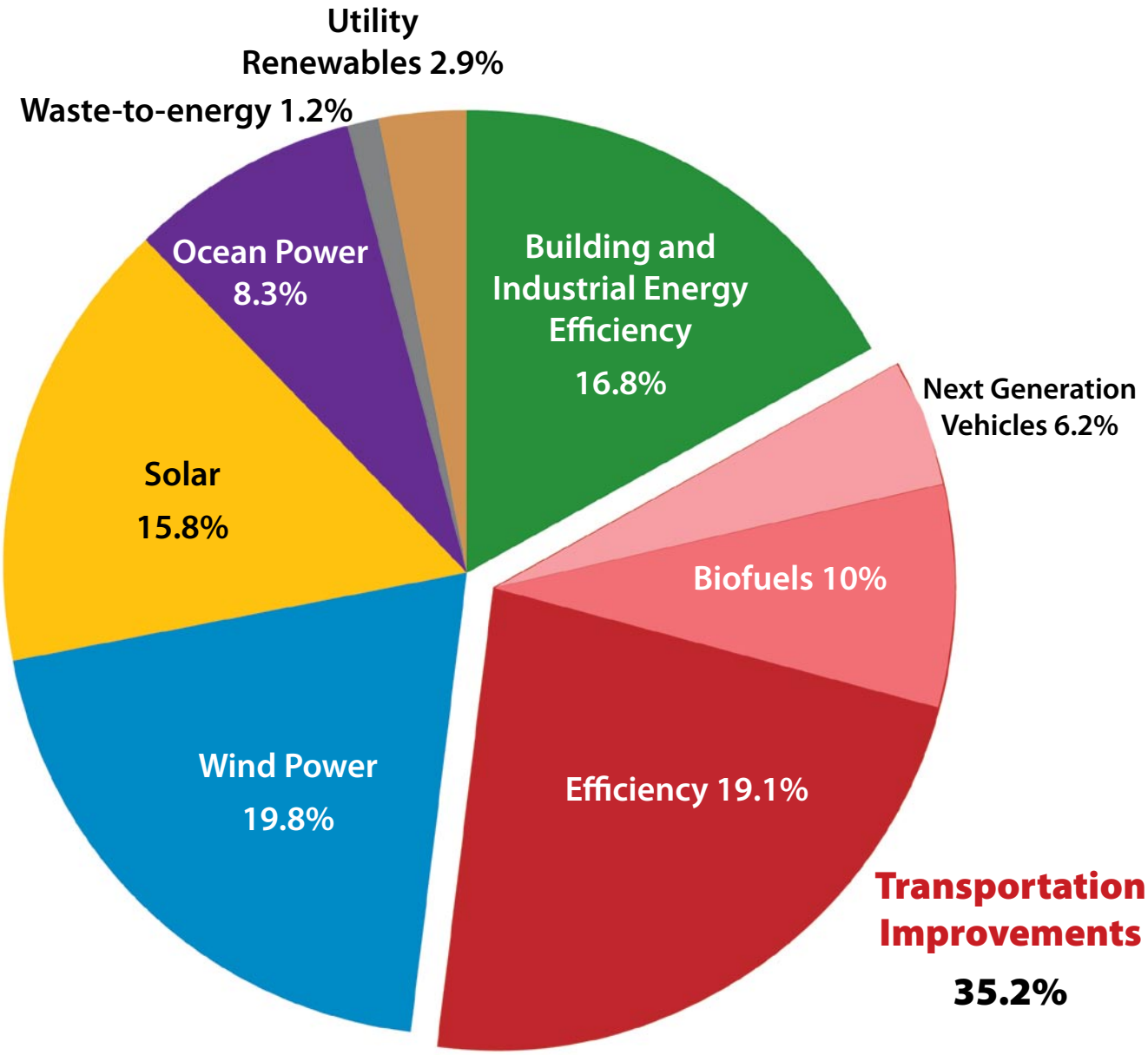
[23] More information on energy efficiency mortgages can be found at the Department of Housing & Urban Development website: http://www.hud.gov/offices/hsg/sfh/eem/energy-r.cfm.

[24] County of Marin website: http://www.co.marin.ca.us/depts/CD/main/comdev/advance/BEST/fossilfree.cfm.

[25] "Palm Desert's energy plan receives funds," The Desert Sun, Dec. 15, 2006. Online: http://www.thedesert-sun.com/apps/pbcs.dll/article?AID=/20061215/NEWS01/612150374/1006.

[26] The ordinance is available online at http://www.ci.berkeley.ca.us/bmc/berkeley%5Fmunicipal%5Fcode/title%5F19/16/index.html.

Chapter 3 | Reducing Petroleum Demand



Introduction

More than half of Santa Barbara County's energy by 2030 will come from petroleum if we continue "business as usual." Most of that oil will be gasoline and diesel fuel consumed by cars and trucks. To meet our goal of weaning our county from fossil fuels by 2033 (or earlier), we will have to focus much of our attention on petroleum use reduction.

Photo: David Cowan

This point cannot be stressed enough. In order to change the course that we are on now – one that threatens our national security and takes us further toward serious climate change – we must tackle the transportation sector head-on.

Fortunately, we have options. Some will require personal and political will – such as taking an honest look at our behaviors and attitudes about driving, and designing communities in ways that make it easier to walk, bike, bus, or take the train. Others will require spurring local markets – such as working with car owners, fuel station owners and fuel manufacturers to move toward biofuels grown in or near our county.

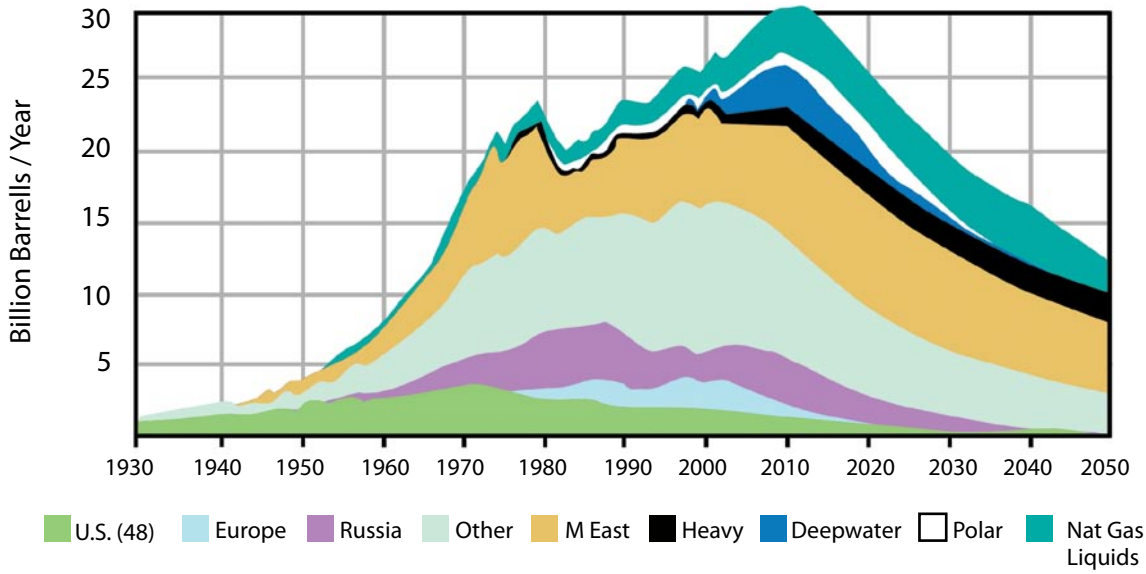
Others strategies for significantly reducing the use of fossil fuels will take personal investment. In a community that boasts the fourth highest rate of hybrids per household in the nation, we must carry that enthusiasm over to new emerging technologies such as plug-in hybrids and electric vehicles, once they're widely available. In fact, making a rapid shift to vehicles that run partially or entirely on electricity – and then generating that electricity through renewable resources such as wind or solar power – is one of the core components of this Blueprint.

If we do nothing and continue with business as usual in our county, we will need 207 million gallons of gasoline, 65 million gallons of diesel, and 24 million gallons of jet fuel and aviation gasoline in our county by 2030 – equivalent to about 11,200 gigawatt hours (GWh). (See Figure 3-2). If, however, our community tackles the transportation sector head-on, we could cut transportation petroleum demand by 50 percent or more, taking it down to about 5,600 GWh. With a total of about 21,500 GWh needed by 2030, this reduction would substitute for 25 percent of our projected total energy demand under the business as usual scenario. When we include 10 percent from biofuels (mostly biodiesel), we can meet 35 percent of 2030 demand from transportation improvements (see pie chart).

What does "Energy Independence" mean?

When we hear the words "energy independence," we should think "petroleum independence" because petroleum is by far the biggest energy import to the U.S. While our nation's oil production peaked in 1970, our voracious appetite for oil has not slowed much since then. To meet our growing needs, almost 70 percent of our petroleum is now imported -- much of it from highly unstable or unreliable nations -- compared with about 30 percent in 1970.

Figure 3-1. Hubbert Curve Projection of Global Oil and Natural Gas Liquids Production
(Source: The Association for the Study of Peak Oil & Gas, C.J. Campbell, June 2004)



Technical Assessment

There are four primary strategies or technologies for reducing petroleum use for transportation in our county.[4] First, we need to focus on alternatives to normal driving such as walking, biking, carpooling, car sharing, trains and buses. Second, better land use planning can make these options more viable for more people. Third, we need to transition to more fuel efficient and smaller cars, biofuels, and hybrid cars because these fuels and vehicles are available today. Fourth, next generation vehicles such as electric cars, plug-in hybrid cars, and hydrogen cars will help us transition away from petroleum in the mid- to long-term, using electricity instead of petroleum as a transportation fuel. Next generation vehicles are discussed in Chapter 4; we focus on the first three strategies in this chapter.

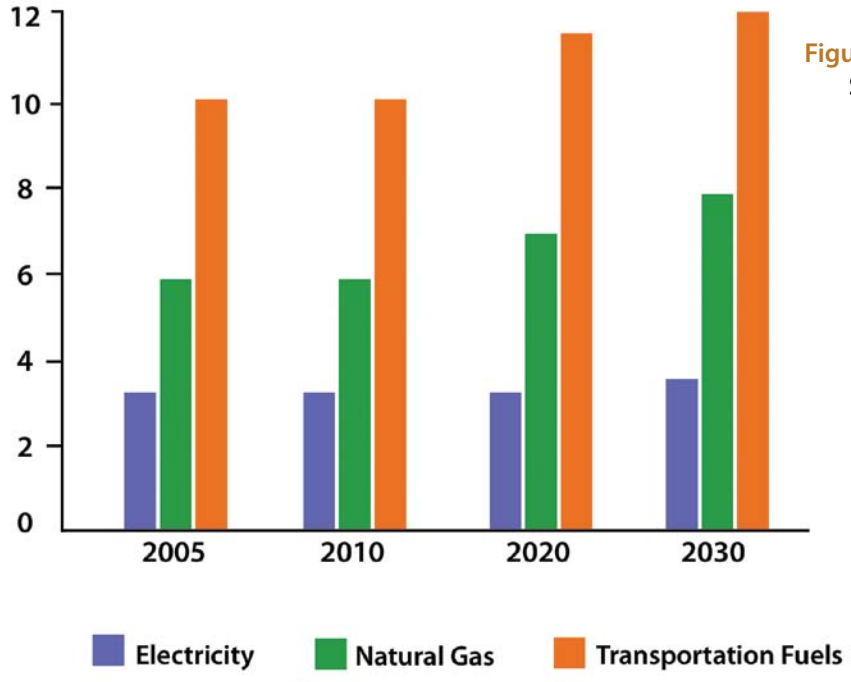
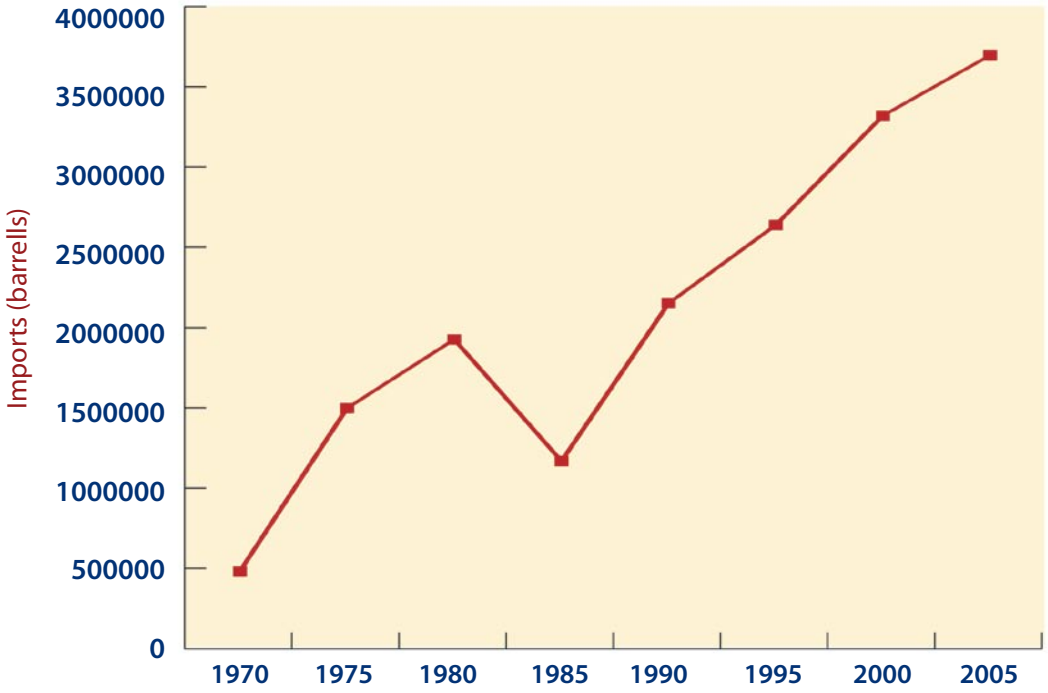


Figure 3-2. Current and projected energy use in Santa Barbara County (gigawatt hours).[2]

Figure 3-3: U.S. oil imports have increased dramatically over the last three decades as U.S. oil production has declined.[3]



Alternatives to normal driving

The fastest and cheapest way to reduce petroleum demand is of course to not drive. However, of all the options we discuss in this Blueprint, changing habits and attitudes about driving is arguably the most difficult. Perceptions about safety and the desire for convenience keep many of us in big cars and single-occupancy vehicles. Complicating matters, the lack of affordable housing in our region forces thousands of workers to commute increasingly long distances to and from their workplaces.

While higher gas prices are probably the biggest factor in changing behavior, our communities can create incentives to encourage more walking, biking, busing, trains, telecommuting, carpooling, and even car sharing. In fact, many creative and successful programs already exist.

For example, ridership on the Clean Air Express, a bus service that takes commuters to and from the City of Santa Barbara, increased 30 percent in 2006. The annual Team Bike Challenge,[5] a South Coast competition to encourage biking to work, doubled its number of participants in 2006 and 2007 – with more than 1,100 people on 230 teams taking the month-long challenge. And Car Free Santa Barbara – a unique project that provides information, vacation packages and other incentives to draw visitors to the region without their cars – has grown to more than 90 partnering hotels, restaurants, and other businesses.[6] While still only a small portion of the county's total population participate in these programs, these statistics show what is possible if our communities were to make it a priority to significantly reduce everyday driving.

Another creative alternative for those who need occasional access to a car but who don't want or need to own one themselves is car sharing. This is similar to renting a car, but allows a person to rent by the hour rather than the day. A driver can pick up the car in various reserved parking spots, drive to his or her destination, and then leave the car at another designated parking spot. Car sharing is available in more than 60 cities in the U.S. and Canada, including Boston, Philadelphia, Chicago, Austin,

Los Angeles, San Diego, and San Francisco. UC Santa Barbara offers a car sharing program, and the City of Santa Barbara is in discussions with Flex Car,[7] one of many car sharing companies in North America, to create a program in that city. (Learn more about car sharing at www.carsharing.net).

New programs are also making it easier for drivers who are interested in carpooling to find one another. Drivers in Santa Barbara County can access Traffic Solutions Online[8] for instant, personalized commute information to find the most convenient carpool, vanpool, commuter bus service or bike route. Traffic Solutions also offers an Emergency Ride Home program and cash benefits to some qualifying commuters.

Programs like these are extremely important for our region and should be encouraged and expanded. However, in the end we cannot significantly reduce our fossil fuel use unless we address the tough issues regarding how our communities are designed, how they connect with one another, and how we transport people and goods between our communities and the rest of California.

Land Use and Petroleum Demand

The post-World War II demand for housing spurred rapid development in our county and elsewhere. This development was increased by the availability of cheap energy and cheap land. Widespread use of the automobile and suburban sprawl have dominated the last 50 years of development, while the nation's standard of living has risen. The resulting land use patterns have had a number of negative consequences, including:

- Inefficient resource consumption – particularly petroleum
- Fostering the automobile as the preferred means of transportation
- Inhibition of transit alternatives
- Increases in the costs of providing infrastructure

Commuter Rail

In recent years, there has been a concerted local effort to have commuter rail service connect the Santa Barbara South Coast and Western Ventura County. In July, 2005, the Santa Barbara Commuter Rail Study was prepared by a consultant for SBCAG. Based upon this report and other considerations, a pilot commuter rail program was included in the proposal for a renewed transportation sales tax (Santa Barbara County's Measure D) that appeared on the ballot in November, 2006.[9]

While Measure D did not unfortunately garner the necessary two-thirds majority required to pass, efforts by both citizen groups and local government to bring commuter rail to the region continue. In 2004, a local citizen's group, Coastal Rail Now, was formed and began a grassroots community effort in support of commuter rail. Coastal Rail Now has continued to analyze and promote commuter rail.[10]

Electric Buses

The Santa Barbara Metropolitan Transit District (MTD) provides local bus service to the cities of Santa Barbara, Carpinteria, Goleta, and other urbanized areas of the South Coast. With a 90 vehicle fleet and over 30 transit routes, it has an annual ridership of over seven million people. The District recently purchased eight new hybrid diesel buses – the first in the region to do so.

MTD was a national transit leader in the 1980s when it began running a fleet of electric buses in downtown Santa Barbara. The electric buses were an instant success, attracting over one million passengers in the first year. With a fleet of 20 vehicles, electric bus service has been expanded to a "cross-town connector" in Santa Barbara and as a "downtown Seaside Shuttle" in Carpinteria. As part of a recently approved enhanced service, electric shuttles will be coming to Isla Vista in 2008.

The MTD Board of Directors recently began examining the feasibility of solar charging of the electric bus batteries. This could take the MTD's electric bus fleet off the grid, a new first if accomplished. The key issue will be cost, as batteries are expensive. MTD is, as of early 2007, examining the issue in detail.

One of MTD's electric shuttles.

The relationship between energy and land use in California is reviewed in detail in the California Energy Commission's *2006 Integrated Energy Policy Report Update*. The Commission concluded that the permanent nature of past land use choices will dictate and possibly limit many of our transportation and energy choices for generations to come.[11]

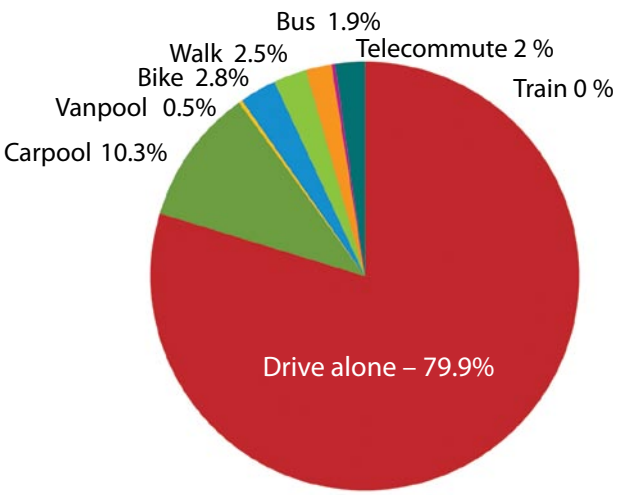
In Santa Barbara County, land use and transportation problems have been exacerbated by the high cost of land and materials, not atypical of other coastal areas of California. The median price of a home in Santa Barbara County (approximately $700,000) and in the South Coast of Santa Barbara County ($1.2 million) far exceeds the state average of $550,000 in 2006.[12]

The upward spiral of housing costs in our county has led to an increasing distance between where people live and work. Accordingly, we are witnessing an ever-increasing number of commuters in our county. As this pattern continues, housing prices will increase over time in areas surrounding high-priced employment centers, and commute distances and duration will continue to increase. Moreover, commuters are overwhelmingly driving cars alone (See Figure 3-4), which is the most *inefficient* transportation mode when we consider energy required for each mode.

Can we change these trends? We could begin by including energy demand, supply, and infrastructure as central considerations in land use planning. State and local governments can then make better use of resources and meet energy-related goals such as reducing greenhouse gas emissions. (California's recently-passed AB 32, the Global Warming Solutions Act, requires a reduction in greenhouse gas emissions back to 1990 levels by 2020.) Broadening the scope of community planning to encompass energy-saving strategies and integrating these strategies into community and regional planning efforts is the first step in that direction.

Numerous local governments and community organizations have attempted to address the issues surrounding the relationships between housing, open space and transportation. The Santa Barbara County Association of Governments (SBCAG), the Santa Barbara Region Economic Community Project,

Figure 3-4. Santa Barbara County commute modes, by percentage of commuters adopting each mode.[13]



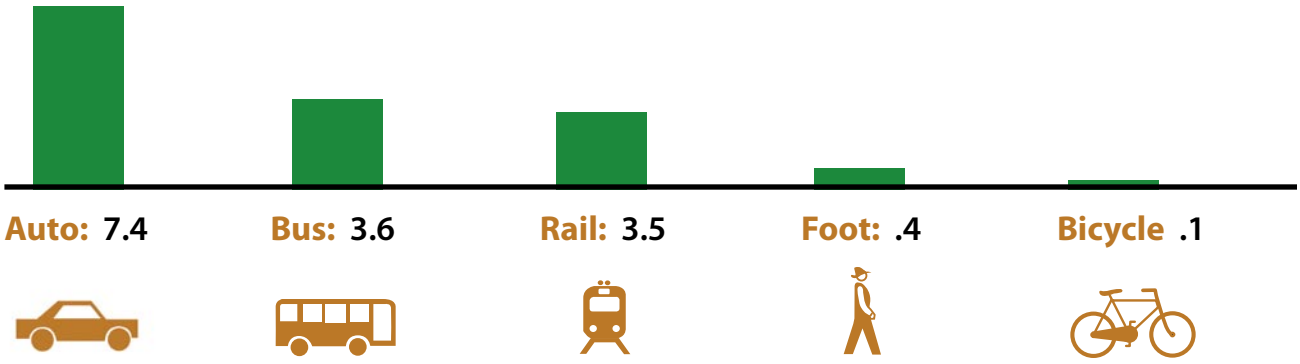
the Community Environmental Council, the Sustainability Project, and coalitions such as the South Coast Livable Communities Project have produced policy papers, guidelines and strategies regarding these regional issues. Most of the recommendations that result from these efforts focus on reducing the use of the single occupant vehicle – primarily as a means of reducing traffic, congestion and air pollution. These actions will, of course, also reduce the use of petroleum – the primary goal of this document. This chapter's Action Plan contains the key recommendations resulting from prior community-based efforts.

Small, Fuel-Efficient Cars and Hybrid Vehicles

While we do not design or manufacture cars in our region, we can affect these markets in our county. In 2006, California was home to more hybrid vehicles than any other state by a long shot. California also had more hybrids per capita and boasted three of the top four communities for per capita ownership in the nation – including Santa Barbara.[15] This is good news not only for hybrids, but for all emerging vehicle technologies, as it shows our residents' willingness to invest in vehicle fuel efficiency.

The biggest incentive for purchasing these vehicles is, of course, the opportunity to save on fuel costs – which is a considerable incentive with gas at over $3 a gallon and climbing. However, as our region explores ways to cut petroleum use, we may want to consider developing other incentives to move even more drivers in this direction. These incentives could include local rebates on fuel efficient cars, designated parking spaces for hybrids and/or compact vehicles, or programs that encourage businesses, agencies and schools to transition to fuel-efficient fleets. Many of these options are described in detail in this chapter's Action Plan.

Figure 3-5: Energy required per passenger mile traveled (in BTUs).[14]



Efficient Small Cars

While hybrid cars have received a good deal of attention for improving gas mileage by running partly on electricity from rechargeable batteries, many non-hybrid models today are smaller and lighter and offer fuel efficiency as good as some hybrids. For example, the 2007 Toyota Yaris and Honda Fit both get about 35 miles per gallon (mpg) combined highway and city – compared to 31 mpg for the hybrid Honda Accord.[16] Other models that achieve more than 30 mpg combined include the Ford Focus, Chevrolet Aveo, Hyundai Accent, Nissan Versa, Kia Rio, the Mini Cooper and the Mazda 3. For drivers who don't need a larger car, these compact, sub-compact, two-seater cars and even mid-sized cars offer the added advantage of being far less expensive -- retailing for about $15,000 compared to about $25,000 for a mid-sized hybrid.

Because diesel engines run more efficiently than gasoline engines, diesel cars offer even better mileage. Volkswagen's diesel versions of the Jetta, Golf and other models achieve about 40 to 45 mpg. Switching some passenger vehicle fleets to diesel vehicles would result in a substantial drop in petroleum demand. If we run diesel vehicles on biodiesel, we will see an even larger reduction.

Fuel efficiency standards in the U.S.

Gasoline consumption in the U.S. fell radically after the introduction of the federal Corporate Average Fuel Economy standards (CAFE) in 1975, when gasoline demand was 6.7 million barrels per day.[17] As a result, gas demand didn't return to 1975 levels until 1985. Unfortunately, CAFE standards have not been significantly strengthened since the early '80s, so demand for oil and gas has continued to rise, slowing only recently in light of historically high prices in 2005 and 2006. In 2006, our nation used about 21 million barrels a day – a three-fold increase from 1975. Efforts to increase CAFE standards significantly are finally gaining traction in Congress in 2007. To help, you can call your congress member to urge her or him to support a strong increase in CAFE standards.

Hybrid Cars

Today's hybrid cars run off a rechargeable battery and gasoline, but in the near future could run off batteries and diesel, which is more efficient than gasoline and could be replaced with biodiesel, an even better alternative. Depending on driving circumstances and the hybrid configuration, the vehicle is powered by the internal combustion engine, by the electric motor, or both simultaneously. The battery in today's hybrid cars does not need to be plugged into an external outlet, as it is automatically recharged by power generated by the engine or by the braking process.

While not all of the dozen hybrids on the market use the hybrid technology to improve the vehicle's gas mileage (some put the increased energy into performance), several hybrids top the list of the least polluting and most fuel efficient vehicles on the road today. The Toyota Prius -- a mid-sized sedan -- achieves "real world" mileage of about 45-50 mpg, and the Honda Civic, the second best performing vehicle, achieves about 42 to 47 mpg. These models achieve almost twice the average of 25.4 mpg for all passenger vehicles sold in 2007.[18]

Today, hybrid cars comprise just one or two percent of all vehicles sold in the U.S., but that figure will probably increase quickly. In contrast to the fairly flat sales of conventional automotive sales, hybrids are experiencing very rapid growth. From 2000 through 2006, annual sales nationwide grew from 9,000 to more than almost 253,000,[19] an annual rate of increase of almost 70 percent. Even at half that growth rate, hybrid sales in the U.S. could top 10 million by 2020. And as mentioned earlier, hybrid ownership in California and Santa Barbara is particularly strong, with almost six hybrids per 1,000 households in the City of Santa Barbara – the fourth highest in the nation.[20]

The Toyota Yaris achieves about 35 miles per gallon.

A recent study found that every hybrid vehicle model on the market in early 2007 was cost-effective compared to similar non-hybrid vehicles when decreased fuel costs, lower insurance rates, depreciation and other costs were considered.[21]

Biofuels such as ethanol and biodiesel

Ethanol and biodiesel -- biofuels typically derived from plants -- provide some of the most immediate opportunities for significantly reducing our petroleum demand because both the cars and the fuels already exist. Our task is not to reinvent the wheel but to smooth the way for vehicle owners to make the transition to these fuels. If we can create biofuels using locally grown fuel crops that don't require prime agricultural land or large amounts of water, this energy source has great promise.

Our county's first challenge is to work with existing station owners to provide ethanol and biodiesel – a process that CEC has already initiated with the help of grants from the California Air Resources Board and the U.S. Department of Energy. Our county can also strengthen the market for biofuels by incentivizing their use in government and corporate fleets and educating the public about how to transition to these fuels today. In concert with these steps, we must make it a regional economic priority to attract manufacturers who are interested in developing biofuels from sustainable and locally produced crops.

Figure 3-6 illustrates where alternatives to petroleum-based fuels -- including ethanol, biodiesel, and synthetic diesel made through the Fischer-Tropsch process – are in terms of commercial development today.

Ethanol

Ethanol -- or ethanol alcohol -- is a biofuel primarily made in America from fermented corn, though it can be produced from other feedstocks such as sugar (primarily in Brazil, which produces almost as much ethanol as America), straw, switchgrass and willow trees. Approximately five million flex-fuel vehicles in the U.S., including more than 328,000 in California, have been designed to run on any combination of gasoline or ethanol. However, only one public fueling station in California – located in San Diego – offers ethanol to the public, and only a small percentage of vehicle owners know that they are driving a flex-fuel vehicle. CEC is working to address this problem by installing five ethanol and/or biodiesel pumps at existing fueling stations on the Central Coast, as part of a 15-station corridor in Southern California. Conserv Fuel, in Brentwood, will be the first station partnering with us to install E85 dispensers.

Generally sold as a mix of 85 percent ethanol and 15 percent gasoline known as E85, ethanol is a clean-burning, high-octane alternative to gasoline. However, ethanol is not currently offered widely at retail pumps in California because state air pollution control agencies have historically been wary of some emissions from E85.

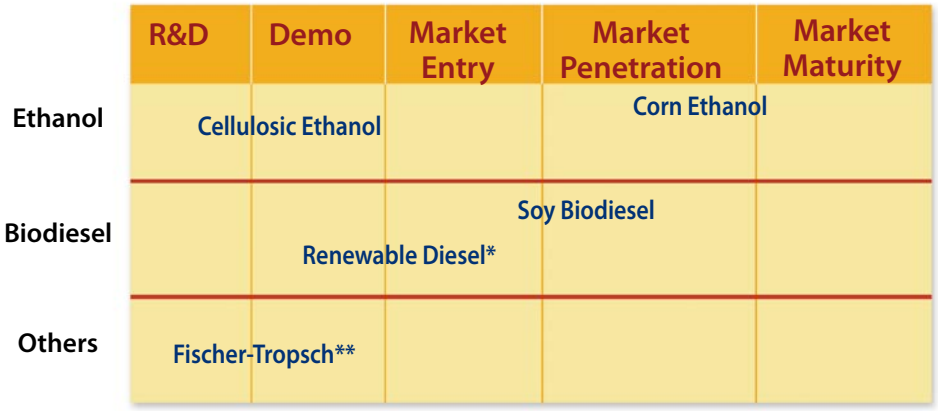
Diesel/electric hybrid cars

General Motors, DaimlerChrysler, and Peugeot (a European car company) are all developing diesel/electric hybrids that are expected to be on the market by 2009 or later. Normal diesel vehicles already get higher mileage than gasoline vehicles -- such as the VW Jetta TDI, which achieves 40 to 45 miles per gallon or more on diesel. By combining hybrid technologies with diesel fuel, VW has achieved 118 mpg in prototypes, although this was not indicative of real-world driving conditions.[25] As we look for opportunities to create a truly fossil free vehicle, one option in the very near future will be to run biodiesel through these new hybrids, with the potential to create an entirely fossil free transportation option.

In light of new research, the state's air pollution control agencies are revising permitting requirements in line with the state's Bioenergy Action Plan,[23] which endorses ethanol as a petroleum alternative.

In addition to E85, ethanol can be blended with gasoline in smaller amounts – up to 10 percent without engine modifications – as an oxygenate. In California, where it is blended into regular gasoline to help

Figure 3-6. Commercial development of key transportation fuel technologies.[22]



** Refers to the conversion of fatty acids in vegetable oils or animal fats into paraffins*

*** Refers to synthetic diesel obtained from thermo-chemical conversion of biomass*

comply with state air quality standards, all gasoline sold contained 5.7 percent ethanol in 2007. Recently, California passed regulations to require all gasoline sold in California to contain 10 percent ethanol starting in 2009, which will boost ethanol demand significantly. As a result of this practice, nearly a quarter of all ethanol sold in the U.S. in 2006 was sold in California – even though we do not yet offer E85 at the pump as is common in Texas and the Midwest.

Ethanol faces three main criticisms – all of which are surmountable. The first is that almost all ethanol produced in the U.S. today relies on a food crop as a feedstock, with more than 95 percent of the five billion gallons of fuel-grade ethanol sold in the U.S. in 2006 being produced from corn, mostly from the Midwest. Some argue that this will diminish the amount of corn available for other purposes and may be providing upward pressure on corn prices.

Although this concern has some merit, we see corn-based ethanol not as a final solution, but as a stepping stone. Even with corn as the primary feedstock, ethanol achieves two important goals: it provides immediate solutions for energy independence and some reduction of greenhouse gas emissions, and it helps create a biofuel infrastructure that will be compatible with more environmentally-friendly ethanol made from "cellulosic" feedstocks being developed by companies like Canada's logen Corp. These cellulosic feedstocks promise much larger benefits in energy returns on energy invested, and large cuts in the amount of CO2 released from liquid fuels. Cellulosic ethanol can be made from fast-growing plant species like switch grass and poplar trees, which require less water and fertilizer and can actually improve marginal agricultural land – and thus will not affect prime agricultural land availability. Cellulosic ethanol can also be made from waste products like straw husks, wood chips or even municipal solid waste.

A second concern is that greatly expanding corn ethanol production entails converting natural ecosystems to industrial agriculture, along with associated water and air pollution from increased corn agriculture and ethanol production facilities. These are serious concerns, and we recognize that trading tailpipe emissions, climate pollution, and energy independence solutions for water and land problems isn't a win-win situation. While it isn't within the scope of this paper to discuss all the complexities of the debate, transitioning to cellulosic ethanol will sidestep many of these problems.

The third main criticism of ethanol is based on the notion that it takes more energy to grow and harvest the corn, produce the ethanol, and transport the fuel than we receive in return. Unfortunately, the

2007 model E85-compatible vehicles

- 4.7L Chrysler Aspen
- 4.7L Jeep Commander
- 4.7L Jeep Grand Cherokee
- 3.3L Dodge Caravan, Grand Caravan & Caravan Cargo
- 2.7L Chrysler Sebring Sedan
- 4.7L Dodge Durango
- 3.3L Caravan & Grand Caravan SE
- 4.6L Ford Crown Victoria
- 5.4L Ford F-150
- 4.6L Lincoln Town Car
- 3.9L Buick Terrazza
- 5.3L Chevrolet Avalanche
- 3.9L Chevrolet Express
- 5.3L Suburban, Tahoe, Yukon, Yukon XL
- 3.9L Chevrolet Uplander
- 3.9L Saturn Relay
- 3.9L GMC Savana
- 3.9L Pontiac Montana 5V6
- 5.3L Sierra & Silverado
- 2.5L Mercedes C230
- 4.6L Mercury Grand Marquis
- 5.6L Nissan Armada

two studies finding this result received a good deal of publicity before the issue was fully explored. Since then, more recent and comprehensive studies show a positive energy balance for corn-based ethanol and soy-based biodiesel.[24] Still, we will work to incentivize producing ethanol from cellulosic feedstocks – preferably those that have been grown locally. To start, we will continue to encourage American Ethanol in Santa Maria – the first biofuel plant in the county – to shift from Midwest corn to other feedstocks as soon as possible.

Biodiesel

Biodiesel is a high-cetane, sulfur-free alternative to petroleum diesel. It is derived from vegetable oil – most commonly from soy beans – but can also be produced from animal fats and waste oil, such as that from a restaurant deep fryer. Biodiesel can be used in most standard diesel engines with little or no modifications, although vehicle owners need to be aware that most warranties won't cover the use of biodiesel blends over five to 20 percent (depending on the manufacturer).

As with ethanol, biodiesel is often blended with traditional fuels. Two of the most popular are B-20 (a blend of 20 percent biodiesel and 80 percent diesel) and B-99 (which is almost entirely comprised of biofuel). Biodiesel's energy content (BTU/gallon) is 10 percent lower than petroleum diesel; however, because it improves engine efficiency, real-world experience indicates that biodiesel fuel economy tends to be only two to three percent lower than petroleum diesel.

Also, as with ethanol, one of the biggest hurdles is the availability of biodiesel. Over the years, a number of vehicle owners have banded together in our county to regularly purchase a delivery of small quantities of biodiesel or to collect restaurant grease to make their own. As of mid-2007, only three public fueling stations in the county offered biodiesel, and only one – USA Petroleum at the corner of Carrillo and San Andres Street in Santa Barbara – offers it on a normal retail basis. Again, CEC is working to address this problem by installing five additional ethanol and/or biodiesel pumps at existing fueling stations on the Central Coast, as part of a 15-station alternative fuel corridor for Southern California.

While only about 60,000 gallons of biodiesel were used locally in 2006, this amount is expected to increase dramatically for a number of reasons. First, in 2006 the City of Santa Barbara began using B20 in all its diesel vehicles. Second, while diesel passenger vehicles historically have not been particularly common in California because of the state's strict air pollution laws, a cleaner variety of petroleum diesel (ultra low sulfur diesel) is now available – which will make both diesel engines and biodiesel alternatives more attractive.

Jatropha plant

Jatropha is a promising biodiesel feedstock plant that can be grown in California. Jatropha has been grown for centuries in India as a hedgerow, but is also grown to provide oil for lamps, as its seeds contain an extremely high oil content of almost 50 percent . Jatropha was recently imported to Santa Barbara by Biodiesel Industries, a local company, and is being tested for feasibility as a biodiesel fuel crop in our county. This plant is very hardy, requires minimal watering and can grow on marginal agricultural land.

Overcoming Barriers to Reducing the Use of Petroleum

Cost of Upgrading to New Fuels or Technologies

Many recommendations in this chapter will not result in increased costs to residents – such as walking, biking or taking the bus. However, we acknowledge that most county residents will continue to own and drive cars. Accordingly, it will be important for us to focus on getting residents into better cars. For most of us, purchasing a new vehicle involves a considerable investment in time and money. Some consumers may be interested in the hybrid or flex-fuel vehicles now on the market, but may shy away from the additional up-front cost of such a purchase. However, according to a recent study by Intellichoice, discussed earlier, the additional costs of hybrids are more than offset by savings during the first five years of ownership from reduced fuel costs, insurance and depreciation. If more consumers knew these facts, we suspect that hybrid sales would be even higher.

One way our region can continue to actively encourage residents to invest in new technology is by offering rebates to those who purchase fuel efficient, flex-fuel or hybrid vehicles. Google, Inc., for example, offers a rebate of $5,000 to employees buying a hybrid with a combined mpg of 45 or better, and Bank of America offers its employees $3,000. In our region, green building contractor Allen Associates offers a $2,500 to $5,000 hybrid car rebate as part of a broad package that also incentivizes using biodiesel or getting to work by bus, bike or foot.

Creative incentives such as these will be even more important as plug-in hybrids, electric-only vehicles and possibly hydrogen internal combustion engine and fuel cell vehicles become available over the next few years. Even though these technologies should follow the same pattern as hybrids by offering significant savings in reduced fuel costs, it is important that we offer incentives to those who make the initial investment.

Lack of Regional Planning or Collaboration

While many individual communities and agencies have developed some creative solutions for getting county residents out of their cars, we simply will not be able to drastically reduce the use of fossil fuels unless we start thinking like a region. This means that honest and respectful conversations about transit options and affordable housing need to take place between all the major cities in our county, and even down to Ventura and Oxnard.

Despite the many previous efforts to improve our county's transportation systems, there has been a mixed record of success, at best. We have not seen the level of regional communication and collaboration that it would take to face the serious transformations that our energy future demands. Current land use incentives, economic pressures, and decision-making systems in many ways prevent our communities from making hard choices. The lack of popular and political will to make the dramatic, but necessary, changes in our lifestyles make decisions even more difficult. The root causes of the general lack of progress in our county include:

- No single entity has enough control or influence to address the issue comprehensively or to compel solutions that will substantively change existing trends
- Local agencies perceive a loss of control that has frustrated any attempt at building agreements on a regional basis; and
- The lack of sufficient financial resources to fund improvements results in competition between short-term and long-term priorities.

Establishing successful regional cooperation will require overcoming serious skepticism by certain stakeholders. Achieving consensus today to solve the problems of tomorrow will be hard. History has shown it often takes a crisis before people and institutions respond in a serious manner, and then it may be too late to avoid serious economic and societal disruptions. If and when "peak oil" manifests in our county (and more widely), it may be too late to make the required changes. It is our hope that this Blueprint will at least prompt discussion of the weighty issues facing us and lead to positive change in time to make a difference.

As local governments implement "smart growth" measures to promote more mixed use development (where people live and work in the same area), we will gradually see a reduction in the amount of petroleum each resident uses. This is, however, a longer term vision and probably will have limited effect over the next 10 years on a county-wide basis.

Misperceptions and Lack of Information About Ever-Changing Technologies

When the first gas/electric hybrid vehicle, the Honda Insight, came on the market in 1999, it was small and had virtually no trunk space. While the two-seat Insight is no longer manufactured, some consumers may still hold a mental image of this or other now-defunct technologies – such as General Motor's EV1, a subcompact electric-only vehicle.

In a culture that tends to equate car size with perceptions of safety, some consumers may reject new hybrid technology without being fully up to speed. However, of the dozen or so hybrid vehicles now on the market, many are mid-size – such as the Toyota Prius (a roomy hatchback), the Ford Escape and Toyota Highlander (both small SUVs), and the Lexus 400h (a mid-size SUV). All of these models received a listing of "good" on a series of tests – the highest listing awarded by the Insurance Institute for Highway Safety, except for the Ford Escape, which received "acceptable" ratings for some categories for the 2007 model year. Visit the Institute's website to check ratings for other vehicles.[26]

As plug-in hybrids, electric-only vehicles, and other alternative fuel vehicles become more widely available, there will likely be a lag time between the time the products are offered and the time consumers become widely aware of the new options. Vigorous efforts in our communities to spread the word can help reduce this lag time.

The Action Plan

It should be clear from the above discussion that, while many factors influencing our petroleum use are outside of our local control, there are many action items we can adopt locally to make a real difference.

What can individuals do?

1. Try alternatives to driving such as walking, biking, carpooling, busing and trains

The best way to reduce petroleum consumption is to not drive. The cheapest alternatives are to walk, bike, carpool, car share, or take a bus or train. These alternatives are readily available in our county or – as with car sharing -- are gaining traction, particularly in light of high gas prices. As our communities focus more on urban villages and smart growth, walking, biking and busing will become viable options for larger numbers of people. Communities that are designed for "mixed use," with more housing than normal in commercial areas, make alternatives to driving more attractive. Individuals can do their part to reduce petroleum use by looking to these alternatives.

2. Buy the most energy efficient vehicle that meets your needs

If you need a car and are in the market for a new car, consider purchasing one of the smaller, more efficient cars discussed above. When we realize that a large portion of the fuel we use is for moving the car itself around – instead of just moving the people and cargo in the car – it makes sense to use smaller cars for most of our transportation needs. Visit the Environmental Protection Agency's website at www.fueleconomy.gov to learn more about fuel efficient cars.

3. Buy a biodiesel vehicle or a flex fuel vehicle

Similarly, consider whether a biodiesel or flex fuel vehicle will meet your needs. Any diesel vehicle can run on biodiesel up to 5 percent without any concerns about the vehicle warranty. Some manufacturers allow up to 20 percent. As manufacturers learn more about the benefits of biodiesel, we anticipate most vehicle owners will be able to use blends up to B100 without affecting their warranty. **However, if you have a car that is still under warranty you should ask your manufacturer what the effect of biodiesel use will be on your warranty before you use biodiesel.** Learn more about biodiesel at the National Biodiesel Board's website at www.biodiesel.org and learn more about diesel vehicles at www.fueleconomy.gov.

Flex fuel vehicles are becoming more widely available. GM is still the primary flex fuel vehicle manufacturer in the U.S., but Ford, Nissan, and Daimler Chrysler now also offer flex fuel vehicles. Visit www.fueleconomy.gov about models offered and how they stack up against other types of vehicles or against each other.

As ethanol from cellulosic feedstocks such as switch grass, straw and poplar trees becomes commercially available, flex fuel vehicle owners will have an increasingly positive effect on climate change and air pollution by substituting cellulosic ethanol for petroleum use. CEC is working with local station owners to install a number of pumps from Oxnard to San Luis Obispo. If prices are favorable for ethanol, we expect flex fuel vehicle use of ethanol to increase. We also expect sales of flex fuel vehicles to increase at a more rapid pace. As discussed above, we are not enamored of corn-based ethanol but see it as a stepping stone to more environmentally friendly cellulosic ethanol.

4. Buy a hybrid vehicle

Hybrid vehicles cost more up front, but save more money in the long run. As discussed above, a 2007 Intellichoice analysis found every hybrid model on the market saved consumers money when fuel savings, insurance savings, lower depreciation, and other factors were considered. Accordingly, if you can afford the additional up front cost, a hybrid car purchase makes a lot of sense – both environmentally and economically. In particular, the Toyota Prius and Honda Civic Hybrid stood out as money savers and fuel savers. Learn more about hybrid cars at www.hybridcars.com. Beware, however, of buying a hybrid car simply because it is labeled as a hybrid. There are a number of "power hybrids" on the market today, such as the Honda Accord, Lexus 400h, and Lexus 450h, that have used the hybrid technology primarily to increase power, not to improve fuel efficiency.

What can businesses do?

Businesses and local governments can do their part by encouraging employees to use the alternatives discussed above. Additionally, businesses can:

1. Encourage employees to carpool, work flex time schedules or telecommute

Employers can save money, increase worker productivity and morale, while also helping save fuel by allowing employees to telecommute (work from home) or work flex time schedules. Flex time schedules generally allow employees to work, for example, four ten hour shifts each week, or work eighty hours in nine days, as a way of providing workers additional days off and achieving other goals such as, for example, reducing traffic congestion if roads are busy. Employers can also offer incentives for such programs, resulting in fuel savings for miles not driven.

Similarly, employers can encourage carpooling as a way of saving fuel.

2. Join car share programs

Car sharing, as discussed, is a fast-growing option that allows consumers to rent cars by the hour while having guaranteed parking spaces in places where they are needed. UC Santa Barbara is currently testing its car sharing program and discussions have begun between the City of Santa Barbara and Flex Car, Inc., about a possible car share program. Large employers should see if a car sharing program would work for their company, while keeping an eye on developments in the community at large. Currently, car sharing programs in the U.S. have been developed in larger metropolitan areas, but we hope to see one or more car sharing programs begin in our county over the next couple of years. Learn more about car sharing at www.carsharing.net or www.flexcar.com.

3. Buy biodiesel for diesel vehicles

Diesel vehicles inherently achieve better mileage per gallon than gasoline vehicles, and this holds true for biodiesel vehicles. Now that "ultra low sulfur diesel" is the only type of petroleum diesel available in the U.S., California and other states that have strict air pollution controls will be allowing many additional diesel vehicle models to be sold in-state. Accordingly, there are many new options for diesel vehicles that can also run on blends of biodiesel. Additionally, California air regulators have historically been concerned about biodiesel due to increased NO_x emissions. Numerous studies completed in 2006 have found, however, that NO_x emissions from

B20 blends of biodiesel are about the same as for regular diesel. While the California Air Resources Board and the county's Air Pollution Control District have not yet embraced this new research, they have issued guidance finding that all governmental fleet vehicles can run up to B20 without any air pollution concerns. By extension, companies can feel secure in purchasing B20 for their diesel vehicles from an air pollution perspective. **However, employers should check with their vehicle manufacturers regarding the impact on warranties from biodiesel use**.

4. Buy flex fuel vehicles

Many trucks offered by American vehicle manufacturers are now flex fuel vehicles, so consider this factor when making new fleet vehicle purchases.

What can local governments do?

Most of the recommendations for businesses also apply to local governments. Additionally, local governments can:

1. Join a county-wide energy task force

CEC will be actively working with local governments and non-profits to create a county-wide energy task force. This task force will, among other things, attempt to create county-wide solutions to our current and future transportation energy problems. Many groups have looked at transportation from a planning or congestion point of view, but very few have focused on energy use and its impacts on our economy and environment. Local governments are becoming increasingly active in energy planning and we urge all local governments to help create a county-wide energy task force.

2. Adopt "smart growth" land use policies and better transit policies

The South Coast Livable Communities project effort, completed in 2004, resulted in the following key recommendations, which are still pertinent in 2007 and are applicable to all of Santa Barbara County, not just the South Coast:

Infill Development - Encourage infill, re-development, and re-use of vacant or under-used parcels within an identified Urban Growth Boundary (UGB). UGBs are an effective way to reduce sprawl, protect agriculture, and promote compact development.

Transit-Oriented Development – Re-zone land within a quarter mile of major transit corridors to accommodate appropriately designed, neighborhood compatible, higher density projects and communities.

Mixed Use Development - Promote development that brings residences, day care centers, shops, restaurants, schools, parks, and employment opportunities within walking distance of each other and to transit stops.

Pedestrian and Bicycle Master Plans - Provide a network of convenient and safe sidewalks, bike paths and crossings that lead to destinations and accommodate people of all ages and abilities. Provide the public spaces with amenities like benches, good lighting and bike parking and storage.

Safe Routes to School - Establish, expand and promote Safe Routes to School activities and improvements, such as at crossings for traffic calming or replacing missing sidewalk links.

Transportation Demand Incentives and Management - Establish, expand and promote

TDM programs that discourage the use of single occupant vehicles and create incentives to encourage the use of mass transit (buses, etc.), bicycling and walking. These can include car share programs, transit subsidies and employee cash-out policies for those leaving their cars at home.

Parking Policies - Allow reductions in parking requirements for businesses that have prepared trip reduction plans and effective TDM programs. Encourage the use of hybrid, electric and other alternative-fueled vehicles by providing free or reduced parking rates or preferential location on street and in public parking facilities.

Local Transit - Expand the provision of local bus service throughout the County, in both transit district service territories. Optimize the frequency of bus service along major transportation corridors. Provide service connecting employment centers, schools and universities, public facilities and major areas of interest. Provide new, dedicated, local sources of transit funding.

Regional Transit – Expand the availability of commuter buses and vans. Integrate regional services with connecting local transit. Create a North County Metropolitan Transit District similar to the Santa Barbara Metropolitan Transit District, which would connect the many smaller transit agencies in the North County. If lanes are added to Highway 101, dedicate them for High Occupancy Vehicles (HOV lanes). Extend commuter rail service between Western Ventura County and the South Coast. Link expanded rail service with local transit systems and Metrolink.[27]

3. Incorporate energy planning into general plans and community plans

Local governments should also include energy planning into general plan updates and community plans. Many communities in our county, such as Orcutt, the unincorporated area of Santa Barbara County, the City of Santa Barbara and others, are in 2007 undergoing updates to their general plans or creating community plans. Long-term change can be achieved by including comprehensive energy planning in these documents. For example, the County of Marin is considering in early 2007 meshing CEC's Fossil Free by '33 goal into their general plan process. Their website has more details.[28]

4. Form a joint car pool for fleet vehicles

Local governments have extensive fleets. Many vehicles in these fleets are used rarely, giving rise to the possibility of cost and fuel savings by sharing vehicles with other local governments. We are not aware of this model being pursued elsewhere, but for certain local governments in our county – such as the cities of Santa Barbara, Goleta and Carpinteria, which are located fairly close to each other – it may make sense to discuss this option.

5. Construct parking structures that encourage alternatives to petroleum

Most parking structures are built for one purpose: to store cars while not in use. However, some recent parking structures are experimenting with alternative missions. For example, the City of Santa Barbara's new Granada parking structure has a bike parking area and a bike maintenance shop in the same building. Some parking structures in our county also have parking spaces reserved for electric cars. While up until recently, these reserved parking spaces seemed out of date due to the

disappearance of most electric cars from our roads, they may find use again soon with the resurgence of interest in electric vehicles. Also, parking structures could have reserved spaces for flex fuel vehicles or for those who carpool (with some means of identifying vehicles that are used for carpooling). Last, parking structures could reserve spots for car share vehicles, making it more likely that car share companies will be attracted to our region.

What will CEC do?

CEC will be working on many initiatives to further reduce our reliance on petroleum, including developing a more detailed action plan than contained in this chapter. More specifically, we'll be addressing the following items.

1. Work with local planning agencies and other stakeholders on mass transit issues such as increased bus service and commuter rail

CEC was involved with Measure D planning, a transportation improvement sales tax discussed above. Commuter rail is one of many mass transit issues facing Santa Barbara County. The CEC's general position is that mass transit solutions are beneficial insofar as they reduce driving and petroleum use by removing cars from the road. The key, as our county develops, will be to ensure we have excellent mass transit options at the same time as we promote increased housing density. We will continue to be involved in these issues and will work with other non-profits in our region and other stakeholders to find the best solutions. We will also help create a county-wide energy task force, also discussed above, that will look at many energy issues, including transportation planning.

2. Encourage purchase of more efficient small cars

There are many small car models available today that are much cheaper than hybrid cars in terms of up-front costs. These cars cost about $15,000 and achieve much higher gas mileage than the average car, though still not as good as most hybrid vehicles. As a potentially economical way of reducing petroleum use, individuals, businesses and governments should compare the costs of small and efficient cars versus hybrid cars, while also considering the better gas mileage that hybrid cars can achieve.

3. Encourage additional hybrid car sales

Where a small fuel-efficient car does not meet the user's needs, users should consider purchasing a hybrid car. The lower fuel costs during the lifetime of the hybrid should be considered when making the purchase decision, as well as the initial cost of the car. All hybrids are not, however, created equal. Topping the list of fuel economy is the Honda Insight, a two-seater (no longer available new). Next is the Toyota Prius, followed closely by the Honda Civic Hybrid. These cars are all in the $22,000-$28,000 price range, demanding a considerable premium over a small $15,000 vehicle. Depending on driving requirements and the cost of gasoline, however, hybrids like the Prius or Civic Hybrid can relatively quickly pay back those extra costs. They are also fully functional cars with more spacious interiors than the small cars described above.

4. Work with farmers to promote growth of fuel crops in or near our county

Our county has considerable agricultural land under cultivation. Some of this land could potentially be used to grow fuel crops such as corn, beets, etc. More preferably, some fuel crops such as jatropha and switch grass can grow on sub-prime agricultural land, giving rise to the possibility of more land cultivation in our county and increasing revenues for local farmers. At the same time, these farmers could help increase our energy independence and reduce our climate impacts. The CEC will examine

the technical and economic feasibility of local fuel crop cultivation. If our research is positive, we will work with local farmers to identify and develop fuel crop opportunities.

5. Work with developers and local permitting agencies to construct additional biofuel plants in our county

There is one ethanol plant proposed for our county already, by American Ethanol, Inc. This plant, at more than 100 million gallons per year, could replace almost half of the gasoline consumption in our county if all our vehicles could run on ethanol today. As ethanol fueling stations are installed, flex fuel vehicle sales will likely increase substantially, allowing more vehicles in our county to use ethanol. The CEC will work with American Ethanol and encourage it to use cellulosic feedstocks grown in our county (switch grass, straw, poplar trees, for example) for future production. We will also continue to work with biodiesel companies, such as Biodiesel Industries, to build production plants in our county. Again, we will do our best to ensure that biodiesel production comes from in-county feedstocks.

Endnotes

[1] Based on data from the U.S. Energy Information Administration.

[2] Source: Community Environmental Council, with data from the California Energy Commission and California Department of Transportation.

[3] Energy Information Administration website: www.eia.gov.

[4] Our consultant report, by Navigant Consulting, available at www.fossilfreeby33.org, focused on biofuels and more efficient use of petroleum as the primary strategies for reducing petroleum use in our county. We expand on those focus areas in this document to include solutions that do not concentrate only on vehicles.

[5] www.sbbikeweek.com

[6] Santa Barbara Car Free, online at www.SantaBarbaraCarFree.org.

[7] www.flexcar.com.

[8] Traffic Solutions Online is available at https://matchlist.trafficsolutions.info/.

[9] 101-in-Motion website: http://www.101inmotion.com/FileLib.

[10] See the Coastal Rail Now website: http://www.coastalrailnow.org.

[11] California Energy Commission, online at: http://www.energy.ca.gov/2007_energypolicy/documents/index.html.

[12] UC Santa Barbara Economic Forecast Project, "Santa Barbara Economic Outlook," October, 2006

[13] Santa Barbara County Association of Governments, 2002 Commute Profile, Final Report, August, 2002.

14 Worldwatch Institute: http://www.worldwatch.org/node/4057

[15] Hybridcars.com Market Dashboard, online at http://www.hybridcars.com/market-dashboard/jan07-regional.html.

[16] Available at http://www.fueleconomy.gov

[17] Energy Information Administration, data available online at: http://tonto.eia.doe.gov/dnav/pet/hist/mgfupus1A.htm.

[18] Survey available at www.hybridcars.com.

[19] Hybridcars.com sales figures: http://www.hybridcars.com/market-dashboard/dec06-us-sales.html.

[20] Hybridcars.com Market Dashboard, online at www.hybridcars.com.

[21] Intellichoice.com survey of full ownership costs and benefits, Jan., 2007,

available online at: http://home.businesswire.com/portal/site/google/index.jsp?ndmViewId=news_view&newsId=20070108005692&newsLang=en.

[22] Navigant Consulting Inc., consultant report to CEC, online at www.fossilfreeby33.org.

[23] California Energy Commission BioEnergy Action Plan, online at http://www.energy.ca.gov/bioenergy_action_plan/documents/index.html.

[24] The University of Minnesota and the University of California, Berkeley, have completed comprehensive studies in 2006, showing a positive energy balance for both corn-based ethanol and soy-based biodiesel. Both studies also recognize that benefits can be enhanced by moving away from corn and soy as the primary feedstocks. A description of the UMinn study is available at: http://www1.umn.edu/umnnews/Feature_Stories/Ethanol_fuel_presents_a_cornundrum.html. The UC Berkeley study is available at: http://rael.berkeley.edu/EBAMM/.

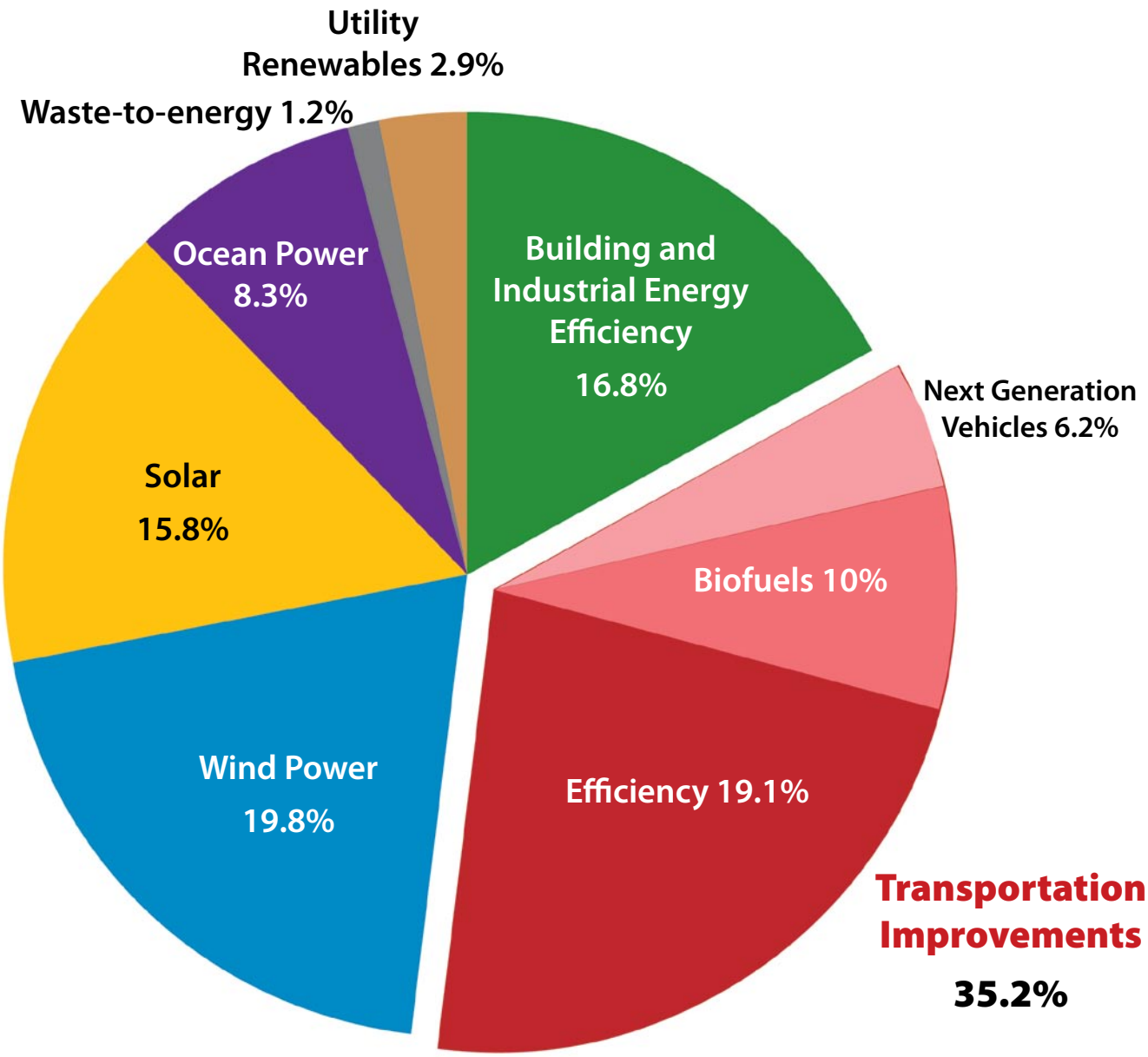
[25] Edmunds.com, online at http://www.edmunds.com/advice/fueleconomy/articles/116512/article.html.

[26] Online at http://www.iihs.org/ratings/default.aspx.

[27] South Coast Livable Communities, Transportation Platform, March, 2002, online at: www.cecsb.org

[28] County of Marin Community Development Agency, online at http://www.co.marin.ca.us/depts/CD/main/comdev/advance/BEST/fossilfree.cfm

Chapter 4 | Next Generation Vehicles



Introduction

To wean our region off fossil fuels, we will need additional options beyond driving smaller cars and hybrid vehicles, or using biofuels such as ethanol and biodiesel. The next generation of vehicles will provide a sea change in how we transport ourselves and goods by allowing electricity to become the primary transportation energy instead of petroleum.

The idea is to "electrify" the transportation sector by actively transitioning to vehicles that run on electricity. This is advantageous even if we remain with today's sources of electricity, because vehicles that use electricity as a fuel are two to three times more efficient than those that run on petroleum. However, the end goal is to change our electricity mix to all, or almost all, renewable electricity.

Photo: CaFCP

Next generation vehicles discussed in this chapter are plug-in hybrid vehicles, electric-only vehicles and hydrogen vehicles. There are many other up-and-coming technologies, but we feel these three warrant discussion as they currently are the focus of major research and development and thus most likely to become commercially viable over the next three to 10 years.

If these vehicles come to market over the next decade and are widely adopted, we anticipate an 11 percent reduction in petroleum demand by 2030. This is equivalent to about 1,150 GWh of the total 21,500 GWh needed by 2030 – or 6.2 percent of total energy demand when we adjust for increased efficiency. Adoption rates could, however, be far higher, in which case the petroleum offsets will be higher. Any reduction in petroleum demand from next generation vehicles will be partly replaced by an increase in electricity demand because all of these vehicles will require electricity as a transportation fuel (or to create hydrogen for hydrogen vehicles).

Technical Assessment

The most promising next generation vehicle technologies we've identified are plug-in hybrid, electric-only and hydrogen vehicles.

Plug-in Hybrid Electric Vehicles

The next evolutionary step in hybrid technology will be the plug-in hybrid electric vehicle (PHEV), which is expected to be widely available over the next three to five years. This technology is similar to today's hybrid car technology, but with a larger battery that can store more electricity – allowing the vehicle to run 30 miles or more on the battery alone. Because short distance driving will be in "all electric mode," these cars will likely achieve over 100 miles per gallon of gasoline on average.

In addition to recharging the battery during normal operation, plug-in hybrids can be plugged into any standard outlet. Because the vast majority of vehicle trips are short, the nightly recharge would mean that most drivers would require gasoline only for long trips, and some could eliminate the use of petroleum in their cars altogether.

A number of car companies, utilities, non-profits and even the Google Foundation are working to bring plug-ins to the market. Toyota, Ford and GM have announced that they are working to develop plug-ins, with Ford announcing in mid-2007 a partnership with Southern California Edison (one of Santa Barbara County's two electric utilities). These companies optimistically project that

vehicles will be available to the public by 2010 to 2012. However, it is clear that some major improvements in battery technology will have to occur before these vehicles can be offered at reasonable prices.

Plug-in hybrid vehicles are key to this Blueprint for two reasons. First, they allow us to "electrify" the transportation sector by using electricity instead of petroleum as a fuel. As our region develops large wind, solar, ocean and biomass projects, we will create the best opportunity our county has for quickly moving away from fossil fuels (see text box). Those who don't want to wait for large-scale renewable energy projects to be developed could install photovoltaic solar panels or a small wind turbine on their home or business to immediately transition to a hybrid vehicle that only needs to use gas on trips over 30 miles.

Do-it-yourself conversions to plug-in hybrids

At least three North American companies can convert Prius hybrids to plug-in hybrids at a cost of around $12,000 to $32,500 for a 15 to 30 mile charge capacity. Target prices for conversions are less than $10,000, and companies are also developing conversion kits for the Ford Escape.[2] Plug-in hybrid conversion kits replace the nickel metal hydride (NiMH) battery with a lithium ion battery (similar to those used in laptop computers), and add electronics and software to interact with the car's computer. Conversion systems generally use the spare tire cargo space and take as little as two hours to install. Three of the companies offering kits are:

HyMotion: www.hymotion.com
Hybrids Plus: www.hybrids-plus.com
E-Drive Systems: www.edrivesystems.com

In an encouraging new development, IC Corp., the country's largest school bus manufacturer, now offers plug-in hybrid school buses.[1] However, they cost about twice that of a standard school bus, and even with reduced fuel use, will take decades to pay back the increased capital costs. As a result, these buses will probably not be widely adopted until costs come down considerably. This may happen soon, as the project developers of the plug-in hybrid electric school bus project, Advanced Energy, anticipate cost reductions of 30 percent on the next group orders, and cost savings on the third group orders. CEC will be working to secure grants and subsidies to help local school districts examine the feasibility of purchasing these buses instead of highly polluting diesel buses.

Another exciting opportunity for plug-in hybrids is Vehicle-to-Grid (V2G) capability. In essence, this would use a plug-in hybrid's large battery to capture and store inexpensive power during off-peak hours at night, then release this energy to the grid during expensive peak power during the day and evening. This could reduce the need for building new power generation and increase the usefulness of intermittant renewable energy sources like wind or solar power. The technology for V2G has been explored and is considered feasible; some studies estimate utilities might pay up to $2,000 to $3,000 to "borrow" each plug-in, which would help offset the incremental cost of the technology.[3] However, this technology will probably not appear for another decade or more because it will require high plug-in hybrid market penetration.

If plug-in hybrids are developed as flex-fuel vehicles (which can run on either ethanol or gasoline) – a relatively easy modification to today's normal vehicles and tomorrow's plug-in hybrid vehicles – drivers could use ethanol when liquid fuels are necessary rather than just battery power, making the entire fuel cycle far more sustainable. The same is true for diesel hybrids, which could also be run on biodiesel and which would achieve 30 percent better gas mileage, due to the inherent greater efficiency of the diesel engine.

The wholesale shift away from fossil fuels in our region is likely to happen only if new vehicle technologies that use electricity as all or part of the vehicle's fuel become more cost-effective and available over the next decade. Electric vehicles, hybrid vehicles and new plug-in hybrids are a key to this shift.

Electrification of the Transportation Sector

The formula is simple: use renewable electricity instead of oil in our vehicles. By transitioning from petroleum to electricity as a transportation fuel, we will "electrify" the transportation sector. Vehicles that use electricity either for their sole power source or in combination with liquid fuel (such as plug-in hybrids) are key to reducing our petroleum demand.

Of course, this strategy only helps us meet our fossil free goal if the sources of electricity are clean and renewable: wind, solar, geothermal, biomass, ocean power and hydroelectric. If cars can also use biofuels for times when batteries are not sufficient, we could achieve an entirely clean and renewable energy fuel-chain.

To achieve this major shift in transportation power, many further developments are required that will take some time. The lithium-ion batteries that are planned for plug-in hybrids are still being perfected. Designs for all-electric, hybrid and plug-in hybrid vehicles are either already in place or well underway, but a large-scale change in mass production of these kinds of vehicles will take significant time and money, as will changeover in our vehicle fleet composition.

We realize that converting our primary supply of transportation fuel from oil to electricity may seem to be a radical program, but it is a tremendously promising path. If we follow this path nationally, we could reduce or eliminate our dependence on foreign oil in just two or three decades and dramatically cut back on our greenhouse gas emissions.

Electric-only Vehicles

Electric-only vehicles don't have a gas engine at all, as hybrid cars today do. Rather, they have an electric motor that relies on batteries to supply electricity. Historically, the range of electric-only vehicles has not been very good (80-100 miles per charge for recent models), but a new crop of vehicles promises much better range.

Surprisingly, electric-only vehicles (EVs) were first developed in 1832, when Robert Anderson invented the first "electric carriage."[4] By 1900, one third of the cars in New York City, Boston, and Chicago were electric.[5] However, mass production of internal combustion engine cars and cheap oil soon put an end to the new electric car industry. After the oil price shocks of the 1970s, electric cars were considered once again. In the 1990s, the General Motors EV1, the Toyota RAV4 EV, the Ford Ranger EV, the Honda EVPLUS and others were sold in California and a few other states, largely to meet state air pollution requirements.

While these models are not available today, a new generation of EVs is taking their place. A number of "neighborhood electric vehicles" such as the GEM cars, Miles Automotive's EVs, and the Zebra, can be seen in our neighborhoods today and sell new for $10,000 to $15,000. The Electric Drive Transportation Association estimates that in 2006 there were between 60,000 to 76,000 neighborhood electric vehicles on the road in the U.S., up from about 56,000 in 2004.[6]

Full-function EVs include the Tesla Roadster,[7] a sporty coupe that will be available soon for a base price of $92,000, and the Zap! Obvio, an adaptation of a Brazilian electric high performance mini-car that will be available for an as-yet-undetermined price. While the Tesla sports car is still far out of reach of average

consumers, other manufacturers expect to have full-function sedans available soon for $29,000 to $45,000.[8] As these EVs become more popular and other companies begin to compete, we expect costs to come down considerably, making electric vehicles more affordable for average Americans.

Tesla Motors' 2007 Roadster.

Today's EV manufacturers are learning from the past. General Motors' EV1 was popular among its owners, many of whom were dismayed when GM recalled the vehicles at the end of their lease rather than providing a purchase option. While U.S. auto manufacturers concluded from that experience that there was limited demand for electric cars, the political and economic climate has changed significantly in the last decade, as sales for gasoline/electric hybrid vehicles over the last few years show.

The next generations of electric vehicles will need to address a key issue: battery costs. Compared with the 80 to 120 mile range offered by the EVs of the 1990s, the Obvio claims a range of 200 to 240 miles on a single charge, and the Tesla Roadster claims 250 miles for its sports car (using lithium ion batteries similar to those used in computer laptops). Battery technologies have improved considerably in recent years – allowing this expansion of driving range. However, batteries are still expensive and reducing battery costs while increasing performance and reliability remain the biggest barriers to cost-effective electric-only cars.

Hydrogen Vehicles

There are two types of hydrogen vehicle technologies: fuel cells that run on hydrogen and internal combustion engines (ICEs) that run on hydrogen and/or gasoline. Recently, both have received considerable attention and funding – from the auto industry and from federal and state government – and have been strongly supported by President Bush and Governor Schwarzenegger, as well as other leaders on both sides of the aisle.

A major benefit of a "hydrogen economy," with hydrogen cars as the centerpiece (ICEs or fuel cell cars), is that intermittent renewable sources of energy, such as wind and solar power, could be used to cost-effectively produce hydrogen. This would allow those intermittent sources to be integrated into the energy grid and would provide a source of "green" hydrogen, as opposed to "brown" hydrogen from polluting sources such as coal, nuclear power or natural gas. In this scenario, hydrogen acts as a storage medium (essentially a battery) for intermittent sources of power, making those sources useful even when the wind isn't blowing or the sun isn't shining. Green hydrogen can be produced by electrolysis of distilled water powered by renewable electricity or via thermo-chemical conversion of biomass.

Hydrogen Fuel Cell Cars

Hydrogen fuel cell vehicles look like any other car on the road, but work very differently. When compressed air and hydrogen from an on-board storage tank enters a fuel cell module, its electrons and protons are separated. A membrane in the cell selectively allows the protons to pass through, while the electrons are routed to provide the electricity to run a motor, provide lighting or power other electrical functions. On the other side of the membrane, the hydrogen, minus its electrons, combines with oxygen from the air to form water and heat – with no other emissions or pollution.[9]

While small portable devices, such as MP3 players and cameras, will be powered by fuel cells in the near future, vehicle fuel cells remain very uneconomical. General Motors announced that it will place 100 prototype hydrogen fuel cell SUVs on the road in 2007, at a likely cost of $1 million each[10]. At such costs, we're still a long way from widespread availability for these vehicles. Although Toyota and GM predict commercial availability in 2010 and 2012, respectively, many industry watchers are skeptical that

this time frame will be met. Honda, for example, considered to be one of the leaders in fuel cell vehicle and fuel cell stack and overall system development has recently projected much longer lead times.

Honda's FCX fuel cell concept car.

One problem with hydrogen fuel cell vehicles arises from how the hydrogen fuel is created. From an environmental perspective, hydrogen would ideally be created through electrolysis of water, using renewable electricity to split water into hydrogen and oxygen. However, in this process energy is lost when hydrogen is created with electricity, through electrolysis, and then converted back to electricity in a fuel cell for use in vehicles. It would be far more efficient to simply use the electricity to directly fuel an electric vehicle or a plug-in hybrid electric vehicle. Because most hydrogen for fuel cell vehicles will probably come from natural gas for the foreseeable future (a hydrogen source considerably less desirable than water electrolysis using renewable electricity), this problem is not serious in the short-term. However, because we view renewable "electrification" on a massive scale as the most promising means for weaning our region off petroleum, we don't see hydrogen vehicles as particularly promising due to the water-to-hydrogen-to electricity conversion inefficiency problem.

Hydrogen Internal Combustion Engine Cars

These cars will run on either compressed hydrogen gas or liquefied hydrogen (at minus 423 degrees Fahrenheit) from a hydrogen fueling station or on gasoline. The advantage of a hydrogen internal combustion engine car is its dual fuel potential. Essentially, the engine is similar to today's engines but can run on either fuel. This technology is considered more likely than hydrogen fuel cell cars to be affordable in the next decade or so because it will adapt many existing engine technologies instead of requiring wholesale change, as fuel cells will. However, ICE hydrogen cars are much less efficient than hydrogen fuel cell cars. They also produce small amounts of nitrous oxides and carbon dioxide, which is not the case with hydrogen fuel cell vehicles. In 2006, BMW announced its plan to place 100 prototype hydrogen internal combustion engine cars on the road in 2007. Drivers of these test vehicles report that BMW's prototype – the Hydrogen 7 – is responsive and powerful, but significant problems remain with fuel storage. This problem, and others, are discussed below.

Barriers to Next Generation Vehicles

Technology Development and Costs

The largest barriers to widespread use of next generation vehicles are the high cost, lack of customer acceptance and the fact that most models are not yet available to the public. Most next generation vehicle technologies are in varying stages, from the early concept car phase (for hydrogen cars) to demonstration (for plug-in hybrids) to early market entry (for electric vehicles).

Auto manufacturers have learned from their market experiences with hybrid vehicles. A much better understanding by manufacturers such as Toyota and Honda, specifically, has been gained in terms of battery technology and charge/discharge management as well as the market acceptance of these technologies. Honda is undoubtedly utilizing this experience, as is evident in its recent announcement that it will introduce a bottom-up designed hybrid vehicle with significant sales projections in 2009. Commercial availability will certainly change in the next decade as technology advances and prices come into line with current fossil-fuel-powered vehicles.

Electric-only Vehicles (EVs)

EVs are the most commercially and technologically advanced of the three types of vehicles we discuss, with more than 60,000 neighborhood electrical vehicles on roads in the U.S., in fleets and the private sector. Costs of $10,000 to $15,000 are affordable for many new car buyers. While EVs produce no tailpipe emissions and fuel costs are less than a third the cost of gasoline per mile traveled, neighborhood electric vehicles usually have a top speed of 25 mph and a range of less than 60 miles per charge. Due to these limitations, they will probably remain a niche product and not successfully compete against traditional vehicles unless they become capable of longer ranges, faster speeds, and faster charging capabilities.

The full-function EVs being developed today will help to close this gap. Although early programs from the 1990s by large auto manufacturers have been scrapped, new smaller and more nimble manufacturers, such as Tesla Motorcars, are producing full-function EVs. These vehicles will be capable of greater speeds and have ranges of over 200 miles. Charging times will, however, still be measured in hours, and for widespread adoption by consumers, faster charging capability will have to be developed.

In the next few years, the range and styles of EVs will grow to encompass everything from small two-seater sports cars to family sedans, trucks and SUVs. Prices remain higher than comparable vehicles, but the lower fuel costs will help offset higher prices. As battery costs decrease, mass production begins, and competition surges, prices will likely come down further.

Plug-in Hybrid Electric Vehicles

Plug-in hybrids are in the demonstration phase, with after-market conversion kits being offered by several companies for 2004-2006 Prius models; conversion kits for Escapes are close behind. The cost of conversion kits is as little as $12,000, with a target price of under $10,000 in the near future. Most of these conversions have been fleet cars, though some individuals' cars have been converted. Conversions use lithium ion batteries instead of the stock NiMH batteries, and also include advanced electronics and chargers. These "plug and play" kits can be installed in as little as two hours without drastically altering the vehicle, **though parts of the warranty will be voided, if the vehicle is still under warranty**.

The Chevrolet Volt is a concept plug-in hybrid car slated for the market by 2010.

As discussed earlier, Toyota, GM and Ford plan to offer plug-in hybrids to consumers by 2010 to 2012.

Hydrogen Vehicles

Hydrogen vehicles are still in the early demonstration phase. While there are some on the road, these prototypes are being leased to high profile individuals as part of the demonstration process. Even if these vehicles were available for purchase, costs would likely be a million dollars or more.

Although mass-produced hydrogen vehicles and the associated fueling infrastructure may be many years to decades away, California is an important testing ground for hydrogen-fueled vehicles. The creation of the California Hydrogen Highway Network, initiated by Governor Schwarzenegger in 2004, seeks to establish an infrastructure for hydrogen fueling for vehicles and other energy users.[11] The California Fuel Cell Partnership is a partnership of car manufacturers, energy companies, technology companies, and government working in a collaborative manner to advance fuel cell technology.[12]

As of mid-2007, California had about 200 hydrogen fuel cell passenger vehicles and buses on the road, with 24 hydrogen fueling stations (and 15 more planned) clustered around Los Angeles, San Francisco Bay and Sacramento.[13] This demonstration network of hydrogen vehicles has logged over a million miles in an array of different driving conditions, geography, and climates.[14]

Hydrogen vehicles also have some unique barriers that relate to using hydrogen as a new fuel carrier. Hydrogen, the lightest element, has high energy content per unit of mass, but low content per unit of volume. Current storage options are to compress hydrogen into pressurized storage tanks or to liquefy it to minus 423º F. Both methods use energy for transformation of the gas, require bulky storage, require expensive pressurized or highly insulated tanks, and don't currently allow enough hydrogen to be stored on a typical passenger vehicle to power the 250+ mile range that consumers expect.[15]

While liquefying hydrogen enables the least bulky transport, the process has additional drawbacks such as a significant use of energy. Even with an extremely highly insulated fuel tank, the BMW Hydrogen 7 car requires up to one third of the energy in each tank to keep the hydrogen fuel liquid. If the engine isn't turned on every day, the fuel warms up and substantial amounts slip out of the tank as "boil off." If the car sits for nine days, it loses half of the fuel in the tank.[16]

Other promising storage technologies use chemicals such as sodium borohydride, a salt similar to borax, to store hydrogen in a solid or aqueous form. Sodium borohydride is a non-toxic salt that is reacted with a catalyst to form hydrogen and sodium borahydrate, a recyclable non-toxic byproduct. Solid storage is promising, yet technological advances in fuel recycling and identifying less caustic liquid stabilizing agents for the catalyst reaction need to be made.[17]

Lack of Infrastructure

The infrastructure for plug-in hybrids -- with their superior gas mileage, long range and dual engines and motors -- is already established. Though most charging will occur overnight during cheap off-peak hours, EVs and plug-in hybrids could benefit from public charging stations at the workplace and in public parking lots. Because EVs and plug-in hybrids can be charged by common electricity outlets, it should be relatively easy to add outlets to parking lots and on street curbs so that vehicles can be charged whenever they are not in use. Electricity could be offered by employers, integrated into parking meters, or provided for free by businesses to entice new customers. Though rapid chargers aren't being incorporated into most current EVs because of cost issues, these will likely be less expensive in the future and enable EVs to make the longer trips that plug-in hybrids and traditional vehicles can make.

Hydrogen vehicles will require a much more substantial investment in infrastructure. While there are 24 hydrogen refueling stations in California and 15 more planned, most of these stations have the capacity to provide fuel for only a few vehicles per day. The California Hydrogen Highway reports that an initial, low volume network of 150 to 200 stations throughout California would cost $75 to $200 million.[18] Estimates on the costs of a more complete hydrogen infrastructure are hampered by a lack of published data on costs of current hydrogen stations. Many stations exceed budget amounts, sometimes by multiples.[19] A 2002 Argonne National Laboratory study estimated the cost of a national hydrogen infrastructure capable of serving 100 million vehicles (about 40 percent of the passenger vehicles in the U.S.) at around $500 billion.[20] The primary costs will be for fueling stations and an expensive network of pipelines or pressurized transportation vehicles to transport the hydrogen. The same study found that with current technology, hydrogen prices are likely to be twice the price of gasoline. It is also important to note that as prices of natural gas (the current and near future primary feedstock for hydrogen production) increase, hydrogen becomes more expensive to produce.

Large-scale renewable energy farms such as geothermal, wind or solar farms, have the potential to produce hydrogen and thus store some of the renewable energy they produce in the form of hydrogen – with hydrogen effectively acting as a battery for these intermittent power sources. However, as there is still vast potential for relatively easy renewable energy penetration into the current electrical grid, it makes more sense to send renewable energy directly into the grid than to pay the extra expense for storage of any kind. This avoids the inefficiencies of converting electricity to hydrogen and then back to electricity, as would be required if hydrogen were used as a battery.

The Action Plan

What can individuals do?

1. Buy an electric vehicle or plug-in hybrid vehicle

Does your family have two or more vehicles? Consider replacing one of your vehicles with a neighborhood electric vehicle for errands around town and short commuting of up to 60 miles per day. These vehicles can go up to 25 mph with plenty of torque and speed for normal city driving. Neighborhood Electric Vehicles are available now from various companies for under $15,000, have no tailpipe emissions, meet safety standards, and currently have fuel costs of less than a dollar a gallon for gasoline equivalent mileage.

Some current EV manufacturers are:

Miles Automotive: www.milesautomotive.com
Phoenix Motorcars: www.phoenixmotorcars.com
Zap: www.zapworld.com

Full-function electric vehicles are experiencing a renaissance, with the Tesla Roadster leading the way. With Miles Automotive and Phoenix Motorcars planning to offer full-function sedans for $29,000 to $45,000, we expect electric vehicle offerings to multiply in the next few years and see a continued downward pressure on prices.

Similarly, with GM projecting its plug-in hybrid to be available to consumers in 2010 to 2012, we are cautiously optimistic that plug-in hybrids will be widely available to consumers within the next five years at affordable prices. Learn more about electric vehicles and plug-in hybrids at www.pluginamerica.com and www.calcars.org.

2. Get educated and spread the word about next generation vehicles

The next generation vehicle field is changing rapidly. Educate yourself and inform others on the realities, benefits and disadvantages of these new technologies. Speak out against myths about EVs, plug-in hybrids, and hydrogen vehicles.

What can businesses do?

1. Consider if a neighborhood electric vehicle meets the needs of your business or fleet.

Businesses that make short deliveries, and/or have vehicles that are only used around town can save money on fuel, reduce air pollution and showcase their green commitment to clients by purchasing a neighborhood electric vehicle. When full-function EVs are available, consider purchasing one as well.

2. Convert your hybrid vehicles to plug-in hybrids.

Plug-in technology is coming to fleet vehicles before it is available to the general public. Fleet managers

can show demand for plug-in hybrids by pledging "soft orders" at www.PlugInPartners.org. Better yet, call the various companies that offer plug-in conversion kits for fleet Prius and Escape hybrid vehicles to see if your fleet hybrids could be converted.

Three of the companies offering kits are:

HyMotion: www.hymotion.com
Hybrids Plus: www.hybrids-plus.com
E-Drive Systems: www.edrivesystems.com

3. Provide incentives for employees to purchase next generation vehicles.

Many employers already offer incentives for employees to purchase hybrid vehicles. Google and Bank of America offer rebates of $5,000 and $3,000 to employees.[21] Local Santa Barbara contractor Allen Associates offers employees up to $5,000. These programs could be expanded to include other highly efficient vehicles. Your business could start a similar program.

4. Provide charging facilities and preferred parking for employees or customers with next generation vehicles.

By charging at work, employees with plug-in hybrids and longer commutes could reduce the need for their gasoline engine. Electricity as a transportation fuel for vehicles is much cheaper than fossil fuels. Employers could provide charging facilities so employees can "fill up" for free. Employers could also provide preferred parking.

What can local governments do?

Items 1 to 3 from "What can businesses do?" apply to local governments as well. Local governments can also:

1. Join Plug-in Partners

Plug-in Partners is an effort spearheaded by the City of Austin to obtain "soft orders" for plug-ins by local governments and businesses around the country. By accumulating advance orders for plug-ins, Plug-in Partners is demonstrating to the auto manufacturers that there is a strong demand for these vehicles, circumventing the often-heard argument from manufacturers that there is insufficient demand. For materials about this public campaign to raise awareness about the potential for plug-in hybrid, go to www.PlugInPartners.com.

2. Provide local tax credits, preferred parking, and/or use of carpool lanes for next generation vehicles

Financial or "ease of commute" incentives allow early adopters to share the cost of new technology and allow perks and more rapid commutes for adopting next generation vehicle technology. Early adopters help mature the market for new technologies, but also often pay more or experience more inconvenience in adopting new technologies. Local governments could provide tax credits to businesses that purchase next generation vehicles. Public parking areas could reserve spots for next generation vehicles or allow them to park longer in limited time zone areas.

3. Install charging systems for employee or public use

Local governments can stimulate the use of next generation vehicles by allowing free or low cost charging of EVs and plug-in hybrids. Public charging systems also would allow employees to take advantage of the electric capabilities of their plug-in hybrids. Until more EVs and plug-in hybrids are

on the road, specific charger recommendations can not be made. Generally however, 110 volt chargers would be inexpensive enough for anyone to add, while more powerful and faster charging systems should be inexpensive enough for medium to larger size businesses.

What will CEC do?

1. Lay the groundwork for electrification of the transportation sector

CEC is working actively to promote renewable energy projects in and near our county. We are working on a pilot wave power project off Platform Irene, developing plans for large concentrating solar power projects and working with developers to build more wind farms onshore and offshore. By producing large amounts of renewable electricity in our county, we set the stage for a wholesale shift from petroleum to electricity as the primary transportation.

2. Encourage new technology vehicles once they become available

As plug-in hybrids and electric-only vehicles become widely available, we will heavily promote these vehicles in the hope that people will buy them *en masse*. These vehicle technologies are more likely to become cost-effective and widespread than hydrogen vehicles (fuel cell or ICE) over the next 10 years, but we will also publicize hydrogen vehicles when they reach the same level of commercial development, if it can be shown that hydrogen vehicles can meet or beat the benefits of plug-in hybrid vehicles and/or electric-only vehicles.

3. Encourage businesses and local governments to adopt our recommendations

As next generation vehicles become more prevalent, we will work with government, businesses and other organizations to increase the market penetration of these vehicles. We will do this by helping various entities adopt policies and create infrastructure for next generation vehicles. We will also initiate outreach campaigns to fleet owners to convince them to purchase and use next generation vehicles. We will help to make connections and disseminate information and experiences from early adopters to other interested parties.

4. Work with local planners to ensure charging stations appear in regional transportation plans

Public charging stations offered for free or at subsidized or full cost will allow easier adaptation of EVs and allow plug-in hybrids to go further on less petroleum. We will work with government and local businesses to install accessible and easy-to-use charging facilities. A number of charging facilities are present in City of Santa Barbara parking lots and elsewhere – currently unused because of the disappearance of most EVs. However, as EVs return to the market, hopefully *en masse*, these facilities and many more will find widespread demand. Longer term, as plug-in hybrids come to market, CEC will work with builders and city and county planners to install electricity outlets at curbs and parking lots more widely. These installations should also be relatively low cost and could be offered as a free "perk" to customers.

5. Continue to educate the public, host green car shows and dispel myths about next generation vehicles

Public attitudes change slowly, and there are many myths about new technologies, including next generation vehicles, which have yet to even come to market. We will work to educate the public about the benefits and the disadvantages of different types of technologies, as these technologies develop. We will do this through our different outreach events, publications, public presentations, website, and other avenues.

Endnotes

[1] Christian Science Monitor, "It's a plug-in hybrid, and it's a school bus," April 2, 2007, online at: http://www.csmonitor.com/2007/0402/p01s03-ussc.html.

[2] HyMotion has converted over 25 hybrids to PHEV for fleet use and plans on doing consumer conversions in late 2007 at a target price of under $10,000. Hymotion is online at http://www.hymotion.com

Hybrid Plus is currently offering commercial conversions for $24,000-$32,000 for 15 to 30 miles charge capacity. They state that in certain states this price can be reduced to $6,000-8,000 with all applicable tax credits, online at http://www.hybrids-plus.com/ht/products.html

[3] University of Delaware Vehicle-to-Grid Power, report online at http://www.udel.edu/V2G/docs/V2G-Cal-2001.pdf

[4] PBS Electric Car Timeline, online at http://www.pbs.org/now/shows/223/electric-car-timeline.html

[5] Ibid.

[6] Saranow, J. (July 27, 2006) "The Electric Car Gets Some Muscle" The Wall Street Journal, pp. D1-2.

[7] Tesla Motor Company, online at www.teslamotors.com.

[8] Two such manufacturers are www.milesautomotive.com and www.phoenixmotorcars.com

[9] California's Hydrogen Highway, online at http://www.hydrogenhighway.ca.gov/vehicles/hydro.htm.

[10] Green, Jeff. (Sept. 18, 2006) "GM to Put 100 Hydrogen-Run Vehicles on the Road by 2007" LA Times

[11] California Hydrogen Highway, online at http://www.hydrogenhighway.ca.gov

[12] California Fuel Cell Partnership, online at http://www.cafcp.org

[13] California Fuel Cell Partnership, online at http://www.fuelcellpartnership.org/fuel-vehl_map.html

14 Ibid.

[15] US Department of Energy, Energy Efficiency and Renewable Energy, Hydrogen Program, online at http://www1.eere.energy.gov/hydrogenandfuelcells/storage/hydrogen_storage.html

[16] The Spiegel, online at http://www.spiegel.de/international/spiegel/0,1518,448648,00.html

17 Daimler Chrysler, online at http://www.daimlerchrysler.com/dccom/0,,0-5-7153-1-75938-1-0-0-0-0-0-243-7145-0-0-0-0-0-0-1,00.html

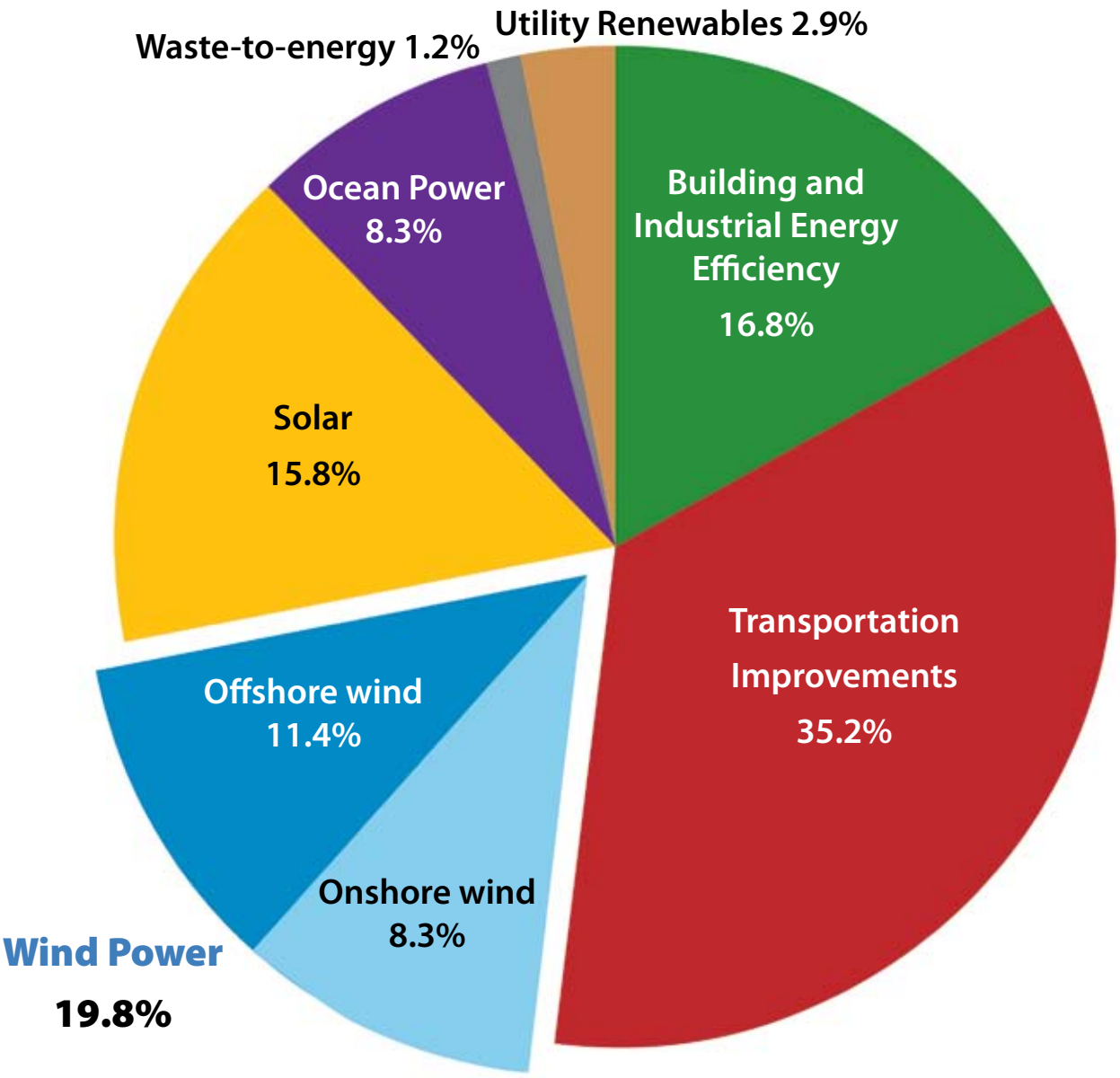
[18] California Hydrogen Highway, online at http://www.hydrogenhighway.ca.gov/vision/vision.pdf

[19] UC Davis, Institute of Transportation Studies report, online at http://pubs.its.ucdavis.edu/publication_detail.php?id=46

[20] Argonne National Lab report, online at http://www.transportation.anl.gov/pdfs/AF/224.pdf

[21] ConsumerAffairs.com http://www.consumeraffairs.com/news04/2006/06/bofa_hybrids.html

Chapter 5 | Wind Power



Pros: Wind power is economical today at good sites and is capable of large-scale generation.

Cons: The wind doesn't blow all the time, so it can't be relied on for peak power supplies. Concerns about how turbines might affect views or wildlife (particularly birds and bats) may limit the locations where we can place them in our region.

Technology readiness: Wind power is the most prevalent renewable energy source in the U.S. after large hydropower. While California has more wind turbines than any state except Texas, there are no wind farms yet in Santa Barbara County. The first project for this region is being permitted -- a 120 megawatt wind farm near Lompoc.

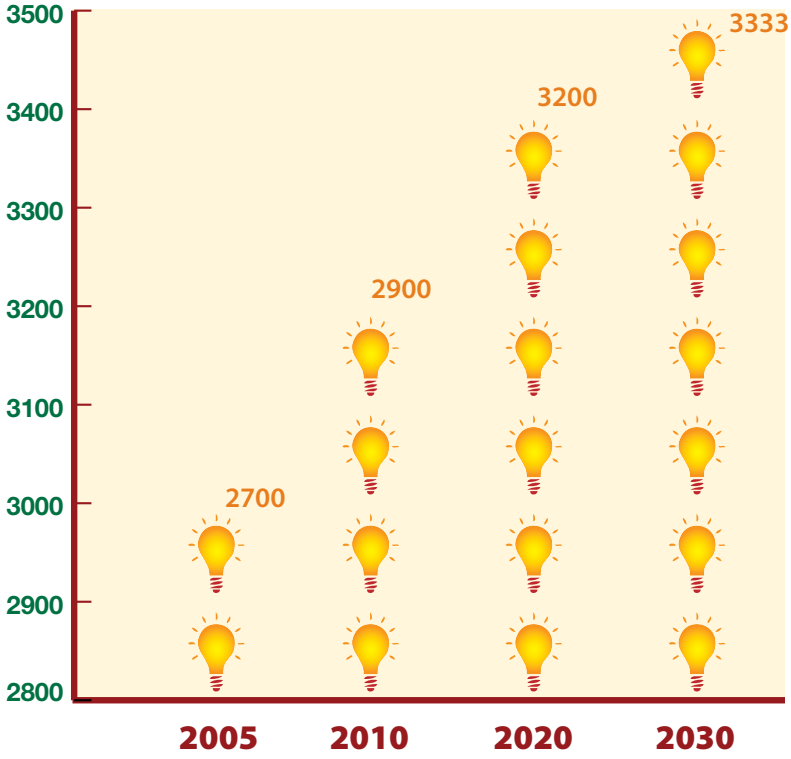
Introduction

Wind energy is a major component of our plan for eliminating the use of fossil fuels in this region for several reasons.

First, it is generally the most economical source of renewable energy, competitive with and sometimes cheaper than electricity from fossil fuels and nuclear power. Good sites can produce wind power at six to eight cents per kilowatt-hour (kWh) – even less when the federal tax credit is factored in. (By comparison, the cost of electricity from a new natural gas plant in California is eight to nine cents per kWh.) Wind power is expected to become even more cost-effective as the industry develops larger turbines and the price of fossil fuels continues to rise.

Second, we have enormous potential for wind power in this region. For example, a 120 megawatt (MW) wind farm proposed near Lompoc by the Pacific Renewable Energy Group could supply 315 gigawatt hours (GWh) a year -- more than a tenth of our county's current demand for electricity.[1] Countywide, wind power potential is much, much greater. Professor Dan Kammen -- chairman of UC Berkeley's Energy Resources Group -- found potential for nearly 3,800 GWh of wind at onshore sites in the county.[2] When adding the potential from offshore sites and small wind turbines, Kammen calculated a potential of 290,000 GWh. In other words, wind power could theoretically produce 100 times our current demand for electricity.

Figure 5-1. Current and projected electricity use in Santa Barbara County (GWh).
Source: UC Santa Barbara Economic Forecast Project



"In other words, wind power could theoretically produce one hundred times our current demand for electricity."

It is for these reasons – the competitive cost, the strength of the industry, and the regional potential – that wind power is a major component of our plan to eliminate the use of fossil fuels in our region. We propose that our county develop about 1,100 megawatts of wind power from both onshore and offshore sites -- enough to meet our total current electricity demand and almost 100 percent of our projected electricity demand in 2030.[3]

Global wind power production has grown by about 30 percent in each of the last five years, a rapid pace of growth by any measure. There are now more than 75,000 MW of wind turbines around the globe – enough for about 20 million American-sized homes. In California, at about 2,300 MW, wind power produces enough power for 700,000 homes.

Technology Assessment

Turbine Types

Turbine types appropriate for this area can be divided into two categories: large (500 kW and larger) and small (under 10 kW). The South Coast of the county has limited potential for either type, but the possibilities are much more promising elsewhere in the county and offshore.

Most manufacturers of utility-scale turbines today offer machines in the range of 700 kW to 2.5 MW. However, the world's largest commercial wind turbine -- a 394-foot rotor capable of generating 5 MW at full output, -- was connected to the German electrical grid in 2006.[4] Currently, 6 MW machines are being tested, and in the future, larger machines – even some as big as 10 MW -- will be deployed, most likely offshore where larger transportation and construction equipment can be used and where visual impacts are diminished.

The actual electricity output of a wind turbine depends on many factors, such as the location, climate, and season – and, of course, wind availability. However, it is the turbine's size that primarily determines its output. Turbines today are truly enormous, as illustrated in Figure 5-3.

Although some "vertical axis" turbines have been demonstrated and show promise, conventional systems — with a basic design similar to old windmills used for pumping water — rely on a "horizontal axis" system with a three blade rotor.

The trend in turbine construction is to build larger rotors and taller structures. Bigger turbines generate more power at less cost. Some multi-megawatt turbines produce power for as little as three cents per kWh, given a good wind resource. Moreover, design improvements

The cost of wind power can be very cheap at good wind sites, at 4 to 6 cents per kWh. A federal tax credit of 1.9 cents per kWh was renewed in December of 2006, which reduces the cost to consumers substantially. Other industries, such as the oil industry and nuclear power industry enjoy a similar tax credit.

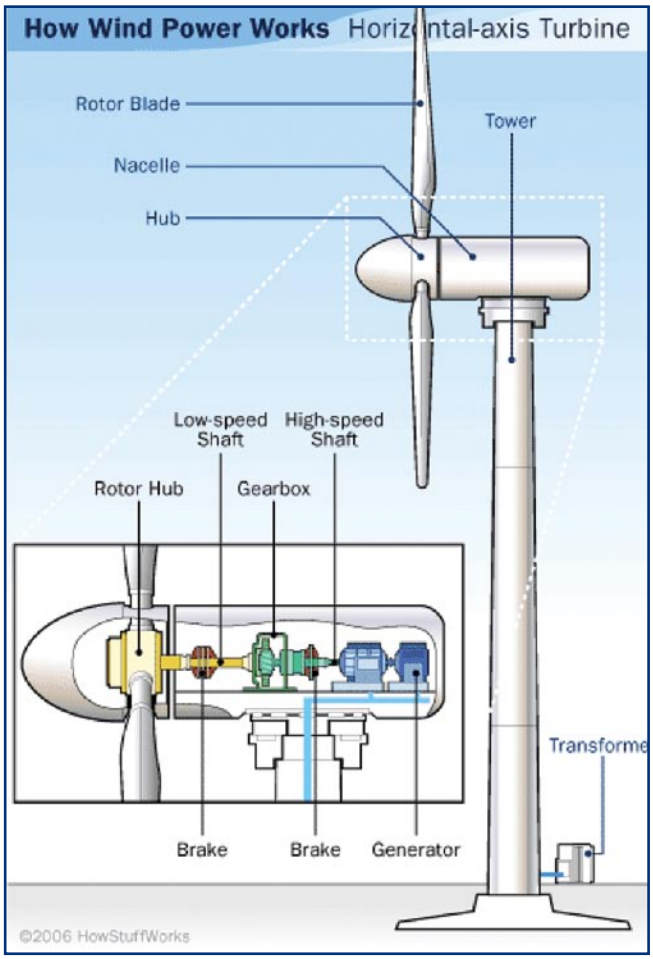


Figure 5-2. The most common wind turbine type today: horizontal axis turbine.

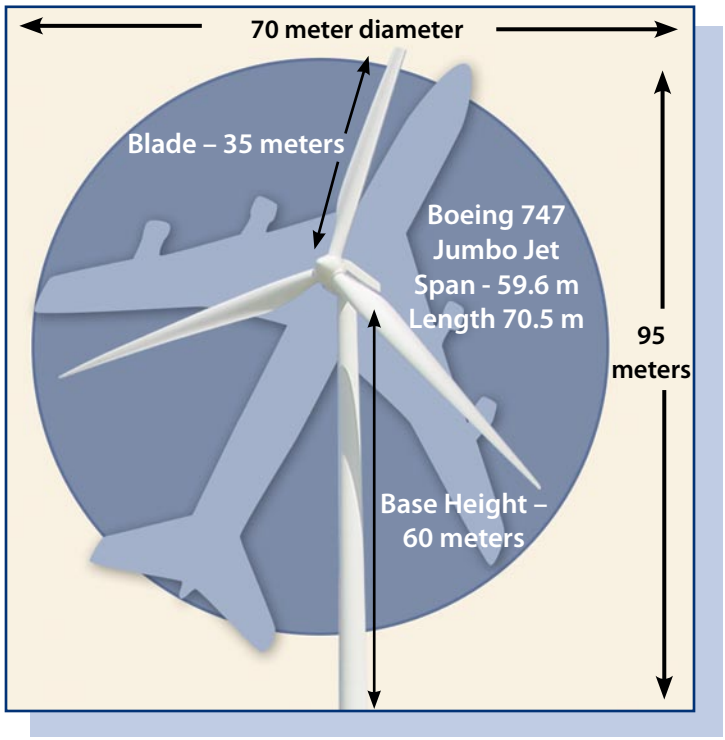


Figure 5-3. Modern turbine compared to a Boeing 747.

in new turbines, including improved blades, gearboxes, generators, and speed variability, can improve output by up to 10 percent.

Still, size isn't everything. Small turbines can be ideal for residential use. These turbines are often similar in design to large wind turbines and are installed on rooftops or towers near the home. With little wind on the South Coast, it's unlikely that residential turbines will become widespread there, but they may be well-suited to parts of the North County, which has a much better wind resource. There are also a number of smaller turbines designed for lower wind speeds, such as Southwest Windpower's Skystream 3.7. [5]

Small wind turbine. Source: Southwest Windpower

Wind Power Potential

The wind power potential in our county is very large. After filtering out urban areas, airports, mountainous regions, wilderness, etc., Professor Dan Kammen found that we have about 3,800 GWh of annual onshore wind power potential. With current annual electricity demand at about 3,000 GWh, we could conceivably produce more power than we consume from wind turbines in our county – at onshore sites alone (see Figures 5-4 and 5-5).

If we look offshore, we find two orders of magnitude higher wind potential, for a total of 297,310 GWh annual production. This is almost 100 times our county's current electricity demand.

Will we develop this much wind in our region? Of course not. We wouldn't want to and wouldn't need to drape the entire county with wind turbines. But these figures give an indication of what is possible.

The "economic potential" for wind power – in other words, what can be produced at competitive prices – is smaller than the technical potential because it becomes steadily more expensive to produce wind power when the wind blows less strongly or less regularly. However, there is still tremendous potential for cost-competitive wind power today – and more each year as technologies improve, lower wind speeds are utilized, and prices fall for transmission and wind turbines.

Most Promising Wind Regions in Santa Barbara County

The most promising regions identified by CEC's consultants are:

The Lompoc region

A 120 MW wind farm is already proposed for this region. Other good sites are located nearby, especially if Vandenberg Air Force Base opens its property to wind development, as we are urging.

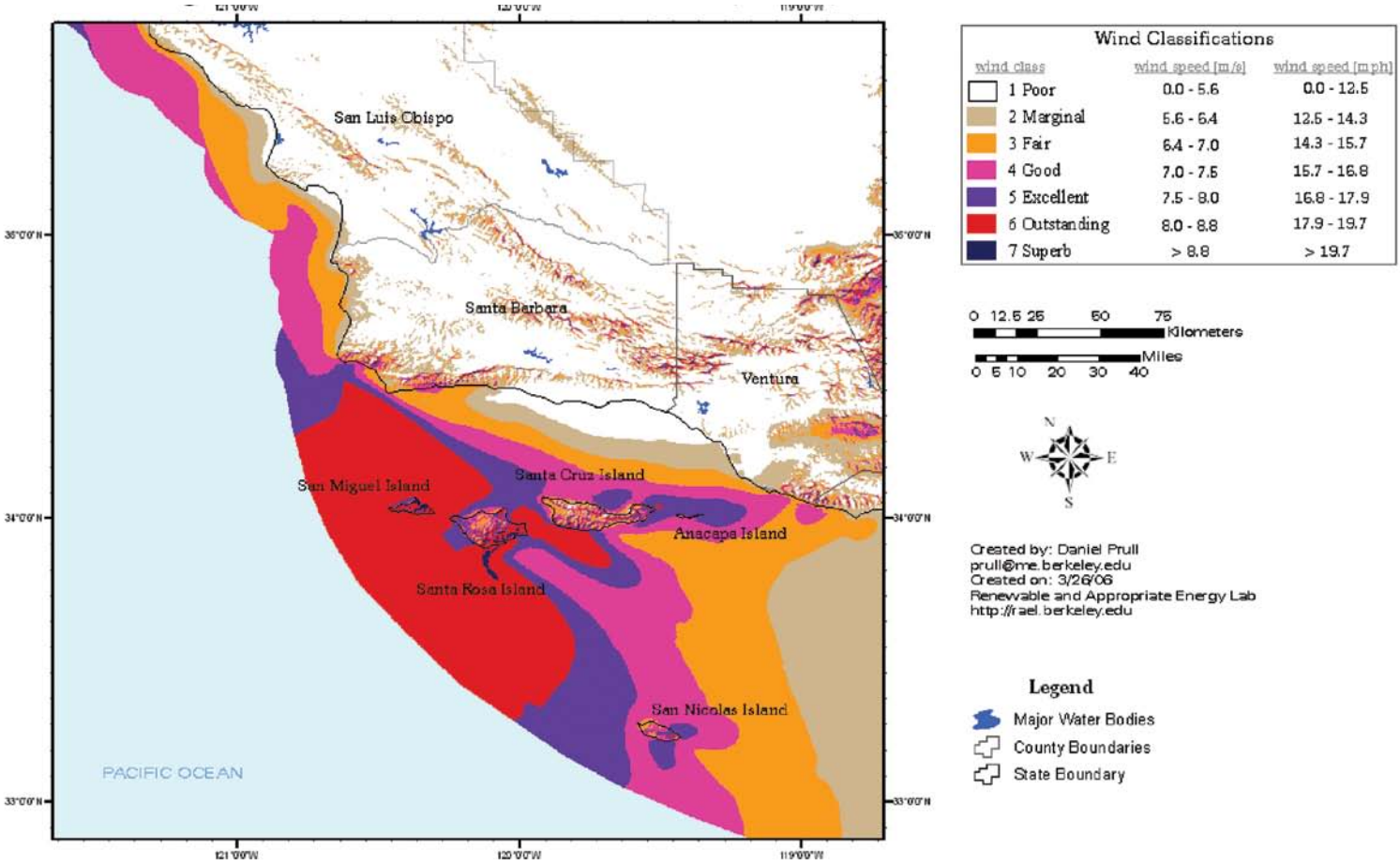
The Zaca Lake Region

This area consists of more than 25 miles of windy ridgelines, some of which could be suitable for wind farm development.

The Hollister Ranch Region

This part of the coast is very windy, but much of the land is not developable due to its steep terrain. Any wind power developer would also have to negotiate with numerous small landowners, imposing another obstacle to significant development.

Figure 5-4. Tri-County Area Average Annual Wind Resource at 50 m (164 ft). (Source: Dan Kammen, UC Berkeley)



The Region Offshore from Vandenberg Air Force Base

This area has a relatively shallow continental shelf, good wind resources, and very few inhabitants. If the Air Force is amenable to development and the wind speeds are consistent with current estimates, this could be a very good site. If offshore development happens in our region in the next five years, it's likely it will be at this site. Marine Protected Areas were recently approved in portions of this region, but wind turbines could be placed outside of the protected areas if necessary.

The Channel Islands Region

Development in this region would be controversial. Most of the islands are a national park and the waters up to six nautical miles from the islands are protected as part of the Channel Islands National Marine Sanctuary. While wind power development is not prohibited, it would likely face strong opposition. CEC is also examining the deep water region between Santa Rosa Island and San Nicolas Island because turbines in this region would be outside protected waters and would not be visible from the mainland.

Figure 5-5. Wind power potential in Santa Barbara County (in GWh)[6]

	Onshore potential	Channel Islands	Small Wind	Offshore
High wind	739	10,148	2,276	166,465
Low wind	3,060	6,584		108,038
Sub-total	**3,799**	**16,732**	**2,276**	**274,503**
			Total wind power potential:	**297,310**

Denmark's off-shore wind farms

Denmark, a relatively small northern European nation, receives about 20 percent of its electricity from wind power and plans to expand that to 50 percent by 2025. Two large offshore wind farms provide the majority of this power: Horns Rev and Nysted, at 160 MW and 165 MW respectively. Together these two farms provide enough power for about 160,000 Danish homes. A recent comprehensive review of the impacts to the marine environment found minimal impacts to wildlife, including birds and marine life. As a result, both wind farms are slated for expansion in the next few years.

Denmark offshore wind turbines

Overcoming Barriers to Wind Power

Disrupted views

Wind turbines can be enormous, with some models approaching 500 feet at their highest point. In addition, wind power often comes from remote regions, where new transmission lines are usually needed. These lines can be unsightly if they cut through open spaces and countryside.

In many areas around the U.S. and other countries, visual impacts are arousing opposition among residents. The most prominent opposition in the U.S. has been to the Cape Wind Project in Massachusetts. This high-profile fight has been mostly over views. Having large wind turbines dotting the offshore horizon troubles some coastal residents and sailors.

We have to acknowledge that many people in our region may not want their views to include wind turbines, and it's possible that wind development may raise similar concerns if turbines are highly visible to residents. Still, in a region where residents are already accustomed to views of off-shore oil platforms, some may not be bothered by turbines or may even find them beautiful -- either literally or symbolically as a clean alternative to fossil fuels.

The most obvious way to resolve this concern is to build projects where people won't see them. This may be possible given the sites we've identified, which allow for turbines to either by hidden away from populated areas, or located offshore, beyond the line of sight. Where this is not possible, turbines can be painted in such a way as to diminish their visual impact by matching the background colors of the landscape.

In addition, CEC will work with residents and permitting agencies to fully consider community concerns like viewshed issues and to develop a protocol for optimal siting of transmission lines, similar to what the Energy Commission is doing in relation to bird impacts. In some cases, undergrounding power lines may be feasible.

Impacts on wildlife

Bird kills have been the most significant problem for wind turbines. A recent U.S. Government Accountability Office (GAO) report examined bird mortality and found that "the impact of wind power facilities on wildlife varies by region and by species. Specifically, studies show that wind power facilities in northern California and in Pennsylvania and West Virginia have killed large numbers of raptors and bats, respectively. Studies in other parts of the country show comparatively lower levels of mortality, although most facilities have killed at least some birds.[7]"

Wind developers and permitting agencies have learned valuable lessons from Altamont Pass and in other regions. Avoiding the placement of turbines in areas where raptors, bats or migrating birds congregate can greatly reduce mortality. To ensure appropriate siting, the California Energy Commission is working with the public and permitting agencies to develop a wind turbine siting protocol. We will inform local agencies and the general public of the protocol once it is finalized.

In addition, on the regional level, wind projects require an environmental review that includes an analysis of impacts on wildlife. Accordingly, if bird or bat mortality is projected to be high, a full public discussion will likely ensue and may lead to the project being denied.

Lastly, the technology itself is improving. New larger turbine blades turn more slowly than smaller and older turbines, and the smooth surface of the newer tower structures do not provide perching space for birds as the lattice structures used in older turbines did.

Wind Variability

Obviously, the wind doesn't blow all the time or at the same speeds. This can be problematic because power sources generally need to match power demand. For a grid to operate smoothly and avoid blackouts, it's necessary for power suppliers to have enough capacity so that every time someone flicks a switch, the electricity flows.

California currently obtains only about 1.5 to 2 percent of its power from wind. The variability of wind power doesn't present much of a problem until wind-generated electricity constitutes between 10 to 20 percent of the grid's total supply of power, partly because California utilities are required to maintain a 17 percent reserve capacity.[8]

Statewide, variability probably won't present any substantial problems until the state depends much more heavily on wind power for electricity. However, our regional goal for renewable electricity is much more ambitious than the state's 20 percent by 2010 renewable electricity goal. We are proposing to produce about twice our current electricity demand from renewable sources by 2033 or earlier, using the excess electricity to reduce petroleum demand through "electrification" of our transportation sector (see Chapter One and Chapter Four for more on this). This much renewable electricity may give rise to problems if a substantial portion comes from variable resources like wind and solar power.

Although variability may be a problem with wind power as it provides more power in California, there are many possible solutions. Appendix C examines the various options for mitigating variability in detail, but the primary options are discussed in brief below.

One effective option for mitigating variability is *geographic dispersion*. The more widely dispersed wind turbines are, the more likely that when wind is slack in one locale it will be blowing elsewhere on the grid. In Western Denmark, widely dispersed wind farms help supply a more constant flow of power from wind than would otherwise be the case. This reduces the wild swings that would take place if all wind turbines were in one small area. Wind turbines in our coastal region will complement other turbines further inland, providing more reliable power from wind.

Another option is *"pumped hydro storage."* During periods of excess wind power generation, water can be pumped to a water reservoir for use at a later date. This effectively uses the

reservoir as a battery, by allowing the water to run through a hydroelectric generator to produce electricity when it's needed. But this option works only in areas with hydroelectric facilities and excess storage capacity. Santa Barbara County has a number of dams and reservoirs, but CEC has not yet determined the feasibility or environmental issues related to using them for pumped storage.

Another way to smooth out the variability of wind power is to use *"electronic shock absorbers."* The Hawaii Electric Company, which depends on large amounts of wind power on the island of Hawaii, uses this technology to absorb power when it detects a sharp increase in output of wind power from strong wind gusts. Conversely, a lull in wind will cause the electronic shock absorbers to provide power back to the grid, keeping the flow of power constant for a limited time. This technology may be suitable for our county, but its use will probably depend on whether it is economical.

Another promising option is to use wind power for *hydrogen production*. California has long been promoting a "hydrogen highway" and a hydrogen economy. If hydrogen does become a commonly used energy source (or carrier, like electricity), wind power could be easily adapted to produce hydrogen for later use. In this scenario, hydrogen acts as a battery.

Transmission Lines

Transmission constraints are one of the biggest obstacles for wind power in California. In our region, we have plentiful wind, but it's often far from major transmission lines. The cost of building new transmission lines will probably be the biggest obstacle to new wind farms in our area. However, the cost of transmission is included in the cost of electricity from wind farms, so these costs will necessarily be included in project development considerations. Accordingly, this is an issue that will be handled – from a cost perspective – by developers and is not an issue that policymakers in our county can influence that much.

San Diego wind farm

A 50 MW wind farm on land owned by the Campo Indian Tribe sells power to San Diego Gas & Electric, one of the state's big three utilities. The Kumeyaay wind farm -- the largest coastal wind farm to date in California -- is owned by GE Energy Services and is part of GE's multi-billion Ecomagination program to promote clean technologies. Completed in 2005, the farm provides enough power for about 20,000 homes, while also providing additional income to the tribe. With California law now requiring that 20 percent of its electricity come from renewable sources by 2010 (up from about 11 percent in 2006), many new wind farms are expected to come online in the new few years in California.

Action Plan

How do we help make the enormous potential of wind power reality? In our action plan, we focus on four sectors: individuals, businesses, local government, and ourselves.

What can individuals do?

1. See if a small wind turbine would work at your home or office

Small wind turbines can be cost-effective at many sites in our region – particularly in the North County. Where they do not completely pencil out economically, the environmental benefits may persuade a homeowner to make the investment. In addition, even homeowners in low-wind areas like the South County may want to consider turbines that are designed especially for lower wind speeds. The new Skystream 3.7 small wind turbine costs about $12,000 to purchase and install and can provide enough power for about one third of an average home's needs.

Generally, small wind turbines are mounted on a pole away from buildings. However, some new small wind turbines are designed to be mounted directly on homes or office buildings. An installer will be able to provide more information on the correct mounting.

For more information on small wind, visit the American Wind Energy Association's guide at: http://awea.org/smallwind.

For information on installing a small wind turbine for your home, call Apex Electric in Simi Valley, California, at (805) 501-9769, or Nostalgic's in Santa Maria, California, at (805) 934-4665.

2. Urge your utility to offer a 100 percent wind power option to its customers

Some states allow their utilities to offer "green pricing" programs, where a customer can choose to receive more renewable energy than normal. For example, Xcel Energy, a private utility in Colorado and other states, offers a 100 percent wind power product. Generally, participating in this option costs a little more, but in some cases customers have enjoyed a discount over regular customers. For example, Xcel's customers normally pay 15 percent more to receive 100 percent wind power, but when natural gas prices peaked in 2005, they paid 15 percent less than other customers for a short time. As natural gas and other fuel costs continue to spiral upward, such cost discounts will become more common.

In California, utility customers don't have this option due to problems stemming from the 2000-2001 power crisis. However, if customers demand that this option be revived, state agencies will have to listen. Call your utility (PG&E to the north of Buellton and Southern California Edison to the South) and ask them to provide a renewable energy option. Then call the California Public Utilities Commissioners and ask that they allow the utilities to provide a "green pricing" option to consumers (also known as "direct access"). Contact information for the five CPUC Commissioners can be found at http://www.cpuc.ca.gov/static/aboutcpuc/commissioners/index.htm.

3. Urge your city or county government to implement Community Choice

"Community Choice" is another way of providing electricity customers with more choices by allowing local governments to buy or build new renewable electricity for their residents – up to 100 percent renewable. We view this as a very powerful tool for weaning our region off fossil fuels and discuss it

in more detail in Chapter 1. In addition to the environmental benefits, Community Choice will likely save consumers money because it allows all utility customers to share in the cost savings that local governments achieve by not having to pay taxes and having access to lower interest rates for loans. Call your city or county government and urge them to conduct a feasibility study, which is the first step to determining whether Community Choice is appropriate.

What can businesses do?

1. See if a small wind turbine would work on your property

Small wind turbines are generally more cost-effective for businesses than for homeowners because businesses can take advantage of additional tax incentives. As mentioned above, small wind turbines can be effective on the South Coast at certain sites, but generally North County wind resources are much better.

For more information on small wind, visit the American Wind Energy Association's guide to small wind: http://awea.org/smallwind/. For more information specific to land owners, see AWEA's fact sheet windy landowners: http://awea.org/pubs/factsheets/WindyLandownersFS.pdf.

For information on installing a small wind turbine for your business, call **Apex Electric** in Simi Valley, California, at **(805) 501-9769**, or **Nostalgic's** in Santa Maria, California, at **(805) 934-4665**.

2. See if a larger turbine would work on your property

A range of turbine sizes are available today, many of which may be economical for landowners. Businesses could receive up to 100 percent of their electricity from wind turbines and can receive credit for power they don't use (under the state's "net metering" law), allowing a landowner's electricity bill to go nearly to zero on an annual basis. Businesses buying wind turbines can receive a 30 percent "investment tax credit" and can use accelerated depreciation over six years (the Modified Acclerated Cost Recovery Schedule), which collectively bring the cost of the turbine down significantly.

Source: Southwest Windpower

Alternatively, landowners can work with private wind developers to lease their land for large turbines. Landowners can still use their land for grazing or agriculture, while granting an easement to the wind developer. Lease income varies by different regions, but can be substantial. This financial model is being used by Pacific Renewable Energy Group, the company that developed the pending 83 MW Lompoc wind farm.

What can local governments do?

1. Examine the feasibility of installing wind turbines for the agency's own use.

Cities and counties can, under existing authority, build power generation facilities for their own use, just as homeowners or businesses can. Local governments are a major source of energy use in our county (and the second largest employer, after the service sector). If all local governments used 100 percent renewable power, this would take us a large step in the right direction.

While there are no tax credits available to local governments, there is zero cost financing available with "Clean Renewable Energy Bonds" (CREBs), which are a type of tax credit bond. With CREBs, the local government issues the bonds to investors, but the federal government pays the interest through tax credits, buying down the interest charged the local government to zero percent. The federal

government recently approved $800 million in CREBs. More information from the American Public Power Association can be found at http://www.appanet.org/files/PDFs/CREB.pdf.

2. Encourage more widespread installation of small wind turbines by reviewing permitting fees and processes.

State law passed in 2001 states: "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." [AB 1207, codified at California Government Code Section 65892.13(a)(5)] The same law limits what local governments can do in restricting wind turbine siting. Although CEC has not heard of any major obstacles being imposed by local governments on small wind turbines, this is probably because our region has not seen many proposed projects, especially in urban areas where aesthetics or views could be concerns. However, with new technology like the Skystream 3.7, we can expect more people to consider installation of small wind turbines in low wind speed areas like the South Coast. We recommend that local jurisdictions preemptively examine -- and if need be amend -- their permitting processes and fees to allow an easy over-the-counter permit for small wind turbines where certain criteria are met, as many jurisdictions allow for solar installations. We also recommend that the cities and County educate their plan-checkers about this technology, to shorten the learning curve that they will face when small wind projects begin to become more common.

3. Examine the feasibility of Community Choice.

As discussed above, Community Choice is a state law that allows local governments to buy or build power on behalf of residents. Local governments could procure up to 100 percent of their residents' electricity demand (as well as their own) from renewable sources under this law, and possibly save money in the process. More information on this option can be found in Chapter 1. We recommend local governments commission a feasibility study to see if Community Choice would work for them and their residents.

What can CEC do?

1. Spread the word about the potential for wind power, in terms of both its technical potential and its economics

Our key action item is to educate policymakers, businesses and the public about wind power. There is a great deal of out-of-date wind power information in the public sphere, so a major push for our program will be to educate people about wind power's true potential as well as its problems.

2. Develop a "community wind" business model for 2 to 5 MW size projects

"Community wind" projects are intermediate in size: bigger than 1 or 2 kW home-size turbines and smaller than the 100 MW size utility-scale wind farms. Community wind projects are, as the name implies, owned by the community and benefit the community where they're sited. With current and projected natural gas prices, wind power could in many locations in the county be produced at or below the cost of electricity from a natural gas plant. Accordingly, selling wind to the investor-owned utilities (PG&E and Southern California Edison) could be a good business, while also providing more clean power to our grid.

3. Work with the public and permitting agencies to implement a protocol for permitting wind projects, and transmission, in a manner that best takes into account public concerns

As more wind farms are proposed in our region, public concerns about wind power will surely grow. Currently, concerns over the proposed Lompoc wind farm have been relatively muted. Some have expressed concerns about views, others about the impact on wildlife. But for the most part the responses to the proposed farm have been positive, both from the public and policymakers. This is largely due to the fact that the farm is located in a remote region, but also due to good advance work by the project developers.

As other proposals come to light, it will become a priority for CEC to work with the public and permitting agencies to implement protocols for optimal siting of wind farms and transmission. If we can identify problems in advance, we can do much to bridge the divide between those who may not like the idea of a wind farm in their backyard and the agencies reviewing future wind power proposals.

4. Work with developers to identify the best sites and develop information on the technical feasibility and economics of optimal sites

Historically, Santa Barbara County was not considered a good region for wind power production due to a lack of good information about wind potential in our county. Also, as a coastal county, it was considered difficult to gain approval for wind farms. However, now that the Lompoc wind farm is in the permitting process, other companies are scanning our region and learning more about the tremendous wind potential. CEC can perform a valuable role in working with developers, policymakers, and the public, to promote wind while at the same time ensuring that community concerns are addressed.

As large-scale wind power becomes a reality in our county, CEC will work with developers to examine further the most optimal sites for wind farms. The regions identified in this report are optimal based primarily on an assessment of the wind resource, urban area proximity (or lack thereof) and the availability of transmission lines.

As part of this effort, we are developing information for a very large offshore deepwater wind farm between San Nicolas Island and Santa Rosa Island. This area has the best wind resources in the state and is outside the Channel Islands National Park and the Channel Islands National Marine Sanctuary. If the wind farm is large enough, it may support enough transmission to make a farm 50 miles or more from shore economically feasible. As deepwater offshore technology develops, this area may become a good site for many gigawatts of wind turbines, with the added advantage of being completely invisible from shore and having minimal impact on marine life or the sea bottom.

Endnotes

[1] This calculation is based on a maximum production capacity of 120 MW with a 30% capacity factor. This means that the facility would produce its maximum capacity of 120 MW 30% of the time on an annual basis. This is considered quite good for wind farms.

[2] The report contains a conservative and a liberal analysis in terms of the amount of land considered excluded in wind potential calculations. The figures cited here are from the liberal analysis.

[3] This estimate is also based on a 30 percent capacity factor.

[4] REPower is a Germany company developing a 5 MW turbine. Online at: http://www.repower.de/index.php?id=1&L=1.

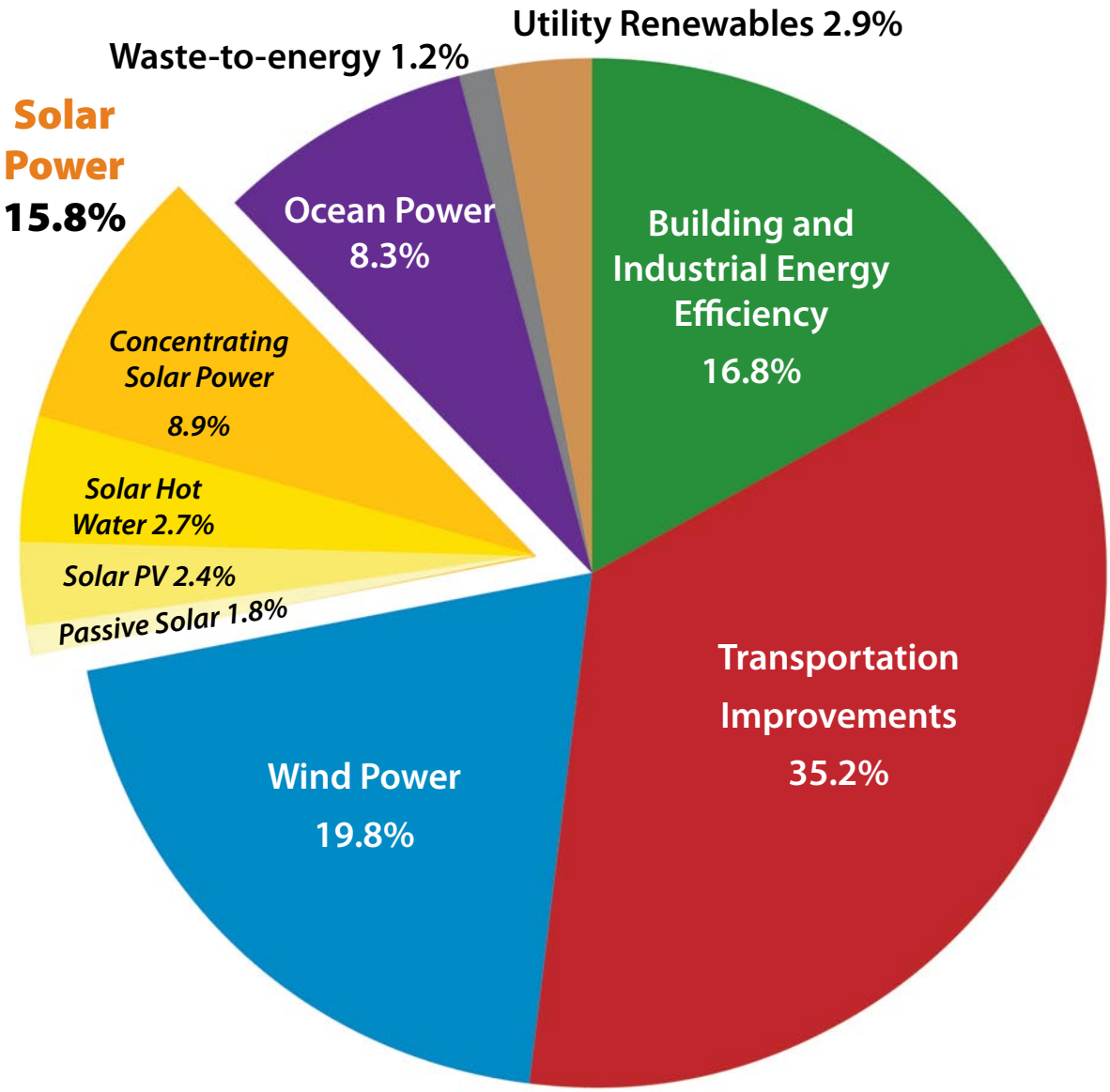
[5] Southwest Windpower website: http://www.windenergy.com/index_wind.htm.

[6] These figures are from the Kammen technical report on wind powering in our county.

[7] GAO, "Wind Power: Impacts on Wildlife and Government Responsibilities for Regulating Development and Protecting Wildlife," 2005.

[8] The California Independent System Operator (CalISO), which manages grids in California, has to balance different regional demands and sources of energy to ensure that power is delivered when and where it is needed. Electricity flows into Santa Barbara County from two utilities, PG&E in the North County and Southern California Edison on the South Coast, and is managed by CalISO.

Chapter 6 | Solar Power

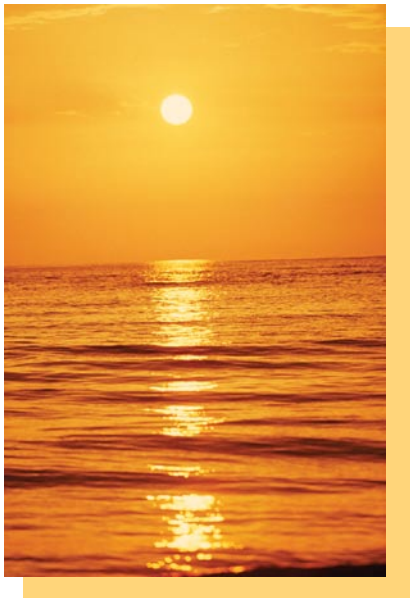


Pros: Solar photovoltaics, passive solar design, and solar hot water systems are available today as viable options for homes and businesses. Utility-sized "concentrating solar power" can provide large-scale power production at reasonable rates.

Cons: The sun doesn't always shine, so solar power is not 100 percent reliable as a power source unless the system has a battery or other type of storage. Although the cost of solar power is dropping, some solar technologies can be expensive.

Technology readiness: Solar photovoltaics, passive solar design, and solar hot water systems are mature technologies that have been around for decades, and are increasingly common in Santa Barbara County. Utility-scale "concentrating solar power" is a younger technology with only a few applications in California and around the world, and none yet in our region.

Introduction



Solar power has the greatest potential of any renewable energy source because of the amount of sunlight that falls on our region. We are, after all, the Golden State! We thrive on sun, and that same energy can provide a significant part of our power needs.

One major advantage for solar power is that many solar techniques and technologies work almost anywhere and can be readily installed on homes and businesses in our region today. For example, passive solar emphasizes the design and orientation of buildings to take advantage of the sun's energy for heating, cooling, and natural lighting. Solar hot water is an inexpensive low-tech option that uses the sun's rays to heat water for building use. And solar photovoltaic panels (PV) convert sunlight into electricity.

In addition, our region could generate large quantities of solar power through the use of concentrating solar power (CSP). These technologies use mirrors or lenses to focus sunlight on either a central point or a tube filled with oil that turns water into steam, which drives a generator to produce electricity. Of all the solar power options that CEC analyzed, CSP is the one that can probably provide us with the most power, reliably, and at the cheapest cost over the long term.

The downside to solar power is that some solar technologies are still expensive compared to fossil fuels and other renewable energy technologies like wind power, hydroelectric power and geothermal power. The upside, however, is that both the cost of development them and the options for financing are changing quickly, making solar technologies increasingly cost-effective. The economics of each type of solar power technology is discussed in detail below. The various types of solar power could provide 2,900 GWh of energy by 2030 - and that's to meet 15.8 percent of our projected 2030 demand.

Figure 6 -1. **Cumulative capacity for solar PV in Santa Barbara County and in California, 2000-2006.** (Source: California Energy Commission).

Solar in SB County		Solar in California	
	Total (kW)	Statewide (kW)	Cumulative (kW)
1999	4.3	965	965
2000	42.0	1,701	2,666
2001	44.7	6,250	8,916
2002	713.4	14,576	23,492
2003	331.1	26,965	50,457
2004	479.4	36,722	87,179
2005	615.3	42,742	129,921
2006	798.7	44,088	174,009

Technology Assessment

Passive Solar Design

Passive solar design uses smart building techniques to maximize solar heating, insulate buildings from over-heating, and provide natural light. These design techniques don't actually produce energy, but can, instead, reduce energy use by more than 50 percent with minimal to no cost. They are generally cheaper options than solar water heating systems and photovoltaics, which do produce energy.

Building orientation is the essential first step for good passive solar design. Buildings can be positioned toward or away from the sun, depending on whether heating or cooling is the primary concern. Shading from other structures or natural features can be avoided or used as desired. Buildings can also be dug into the ground to take advantage of the more constant temperature of the earth itself. It takes far more energy to change the temperature of the earth in even a small lot than it does to change the temperature of a house and this constancy can be used to maintain household temperatures in a narrower range year round.

Passive Solar Design Can Save Big Bucks

Amory Lovins, CEO of the Rocky Mountain Institute, a well-known energy policy think tank, built his home at 7,000 feet in the Rocky Mountains in 1982. His heating bill was reduced by 99 percent and his electricity bill by 90 percent.[1] He grows bananas in his built-in greenhouse. How? Due in large part to passive solar design. Good design can easily reduce energy use by 50 percent or more with minimal to no additional cost. Picture: banana trees in Amory's greenhouse.

Another type of passive solar design uses tubes, in which water flows through loops drilled into the earth to heat or cool air in buildings. Because of the more constant temperature of the earth's thermal mass, this technique helps provide a stable temperature throughout the year with very little outside energy required. Santa Barbara County's historic courthouse uses this type of system to maintain temperatures in its Hall of Records, as does the new County Wellness Center in Lompoc. The projected payback period for the system in the Hall of Records was only 3.87 years (without interest), so these systems may be quite cost-effective.

On a much larger scale, some areas use cold sea or lake water for cooling. For example, Enwave Energy in Toronto, Canada, uses deep water from Lake Ontario to cool homes and offices in the city. This system has reduced energy consumption 90 percent compared to conventional air-cooling systems and saves the equivalent energy used by 6,800 homes.[2] A similar system may work in our county, using deep sea water for summer cooling needs, if our regional air conditioning demand is large enough to make such a system cost-effective. This technology is not strictly a passive solar technology, but may be appropriate for our region nonetheless.

The shape, color and surface area of a building can also reduce heating or cooling requirements, by either reflecting or absorbing solar energy. For example, "cool roofs" are white roofs that reflect sunlight and keep buildings cooler.[3] Similarly, "green roofs," which contain soil and plants, absorb sunlight and add an insulating layer to the roof while also providing a pleasant garden environment.[4]

Landscaping materials, such as trees and plants, can reflect or absorb heat, and create shade and shelter from the wind. Deciduous plants, which allow sunlight to pass in the winter and shade in the summer, can be very effective.

The potential for energy savings in our county through passive solar design largely depends on the rate of new buildings constructed and retro-fits completed, and whether additional standards or local ordinances are passed that require increased energy efficiency. We project a 340 MWh equivalent potential for passive solar by 2030.

Solar Hot Water

Solar hot water technologies use sunlight to heat water for later use. There are two general types of solar hot water: solar hot water systems for home or business use, which are typically panels a few inches thick, four feet wide and eight feet long; and solar pool heating systems, which are typically much thinner, with small tubes comprising a mat. Both types circulate water through tubes that use

A typical rooftop solar pool heating system. (Source: The Renewable Energy Resource Center)

The Architecture 2030 Challenge

CEC is spearheading an effort to implement the Architecture 2030 Challenge in our county. Created by New Mexico architect Ed Mazria, this challenge calls for all new or retrofitted buildings to be carbon neutral by 2030. The U.S. Green Building Council, which designs and administers the national Leadership in Energy and Environmental Design (LEED) program, recently announced it plans to incorporate the Architecture 2030 (www.architecture2030.org) goals into its building standards. Locally, the City of Santa Barbara is considering an ordinance to incorporate the Architecture 2030 goals. If the ordinance is passed, it will be the first in the country to take such a step and will provide a great model for others to follow.

sunlight to directly heat the water.

Solar hot water systems and solar pool heating systems can be one of the most cost-effective forms of renewable energy for homeowners and businesses, with payback periods often in the range of four to six years – less if the customer has exceptionally high water heating bills. These technologies are even more affordable in part because of state and federal incentives. In 2006, solar hot water systems began to qualify for a federal 30 percent tax credit. For residential users, this tax credit is capped at $2,000 and expires at the end of 2008; however, for businesses, there is no cap, so this can be a major incentive for businesses to invest in solar water heating. In addition, the state is offering rebates to San Diego County residents for solar hot water systems through a pilot program that may be expanded to the state as a whole.

While solar pool heating systems don't qualify for any financial incentives in 2007, customers have been installing these systems in large numbers, suggesting that they are cost-effective without incentives.

We project a 500 MWh equivalent potential for solar hot water in our county by 2030.

Solar Photovoltaics (PV)

Solar PV converts sunlight into electricity by exploiting the transfer of electrons stimulated by sunlight in certain materials such as silicon.

Historically, the expense of solar PV limited its use to space satellites and other remote off-grid sites, where it would be impossible or prohibitively expensive to connect to transmission lines. However, in the last decade, solar PV has experienced major cost breakthroughs, causing the industry to boom in California and around the world. In our state, the boom has also been aided by significant subsidies; without these, solar PV would not be growing at its current rate.

A typical ground-mounted solar PV system. (Source: REC Solar).

Over the last 25 years, solar PV installations have seen steady and, lately, exponential growth in California and Santa Barbara County. (See Figure 2-5.) If the trend continues, solar PV could contribute a significant share of our energy needs over the next few decades, though it's not at all clear that this trend will continue.

While over the long-term the cost per watt for solar PV has been dropping, in 2003 through 2006 the cost rose substantially due to sharply increased demand and the inability of companies to bring on new supplies fast enough.[5] Currently, solar PV modules cost about $5.50 a watt[6], but over the next decade we may see this reduced to $1 a watt through as the industry makes improvements to the technology. At this five-fold reduction in price, solar PV would become cheap enough to be an automatic choice for most consumers as well as for utilities for large central station generation.

In the meantime, solar technologies continue to be supported through state and federal incentives. California, for example, recently approved a new $3.2 billion incentive package to promote PV and solar hot water technology over the next 10 years, with the intent of pushing the price for PV down to the point where no subsidies are required. This approach has worked in Japan, where the PV market is booming and government incentives have almost disappeared.

As a result, the total cost for solar PV in California – including installation -- is $9 to $10 a watt. An average residential 3 kW system, therefore, costs about $27,000 to $30,000 before rebates and tax credits, and about $17,500 to $20,500[7] after. If a business pays for the system, there is no cap for the federal tax credit, and the costs of the system can be depreciated over five years, significantly reducing the cost.

We project a 440 MWh (200 megawatts) potential for solar PV in our county by 2030, based on a study completed in 2001 by local solar energy experts at REC Solar, Inc., as well as subsequent developments.[8] REC Solar's analysis assumed 50 percent of all residential roofs with solar PV, and didn't consider commercial roofs or ground-mounted systems. Of all the renewable energy technologies, this technology's growth is probably the most difficult to project with any certainty because there are so many possible breakthroughs in technology and pricing on the horizon.

Concentrating Solar Power

Concentrating solar power (CSP) technology is not widespread in California today and there are no installations in our county, but this technology holds great promise for large-scale power production at attractive prices. There is also the potential for smaller residential or business-size applications with some CSP technologies.

A number of CSP facilities were first built in California and other Western states during a period of favorable federal legislation in the 1980s and 1990s. Over the next decade, very few new projects were constructed because of changes to the incentive structure at the federal and state level. This 10-year lapse has recently been broken by Solargenix, Inc., which is constructing a 1 MW trough system in Arizona and a 64 MW system in Boulder City, Nevada. Other companies have projects planned for California, Spain and Australia.

According to a report for CEC by Segue Energy Consulting[10], the largest CSP system in operation today consists of nine arrays near Kramer Junction, California, totaling 354 MW – enough for about 300,000 homes at peak production. New CSP facilities that are planned in California range in size from 500 MW to 900 MW. When compared to the largest solar PV systems in operation (10 MW in Germany) or planned (64 MW in Portugal), it's easy to see why CSP can and should be a major part of our region's energy plan.

In fact, the potential for this technology not only in our region but in California and other sunny parts of the West is enormous. The Western Governor's Association recently reported that up to 8,000 MW of CSP could be installed in the western states by 2015.[11] Based on these figures and other research, we project a 1,000 MW potential for CSP by 2020 in our region, which includes Carrizo Plain in San Luis Obispo County.[12]

The main types of CSP are: trough systems, which use a trough-shaped mirror to focus sunlight on a fluid-filled tube; dish systems, which have dish-shaped mirrors focusing sunlight on a single point; and "power towers," which have many flat mirrors surrounding a central tower that holds the generator.

Trough systems

With this technology, the sun's energy is concentrated by parabolically curved, trough-shaped reflectors onto a receiver pipe running along the inside of the curved surface. This energy heats oil flowing through the pipe; the heat energy is then used to generate electricity in a conventional steam generator.

California CSP Systems On the Way

All three of California's big electric utilities have recently signed contracts for large CSP systems. Pacific Gas & Electric, a major California utility, has signed a contract with Luz II, Inc., for a 500 MW trough CSP system, scheduled for completion in 2010.[13] Southern California Edison has signed a contract with Stirling Energy Systems for up to 850 MW of Stirling engine dishes. San Diego Gas & Electric has signed a contract with the same company for up to 900 MW. No sites have been selected for any of these projects as of late 2006.

Most parabolic trough plants are "hybrids," meaning they use fossil fuel to supplement the solar output during periods of low solar radiation. Typically a natural gas-fired heat or a gas steam boiler/reheater is used, although troughs also can be integrated with existing coal-fired plants. The 354 MW of CSP near Kramer Junction, for example, produces 80 percent of the facility's power from the sun and 20 percent from natural gas – a ratio much more green than California's overall power mix, which was about 11 percent renewable in 2006.

A major advantage of trough CSP systems is their capacity for heat storage (generally using molten salt storage systems). By storing heat for later use, this technology can continue to generate electricity for several hours into the evening – thus addressing one of the barriers to solar power: producing energy even when the sun isn't shining. In contrast, storage for solar PV is still expensive, as it requires many batteries.

Although CSP storage systems have been built, they add cost to the facility and are rare. In fact, most of the CSP systems being built today do not plan to include storage. However, even without it, CSP systems could potentially produce peak power on a fairly reliable basis, allowing CSP power to earn a premium over non-peak power sources like wind power through hybridization with other power sources. For example, CSP systems can be hybridized with natural gas to "firm up" the CSP system even when the sun isn't shining, as is the case with the SEGs plants.

Dish systems

Instead of a trough, dish CSP systems collect solar energy from the sun with dish-shaped mirrors and focus it on a small area, instead of a tube. An electric generator then "burns" sunlight instead of gas or coal to produce electricity.

The power conversion unit includes the thermal receiver and the engine/generator. The thermal receiver is the interface between the dish and the engine/generator. A thermal receiver can be a bank of tubes with a cooling fluid, usually hydrogen or helium, which serves as both the heat transfer medium and the working fluid for an engine. Other types of thermal receivers are heat pipes wherein the boiling and condensing of an intermediate fluid is used to transfer the heat to the engine.

In addition to systems that can focus the sun's heat on a Stirling engine, they can also be built to focus on "high efficiency PV" -- a type of PV that can withstand very high temperatures and produce a relatively large amount of electricity from a small surface area. Australia-based Solar Systems, Inc., and U.S.-based Thousand Suns, Inc., are developing dish PV systems. Thousand Suns is working with American Ethanol to place a number of dishes on an ethanol plant planned in Santa Maria. This is the first use of CSP technology planned for our county.

One of the primary advantages of dish-engine systems is their size. They can be relatively small -- generally between 10 and 25 kW in size – making them the only CSP technology appropriate for residential or business applications. They can be configured to provide "distributed generation" – small generators close to the place where power is needed – or in large clusters for central station power, as is planned for two very large facilities for Southern California Edison and San Diego Gas & Electric.

Dish System Plans

Dish systems are planned for two very large CSP projects to supply electricity to California utilities. Arizona-based Stirling Engine Systems has signed contracts with San Diego Gas & Electric and also Southern California Edison for 900 MW and 850 MW dish system CSP plants, respectively. Sites haven't been selected for these plants as of late 2006.

Power towers

This technology uses large, sun-tracking mirrors (heliostats) to focus sunlight on a receiver at the top of a tower. A heat transfer fluid heated in the receiver is used to generate steam, which, in turn, is used in a conventional turbine-generator to produce electricity.

One of the primary advantages of dish-engine systems is their size. They can be relatively small -- generally between 10 and 25 kW in size – making them the only CSP technology appropriate for residential or business applications.

Early power towers (such as the Solar One plant near Kramer Junction) used steam as the heat transfer fluid; current designs use molten nitrate salt because of its superior heat transfer and energy storage capabilities. Individual commercial plants will likely be sized to produce anywhere from 50 to 200 MW of electricity.

Power towers may become cost-effective more quickly than trough or dish systems because of their centralized power plant design, allowing cost savings through economies of scale. According to a 2004 report from the California Energy Commission, power towers hold considerable promise due to likely cost breakthroughs.[14] However, because no one is working to develop new power tower projects in California, we don't foresee this technology having much impact in our region over the next decade or so.

We project up to 1.6 GWh (750 MWh) of CSP in our region by 2030.

Overcoming Barriers to Solar Power

Cost

The most significant barrier for some solar technologies is the cost, although cost can vary widely between technologies, and even between different installations of the same technology. On the whole, passive solar design and solar water heating and pool systems are relatively inexpensive and easy alternatives for most people, while electricity from solar PV and power plants that use concentrating solar power (CSP) can be relatively expensive. (See Figure 6-2 for a snapshot of current costs and future projections.)

Three issues may dramatically influence the cost-effectiveness of solar over the next few years: the comparative cost of electricity from non-renewable sources, financial incentives such as tax credits and rebates, and new ways of financing solar systems.

The first issue requires exploring the underlying assumptions about the future cost of utility electricity. If we project a three percent annual increase in utility rates, solar PV and CSP will typically be expensive in comparison. But if we project a five or 10 percent annual increase, the relative cost drops substantially. In fact, utility rates have risen significantly over the last few years, so it is not unreasonable to project a continuation of this trend. (For example, Southern California Edison raised rates three times in 2006: 9 percent, 5.5 percent, and

Figure 6-2. Cost-effectiveness of solar energy technologies.

	Passive Solar	Solar Hot Water	Solar PV	Concentrating Solar
Cost Today	Very inexpensive	Expensive	Generally fairly expensive	Expensive
Cost within 10 years	Very inexpensive	Inexpensive	Possibly much less expensive	Probably much less expensive

8 percent.[15]). At the core of these increases are the rapidly rising costs of fuels like natural gas (up 300 percent since 1999), coal (up 20 percent since 2004), and uranium (up 40 percent since 2001[16] and up 1,000 percent on the spot market since 2000[17]).

Also, it is important to note that while solar PV and CSP have significant up-front costs, one of the major advantages of solar energy is that the cost of electricity can be locked in for the life of the project. This eliminates the uncertainty, for consumers and power providers, of wildly fluctuating energy prices for natural gas, oil and, to a lesser degree, coal.

The second issue that will influence the affordability of solar power in our region is the incentive level available for solar hot water, solar PV and CSP. For the first two technologies, these incentives vary widely depending on the purchaser. Businesses and residential users with very large utility bills benefit the most, as businesses can generally take advantage of all the available tax incentives, and large residential electricity users can eliminate the most expensive electricity they use with solar PV and other measures.[18] Non-profits and local governments benefit the least, as they don't pay taxes and therefore don't benefit from tax credits. (However, the state of California offers additional incentives to these entities and affordable housing projects through higher rebates.)

The last issue that will likely influence affordability is a promising new financial model for large (and possibly small) solar PV systems. Offered by companies such as URS Corp., SunEdison, MMA Renewable Ventures and Cerox Corp, this "no capital cost" financial model means, as the name implies, that the consumer does not pay the high capital costs of installing a system. Instead, the customer pays only for electricity produced by the system. These companies are generally interested only in systems of 100 kW or larger (in some cases 500 kW or larger), which makes this model appropriate for businesses, schools, local governments and other large building owners. Cerox Corp, with an office in Santa Maria, hopes to make financing available to systems as small as 50 kW, though their plans are still being developed.

Figure 6-3. Financial incentives for solar systems in California.

	Passive Solar	Solar Hot Water	Solar PV	Concentrating Solar
Federal Incentives	None	**Commercial:** 30% federal investment tax credit of the net systems cost with no cap	**Commercial:** 30% federal investment tax credit of the net systems cost with no cap	30% federal investment tax credit
		Residential: 30% federal investment tax credit of the net systems cost capped at $2,000	**Residential:** 30% federal investment tax credit of the net systems cost capped at $2,000	
		Non-Profit: None	**Non-Profit:** None	
State incentives	None	Only available as a pilot program in San Diego in 2007	**Commercial:** $2.50 per watt for systems <30 kW	$2.50 per watt rebate, or $.39/kWh for up to 5 MW
			Residential: $2.50 per watt for systems <30 kW	
			Govt. & Non-profit: $3.25 per watt for systems < 30kw	

Permitting Barriers

CEC has been the regional coordinator for the local Million Solar Roofs Partnership, a federal program to promote solar power, since late 2003. As part of our mission, we have succeeded in streamlining the local government permitting process in some jurisdictions (the City and County of Santa Barbara) and helped educate people on the potential for solar power in our county. Though we have helped reduce permitting barriers in some jurisdictions, there is more that can be done. The ideal permitting process allows most systems – 10 kW and under, for example – to receive "over the counter" permits not subject to discretionary review. The City of Santa Barbara instated such a system in 2006 and the County of Santa Barbara is moving toward this system. See our detailed report on solar PV in our county at our website.[19]

Transmission Lines

One advantage of passive solar, solar hot water and solar PV is that these technologies either save energy or generate it at the place it's used – meaning that they don't require additional transmission lines. However, CSP – like wind power – does require access to major transmission lines, and like wind, the best sites are often located in remote areas.

This is the case in our region, where access to potential CSP sites in Carrizo Plain and the Cuyama Valley could be one of the biggest barriers to this technology. However, the cost of transmission will be included in the cost of electricity from any new CSP development, so these costs will necessarily be included in project development considerations. Accordingly, this is an issue that will be handled – from a cost perspective – by developers and is not an issue that policymakers in our county can influence that much.

Competition

As mentioned earlier, Concentrating Solar Power (CSP) is experiencing a resurgence of interest, due to rising fossil fuel costs, concerns over climate change and diminishing costs for CSP. However, while interest is growing, only a few projects have been announced for California, and these are likely to be further inland than Santa Barbara County, where insolation is particularly strong due to consistently sunny weather. While our region has a few good sites for CSP – mainly in the Carrizo Plain area -- insolation is still not as strong here as it is in Kramer Junction and elsewhere.

However, our region may be able to incentivize the development of CSP projects through favorable local tax incentives. We also may be able to build our own facilities through local companies and/or government agencies that have an interest in local development of this technology. One possibility is Community Choice implementation, which allows local governments to buy or build power facilities on behalf of their residents. Community Choice is discussed in more detail in Chapter 1.

The Action Plan

Solar power clearly has huge potential in our county, but how we make that potential reality? In our action plan, we focus on four sectors: individuals, businesses, local government, and ourselves.

What can individuals do?

1. Incorporate solar passive design into your new home or retrofit

As discussed earlier, passive solar design can save significant amounts of energy in a cost-effective way. Some local architects and builders specialize in this technology. Contact information can be found at the Built Green Santa Barbara (a non-profit entity that promotes green building in Santa Barbara) website: http://www.builtgreensb.org/members/members.html.

In the City of Santa Barbara, the plan-check process can be expedited by choosing to become a Built Green project, which requires that the builder follow a checklist for various building features. For more information, go to www.builtgreensb.com.

The County of Santa Barbara also offers incentives for builders who go through their Innovative Building

Review Program. More information can be found at http://www.sbcountyplanning.org/projects/ibrp/index.cfm. More detail on these programs can be found in Chapter 2.

2. Consider solar hot water or solar PV for your home

Solar hot water systems and solar PV provide immediate opportunities for you to gain energy independence, reduce greenhouse gas emissions, and create an insurance policy against continuing rate increases by your utility. By combining smart financing with energy efficiency measures that first help reduce your energy use, you can also save money. (See Chapter 2 for more on energy efficiency in your home).

To calculate the economics of a PV system for your home, use the Clean Power Estimator at http://www.consumerenergycenter.org/renewables/estimator/index.html. However, keep in mind that this calculator only allows you assume up to a 5 percent increase in annual utility rates. As mentioned earlier, the cost-effectiveness of solar technologies depends greatly on your assumptions. If you assume a five or 10 percent annual increase, as has been the case for a few years, solar PV systems can pay themselves back in eight to 12 years, and solar hot water systems in four to six years. PV systems can be more-cost effective if they are sized to eliminate only the most expensive electricity a home uses, which all solar installers will be able to discuss with you.

State and federal incentives also make solar technologies more affordable. Homeowners can receive a federal tax credit of 30 percent of the cost of a solar hot water or solar PV system, up to $2,000. In addition, homeowners qualify for a state rebate for solar PV, and in the future may receive a rebate for solar hot water systems if a San Diego pilot program is expanded state-wide. While solar pool systems don't currently qualify for any incentives, they tend to be economical without incentives.

By combining smart financing with energy efficiency measures that first help reduce your energy use, you can also save money.

View our Getting Started with Solar brochure, which can guide you through the process of installing solar PV on your home and also lists a number of solar installers in our county: http://www.communityenvironmentalcouncil.org/Programs/EP/energySolar.cfm.

What can businesses do?

1. Incorporate solar passive design into new buildings or retrofits

Our recommendations for homeowners are even more apt for businesses and their buildings. Energy costs are highly volatile and reduce certainty for businesses in projecting their cash flow, among other things. By significantly improving the energy efficiency of buildings through passive solar design, businesses can project with greater certainty what their energy bills will be – and those bills can be much lower if passive solar design and other energy savings measures are implemented.

2. See if solar hot water or solar PV works for your business

Similarly, our recommendations for homeowners regarding solar hot water and solar PV apply more strongly for businesses because businesses enjoy additional tax incentives that aren't available for homeowners. Businesses with tax liability can take advantage of the 30 percent tax credit for solar hot water systems and solar PV systems, with no cap on the amount of the credit! Also, these systems can be depreciated on an accelerated schedule.[20] These additional incentives make solar hot water and solar PV systems more economical for businesses than they are for homeowners.

The Clean Power Estimator distinguishes between solar PV for a business and solar PV for a home, so this should be the first stop for a business looking to install solar: http://www.consumerenergycenter.org/renewables/estimator/index.html.

3. Lease your land for a large solar array

As with wind farms, discussed in Chapter 3, landowners can lease land to a developer for a large solar array. This is not a common model in California or elsewhere, but as Concentrating Solar Power technologies take off, or if solar PV prices come down significantly, a land lease model may become more common. Essentially, this financial model allows a developer to avoid purchasing land for development and thus reduce the project costs substantially.

Sunlight (or "insolation") must be very strong for these technologies to work on a large scale, so check the National Renewable Energy Laboratory's insolation website to see if your property has the kind of sunlight required: http://rredc.nrel.gov/solar/old_data/nsrdb/redbook/atlas/

Or contact CEC for more information on this topic at (805) 963-0583, ext. 122.

What can local governments do?

1. Incorporate solar passive design into new buildings or retrofits

Our recommendations for homeowners also apply to local governments and their buildings. Local governments don't qualify for tax benefits for solar hot water or solar PV, so passive solar design is a readily available solar alternative. By significantly improving the energy efficiency of buildings through passive solar design, local governments can project with greater certainty what their energy bills will be – and those bills can be much lower if passive solar design and other energy savings measures are implemented.

2. See if solar hot water or solar PV works for government buildings or property

As mentioned, local governments don't qualify for tax benefits for solar hot water or solar PV. However, in some situations these technologies can be installed in a cost-effective manner. Any judgment of cost-effectiveness for a local government should include the fact that local governments can plan much further into the future than a business or homeowner. Accordingly, a project that provides a positive cash flow over its lifetime, but takes 25 years to pay for itself, could still be considered cost-effective because it's unlikely the local government is going anywhere in that time.

Also, local governments may be able to obtain "no capital cost" financing for large solar PV systems. Companies like SunEdison[21], URS Corp.[22], and MMA Renewable Ventures[23] typically offer this type of financing for systems of 100 kW and above. Some companies will require even larger size systems to qualify for their financing because there is tremendous interest in this financial model around the country. As a result, very large systems are being installed with no up front cost to the end user. For example, a 1.5 MW system was recently completed by URS Corp. on a General Motors building in the Los Angeles area,and SunEdison is planning an 18 MW solar PV system for an Air Force base in Nevada.

The City of Santa Barbara is currently in discussions with URS Corp. for a 200 kW solar PV system on its Garden and Laguna Street facilities.

Keep in mind that solar systems don't have to go on rooftops, so consider any open land owned by the agency for solar installations.

3. Reduce barriers to solar permitting

Some jurisdictions in our county have already done much to reduce barriers to solar installations. However, there is more that can be done in every jurisdiction. The state Solar Rights Act (Gov. Code section 65850.5 and Civil Code section 714) forbids local governments from imposing unreasonable barriers on solar systems. The state law also makes it clear that it is state policy to not allow aesthetic concerns to be a factor in approving or denying a permit. Only "public health and safety" concerns may be considered. Accordingly, every jurisdiction should examine their permitting procedures in light of this state law.

Also, many jurisdictions around the state have substantially reduced fees for solar permitting. CEC encourages all local jurisdictions to reduce fees for solar as much as possible and also find other ways to encourage solar power in our county.

4. Implement the Architecture 2030 Challenge

The Architecture 2030 Challenge encourages all buildings to become "carbon neutral" by 2030. In other words, there should be no net emissions of carbon dioxide or other greenhouse gases. More information can be found at www.architecture2030.org. This goal is completely in line with our goal to wean our region off fossil fuels by 2033 and we are working with local governments to implement this challenge.

Buildings can be designed or retrofitted to emit 50 percent less carbon emissions with little to no cost. It's the other 50 percent that will be more problematic. Local governments should, as part of their efforts to reduce their "carbon footprint" more generally, do their best to meet this challenge.

CEC is currently working with a local group of architects, builders and non-profits to develop a plan for local governments to achieve the Architecture 2030 goal in a cost-effective manner. Call us at (805)963-0583, ext. 103, for more information.

The Architecture 2030 Challenge encourages all buildings to become "carbon neutral" by 2030. CEC is currently working with a local group of architects, builders and non-profits to develop a plan for local governments to achieve the Architecture 2030 goal. More information can be found at www.architecture2030.org.

5. Examine Community Choice as a tool for building CSP facilities

Community Choice is a legal tool that allows local governments to buy or build power on behalf of their residents. We discuss Community Choice in detail in Chapter 1. If local governments in our county implemented Community Choice, they could finance and build large Concentrating Solar Power facilities in our county. Alternatively, they could join with other Community Choice agencies and build CSP facilities further inland where they may be more appropriate. This second model is currently being pursued by the Southern California Public Power Assocation (SCAPPA) under a contract with URS Corp.

A number of feasibility studies by Navigant Consulting, a well known consulting company, found that eleven jurisdictions interested in implementing Community Choice would save on average 3 percent annually on their residents' electricity bills. And this analysis assumed an extremely low annual average appreciation for utility rates. If a more realistic annual appreciation for utility rates is included, the likely savings increase substantially.

We strongly urge local governments to examine the possibility of implementing Community Choice as a means of building CSP and other renewable energy projects in or near our county. The first step is to commission a feasibility study from Navigant Consulting or a similar company. Navigant's John Dalessi can be reached at (916) 631-3200.

What can CEC do?

1. Encourage the use of passive solar design in new buildings and remodels

As mentioned, CEC is coordinating a coalition of architects, builders and non-profits interested in implementing the 2030 Challenge in our region. By implementing strong energy efficiency measures, including passive solar design, and encouraging the use of solar power on buildings or small wind turbines where appropriate, local governments should be able to reach these goals in a cost-effective manner.

CEC is working with the City of Santa Barbara and the local branch of the American Institute of Architects to develop a plan for the City to achieve the 2030 Challenge. Our coalition is also working with the County of Santa Barbara on similar efforts. CEC will offer to aid other jurisdictions in our county to also meet the 2030 Challenge by relying on energy efficiency and solar power.

2. Promote solar PV and solar hot water with new financing ideas and education

We have been working with a number of "no capital cost" solar financing companies, including URS Corp., SunEdison, and MMA Renewable Ventures, to finance large solar PV installations in the county. We will continue to promote this financial model for parties not able to finance solar power directly, and thereby significantly increase the number of large solar installations here. We are encouraged by the arrival of a new company, Cerox Corp.[24], with offices in Santa Maria, that has expressed an interested in financing solar PV installations in the 50-100 kW range. This is generally smaller than the range for the companies mentioned above.

3. Work with businesses and local governments to identify ideal sites for concentrating solar power plants in Santa Barbara and San Luis Obispo counties

We have been in discussions with SolarGenix and URS Corporation about possible CSP facilities in our region. These companies have not thus far expressed a strong interest in our region, but we continue to seek insolation data for the Cuyama Valley region and Carrizo Plain, with the hope that more accurate data will show strong potential for CSP sites locally. Alternatively, local governments or residents could study, design, finance and build CSP facilities in our region. As mentioned above, a coalition of Southern California municipal utilities (SCAPPA) is doing just this, so local governments in our region can learn from that experience. Community Choice, discussed in detail in Chapter 1, will probably be the best mechanism for allowing local governments in our county to finance and build large CSP projects.

Endnotes

[1] Smart Energy Living website: http://www.smartenergyliving.org/cm/Solar/Passive%20Solar%20Design.html.

[2] City of Toronto website: http://www.toronto.ca/environment/initiatives/cooling.htm.

[3] More information on cool roofs can be found at: http://www.coolroofs.org.

[4] More information on green roofs can be found at: http://www.greenroofs.net/index.php.

[5] Visit www.Solarbuzz.com for a monthly tracker of solar module prices in the U.S. and Europe.

[6] This figure represents the average module price in the U.S., from www.Solarbuzz.com.

[7] These figures reflect a $2.50 per watt state rebate and a $2,000 federal tax credit.

[8] Report on file with CEC. The report found a potential for 132 MW in the county. We reduce that figure because we don't believe we will see 50 percent penetration on residential roofs by 2020 – though we hope this will happen.

[9] California Energy Commission installed solar capacity report update from October 13, 2006, on file with the Community Environmental Council.

[10] This report is available at our website, www.fossilfreeby33.org, as are all of the technical consultant chapters used as the basis for our Regional Energy Blueprint.

[11] Western Governor's Association report on solar power available at: http://www.westgov.org/wga/initiatives/cdeac/solar.htm.

[12] We include Carrizo Plain in our analysis, though it is outside of Santa Barbara County, because it is close by, is a great site for solar power, and had a 5 MW solar PV plant there until the late 1990s. There is also transmission infrastructure in the Carrizo Plain that may be available for a large CSP plant in PG&E territory.

[13] PG&E website: http://www.pge.com/news/news_releases/q3_2006/060810.html.

[14] "Developing Cost-Effective Solar Resources with Electricity System Benefits," June 2005, available at: http://www.energy.ca.gov/2005publications/CEC-500-2005-104/CEC-500-2005-104.PDF.

[15] Los Angeles Times, "Edison Receives OK to Boost Rates 8%," (May 12, 2006).

[16] A report from the Edison Foundation found that fully 95 percent of the recent price increases for utility electricity could be attributed to increased fuel and purchased power costs. "Why are electricity prices increasing? An Industry-wide Perspective," Edison Foundation, 2006, available at: http://www.eei.org/industry_issues/electricity_policy/state_and_local_policies/rising_electricity_costs/Brattle_Report.pdf.

[17] Los Angeles Times, "Mining Firms Again Eyeing Navajo Land," Nov. 22, 2006. Also, visit www.uxc.com for up to date uranium spot market prices.

[18] In California, electricity rates are "tiered" in that the more a customer uses, the higher the rate charged for that electricity, as a disincentive to higher use.

[19] CEC report "Removing Barriers to Solar Energy Use in Santa Barbara County," (2005): http://communityenvironmentalcouncil.org/Programs/EP/PDFs/Removing%20Solar%20Barriers.pdf.

[20] The Modified Adjusted Cost Recovery Schedule (MACRS).

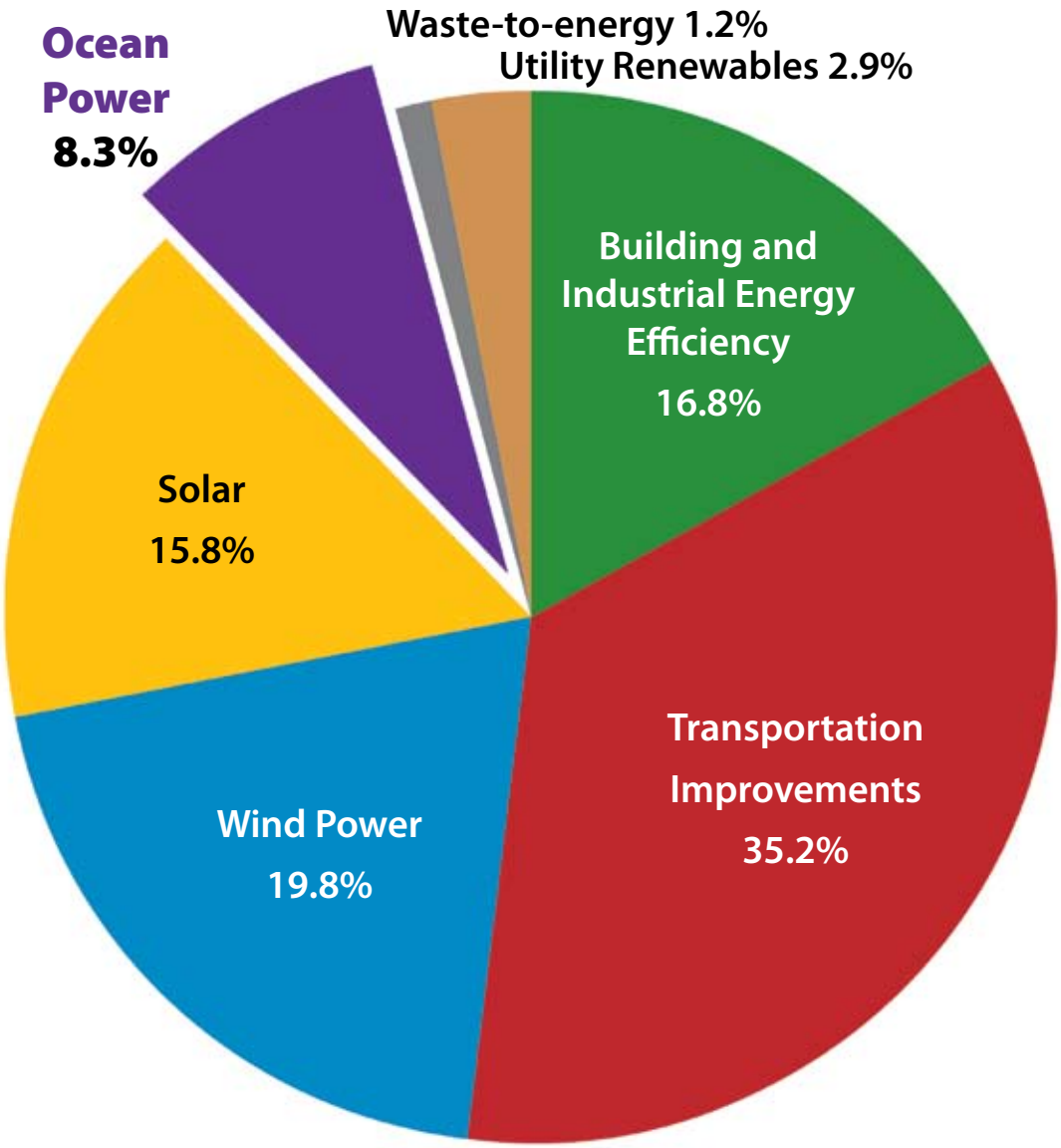
[21] Tom Oelsner is URS' sales representative for its third party financed solar products. He can be reached at (805) 964-6010.

[22] More information is available at www.sunedison.com.

[23] David Felix is MMA Renewable Ventures' sales representative. He can be reached at (520) 465-3128. MMA Renewable Ventures is distinct from URS and SunEdison in that these companies are "one stop shops" that design, finance and build the solar facility. MMA Renewable Ventures is a financier only.

[24] Cerox Corporation's contact for their solar products is Paul Detering, who can be reached at Paul@cerox.com.

Chapter 7 | Ocean Power



Pros: The ocean contains enormous potential for generating energy in our region, particularly through technologies that harness the power of waves. Wave power devices will have to developed in ways that have minimal impact on wildlife, the fishing industry, views from the shore, or marine recreation.

Cons: Wave power technologies are very young and their true costs are not fully known. Any project located in or near the ocean may need to be permitted by up to a dozen federal, state and local agencies – almost all of them unfamiliar with the technologies.

Technology readiness: There are a few small commercial projects operating around the world in 2007. However, the industry is growing fast and our region could see medium-scale commercial facilities up to 100 megawatts (MW) in the next 10 years.

Introduction

Our beautiful ocean and shoreline are our region's most remarkable physical resources. Within that vast expanse of water is energy that could provide a significant part of our county's electricity needs by 2020.

Ocean power technologies are varied, but the primary types are: **wave power** conversion devices, which bob up and down with passing swells; **tidal power** devices, which use strong tidal variations to produce power; **ocean current** devices, which look like wind turbines and are placed below the water surface to take advantage of the power of ocean currents; and **ocean thermal energy conversion devices**, which extract energy from the differences in temperature between the ocean's shallow and deep waters.

The most promising ocean power technology in our region is wave power, as we do not appear to have sufficiently strong tides, ocean currents, or thermal gradients to make other technologies feasible. The good news is that a recent study of California's coastline found enough wave power potential for about six hundred thousand homes in our county and southern San Luis Obispo County.[1] With only about 150,000 households (420,000 people) in the county today, this is obviously far more energy than we need – if the total potential were developed, which is highly unlikely.

As with all energy technologies, the key issues are availability and cost. For the most part, ocean power technologies are very young. The first commercial facilities were installed in 2000 and 2006, in Scotland and Portugal, respectively, but most projects in the water today or slated for the near future are pilot projects. Still, while we can't expect to see the same kind of deployment over the next 10 years that we might for more advanced wind and solar power technologies, we can expect them to begin to come online over the next two decades. With the increasingly strong focus on renewable-energy technologies around the world, we should see medium-scale commercial facilities up to 100 megawatts (MW) by 2010 or 2015, and larger facilities up to 200 MW and more by 2020. However, without existing large-scale wave power facilities to point to, it is difficult to know how much such installations will cost.

Considering the various subsidies available at the state and federal level, wave power technologies could be competitive today – though we will need a track record to establish this as fact. In light of the potentially favorable economics, and with the state's strong support for renewables generally, we project that wave power could supply about 500 MW for our county by 2020, equivalent to about 1,500 gigawatt hours (GWh) a year. This would meet about eight percent of our total energy demand at that time.

As with any technology placed in our oceans, we must fully consider at every step of the way the impacts to fish and other wildlife, as well as to commercial and recreational uses. CEC will work with local stakeholders and policymakers to ensure the utmost sensitivity to any concerns that arise in ocean power development in the future.

Technical Assessment

Of the four ocean power technologies mentioned above, wave power is the most feasible for our county and it will be our focus for the near term. We discuss the remaining three technologies briefly because at some point in the future, technologies and assessments may change to the point where they are feasible in our county.

Wave Power

A number of companies in the U.S., Europe, and elsewhere are developing wave-energy conversion devices (WECs) to capture the energy contained in ocean waves. Some devices, generally known as wave buoys, capture only vertical wave energy — the energy gained from the troughs and crests of waves as they pass by the device. Other devices, such as attenuators, can capture vertical wave energy as well as energy from any other direction.[2]

Pelamis

The most commercially advanced WEC is the Pelamis attenuator, developed by Ocean Power Delivery, Ltd., based in Edinburgh, Scotland (Figure 7-1). The device — a long, tubular structure — floats on the surface of the ocean and converts incoming waves for all directions into electricity. Widely considered the leading WEC technology, the Pelamis has been deployed on a full-scale basis and has endured thousands of hours of testing with no significant design problems. A 2.25 MW pilot project, consisting of three 750 kW devices, will be commissioned in early 2007 in Portugal, with plans to be expanded to 22.5 MW in coming years.[3]

Figure 7-1. The Pelamis attenuator, developed by Ocean Power Delivery of Scotland.

PowerBuoy and WaveBuoy

Ocean Power Technologies, Inc., based in New Jersey, is not far behind in commercializing its WEC device, the PowerBuoy. This is a buoy connected to a piston system that generates power with each vertical oscillation of the buoy. PowerBuoys were deployed in New Jersey, Hawaii, and Spain in 2005 and 2006, and a larger project is planned for Reedsport, Oregon (see sidebar). While the Hawaii project PowerBuoy's power output is small — 40 kW, compared to the 750 kW Pelamis — the technology has been scaled up to 150 kW for the UK Wave Hub project and will be scaled up 250 kW or more for future projects, and large arrays could be connected to generate hundreds of megawatts. In 2006, hurricane Wilma subjected the New Jersey installation to very rigorous testing. The PowerBuoys survived, and continue to undergo testing in 2007.

Figure 7-2. Ocean Power Technologies PowerBuoy, as seen from above water.

Similar to the PowerBuoy is the AquaBuoy by AquaEnergy (now part of Finavera Renewables). In November 2006, AquaEnergy requested a license to build and operate a 1 MW pilot project on the Pacific side of Washington's Olympic Peninsula. AquaEnergy has other projects planned for Oregon, Northern California, Portugal, Vancouver Island, British Columbia, and South Africa, with some projects planned for 100 MW or more.

In July 2006, Ocean Power Technologies, Inc., filed an application — the first on the West Coast — for a commercial wave energy facility off the shore of Reedsport, Oregon. The project will initially consist of 2.5 MW of PowerBuoys about two miles offshore. If all goes well, the project will be expanded to 50 MW over the next few years.

Wave Dragon

The Wave Dragon is a large floating structure that allows water to enter over the sides, then exit the system through a turbine at the bottom. In late 2005, KP Renewables PLC of the United Kingdom entered into a joint contract with Wave Dragon, Inc., to deploy a 7 MW Wave Dragon off the shore of Wales.[4] If the first phase of the project is successful, it has the potential to be expanded to comprise 11 Wave Dragons generating a total of 77 MW.

Fig ure 7-3. The Wave Dragon.
(Source: © 2005 Wave Dragon)

Wave power potential in our region

A 2005 study funded by the California Energy Commission found 3,357 MW of energy potential at "primary" wave energy sites along 76 miles of southern San Luis Obispo County and Santa Barbara County north of Point Conception.[5] The study also found 3,347 MW of potential at secondary sites outside of the Channel Islands. The report projects that a maximum of 20 percent of this potential could be developed, for a total of 1,340 MW. However, our more conservative projection is that 500 MW could be developed in our county by 2020 or a few years later. Two or three large facilities could provide that 500 MW, although it is more likely that we would see a number of smaller projects.

In addition to the sites near shore, our community may also want in the future to explore the region around the Channel Islands, where consistently strong waves offer considerable potential. However, there are many political and environmental issues regarding the development of wave power devices near the islands, similar to the issues with off-shore wind power discussed in Chapter 5.

In particular, the first six nautical miles from the islands comprise the Channel Islands National Marine Sanctuary, and a significant portion of the land comprises the Channel Islands National Park (although 75 percent of Santa Cruz Island is owned by the Nature Conservancy). Ocean power development in this area may be prohibited and would of course raise significant concerns. If offshore wind projects are also developed on or around the islands, it could be feasible and desirable to combine them with wave energy projects, so that both could use the same transmission cables to bring the power back to shore.

The following ocean technologies are not currently feasible in our county, but may become so in the future.

Tidal Power

Unlike wave power conversion devices and current devices, tidal power conversion devices are located near shore. A typical first generation tidal device traps water at high tide, then releases it back to the ocean at low tide through a turbine, which generates electricity. Most first generation tidal power conversion devices are similar to small hydroelectric facilities, which also generate electricity by inducing water to flow over a turbine. A new second generation in-stream tidal power device is being developed, which extracts a portion of the kinetic energy from the moving water stream and it is this second generation that is the focus of interest and application today. Tidal flows are fairly predictable; seawater flows inland for 12 hours of the day, and back out to sea for the remaining 12 hours.

The largest first generation tidal power device in service today is a 240 MW facility at La Rance, France. A 20 MW device has been installed in Canada's Bay of Fundy, which has the highest tides in the world.

Verdant Power, a Virginia-based company, has installed the first two of six water turbines planned for New York's East River.[6] This is a tidal power application because the flow in the East River adjacent to Roosevelt Island is a two way tidal flow. The Roosevelt Island Tidal Energy project began installation in December, 2006. In its first 35 days of operation, it had delivered over 9,450 kWh of tidal electricity to a supermarket on Roosevelt Island.[7]

The kinetic energy in tidal water is about 5 kilowatts per square meter at places like the Bay of Fundy, and 2 to 3 kilowatts per square meter in San Francisco's and Seattle's faster tidal regions.[8] Tides in our county do not appear to be high enough in kinetic power density to make existing tidal energy devices economically feasible. While San Francisco is considering a tidal power device for the waters below the Golden Gate Bridge, the land formations conducive to this technology that are found in that inlet are not present in our county.

Current Power

Current power devices also rely on the directional flow of water but do not require high tides for operation. Instead, they can use constant ocean currents or river flows. The energy from currents is highest in the U.S. in the Gulf Stream off the coast of Florida, which moves at about 1.5 meters per second.[9] Our coastal current, the California Current, moves much more slowly, from 0.03 to 0.07 meters per second,[10] and is periodically disrupted by the El Niño phenomenon.

Aquantis, LLC, a company based in Carpinteria, California, and associated with Clipper Windpower, LLC, is developing a current turbine for deployment in the Gulf Stream and other strong currents. At 2.5 MW, the "C Plane" would be the largest device of all the current power prototypes being developed. While current power technology could generate a significant amount of energy in such places as Florida (whose coast is very near the Gulf Stream) and areas with strong river currents, Santa Barbara County doesn't appear to have sufficiently strong ocean or river currents to make this technology viable.

Ocean Thermal Energy Conversion

Ocean thermal energy conversion (OTEC) devices are usable only in waters with a large thermal gradient — in other words, a large difference in temperature between warmer and cooler waters. The most common OTEC process exploits this gradient to generate electrical energy by using the ocean's warmer surface water to turn liquid ammonia into a gas, which then turns a turbine to generate electricity. The deeper, cooler water is then used to cool and condense the gas back into a liquid.

This technology received substantial support from the Ocean Thermal Energy Conversion Act of 1980, and a number of pilot facilities were built around the U.S. As energy prices dipped in the 1980s, however, governmental support waned for this and other renewable energy technologies. Today, only a few OTEC

devices exist around the world, with one relatively large device continuing to operate on the Big Island of Hawaii, at the Natural Energy Laboratory near Kona.

Unfortunately, the temperature gradient must generally be 20º C (36° F) or higher for OTEC to work.[11] Gradients in our region are not large enough to be useful for this technology.

Overcoming Barriers

The barriers to ocean power development in our region include potential environmental effects, a complex and difficult regulatory process, and a current lack of government support for development.

As outlined above, we will focus only on the wave-energy conversion devices, as these are the only technologies with real potential in our region in the foreseeable future. Because wave-energy conversion devices use the motion of the waves to generate energy, these technologies primarily float on the surface of the water, but are moored to the ocean floor. Such facilities would require transmission lines to shore and on-shore support facilities. The following discussion briefly describes some of the issues surrounding the development of such devices in our coastal waters.

Environmental Impacts

Development of wave-energy conversion facilities can entail a number of potential complex environmental effects:

- ***Interactions with marine life (fish and mammals)***
- ***Atmospheric and ocean emissions***
- ***Visual impacts***
- ***Conflicts with other uses of the sea space (fishng, boating, shipping, diving, etc.)***
- ***Impacts from installation and decommissioning***

An environmental review under the California Environmental Quality Act (CEQA) will be required before any wave power projects, pilot or permanent, are installed in our county's coastal waters. Similarly, a review under the National Environmental Policy Act (NEPA) will be required for any devices in federal waters (more than three miles from shore) or projects involving federal funding. Connecting to on-shore transmission lines would require approval by the California Coastal Commission and other local, state and federal permitting agencies . Potential environmental effects and policy conflicts will have to be studied, mitigation measures identified and implemented, and alternatives considered prior to final permitting.

In weighing the pros and cons of these technologies, we hope that the debate will include a discussion of how traditional fossil fuel energy sources -- coal, natural gas and nuclear power -- all have a significant impact on the environment. The marine environment is particularly affected, both directly through emissions, and indirectly by raising the temperature of our oceans through global warming.

Permitting Issues

Because of resource sensitivity and public perception issues regarding ocean energy facilities in our coastal waters, new project permitting will in all likelihood involve a detailed and complex review by a number of Federal, State and local agencies. These will most likely include, among others:

- *California Coastal Commission*
- *Department of Fish and Game*
- *State Lands Commission*
- *Public Utilities Commission*
- *Santa Barbara County*
- *Santa Barbara County Air Pollution Control District*
- *Federal Energy Regulatory Commission*
- *United States Department of the Interior*
- *United States Department of Energy*
- *United States Environmental Protection Agency*
- *National Oceanic and Atmospheric Administration*
- *United States Coast Guard*

While the California Coastal Act provides policy direction for the development of coastal-dependent industrial facilities, including new thermal electric generating plants, new technologies such as those considered in this chapter are not specifically addressed or provided for in this law. Given the history of public opposition to energy-related industrial development in the off-shore environment, wave power facilities will be highly scrutinized by the public and by permitting agencies.

In addition to a difficult regulatory process, the Electric Power Research Institute has concluded that the primary barriers to wave energy technology are not technical but political:

- *Uncertainty in the regulatory system*
- *An un-level playing field for ocean power due to more favorable subsidies for fossil fuels*

These factors will affect the timing and viability of ocean power development in our region.

Cost

With wave energy technologies still relatively young, we have limited price data available and must rely on a few case studies and assessments. In Scotland, a shore-based wave power device known as the Limpet (operated by Wavegen) sold power to the Scottish grid at 7 cents per kilowatt hour in 2005 – a fairly competitive price when we consider that new wind power projects sell power at a wholesale price of about 6 cents per kilowatt hour in California, with a 1.9 cents/kWh federal subsidy. In Washington State, AquaEnergy has contracted with the local utility to sell power from its pilot facility at 4.5 cents per kilowatt hour.[12] However, it is too early to judge whether this reflects an accurate price for actual production costs.

A rigorous assessment of the Pelamis device and the Energetech Wave Dragon in California found projected real "cost of electricity" to be 11.2 cents and 9.2 cents per kilowatt hour, respectively. Conducted by the Electric Power Research Institute, the assessment took into account some of the available state and federal tax incentives (10 percent federal investment tax credit and California's six percent investment tax credit).[13] These costs are higher than projected costs for new natural gas (about 9 cents/kWh), wind (about 6 cents/kWh), or geothermal plants (about 6 cents/kWh).

However, the federal Renewable Energy Productive Incentive (REPI) provides a 1.5 cents per kWh (in 1993 dollars) incentive to local governments, tribes and other non-tax paying entities.[14] This figure is adjusted for inflation annually, so is 1.9 cents per kWh in 2007.[15] This incentive could make wave power projects competitive with new fossil generation – particularly with the Wave Dragon device, though local governments developing wave power facilities could not take advantage of investment tax credits because they don't pay taxes.

Additionally, the state's Renewable Portfolio Standard (SB 1078) provides "supplemental energy payments"[16] for eligible renewables that cost more than the market cost for new natural gas plants in California. Essentially, this subsidy pays investor-owned utilities the additional cost above approximately 9 cents/kWh that it would pay to purchase the power from the wave power facility. There are limits to what the supplemental payments can provide and, as of early 2007, no renewable energy contract had qualified for supplemental energy payments, so we cannot say how effective this subsidy has been or will be.

It is still unclear, accordingly, whether all these cost estimates and subsidies will allow commercial-scale facilities to be built at competitive costs in California – or whether commercial-scale facilities could even be permitted.

For better or worse, the cost barrier will be resolved over the next decade. As small commercial projects come online around the world, we will gain a better understanding of their actual costs. Spain and Portugal, where commercial facilities are being built currently, provide large subsidies for wave power production, in the form of a guaranteed price per kWh (known as a "feed in tariff"). Although state energy agencies are not currently very friendly to ocean power technologies because of entrenched opposition to any type of ocean development in California, this situation may well change quickly given the state's commitment to mitigating climate change. In particular, AB 32 requires that California's greenhouse gas emissions be reduced back to 1990 levels by 2020. Renewable energy of all types will be key to achieving this goal.

As wave power technologies are commercialized around the world and economies of scale bring costs down, we will be able to better assess the true costs for these technologies. It's key, however, that we build pilot projects and small commercial projects as a means of achieving economies of scale.

The Action Plan

Because ocean energy is a relatively new technology, it is not available to homeowners or most businesses. Individuals can, of course, contact their state and local elected officials to urge them to support ocean power and to urge the development of a pilot project or commercial project. Our action plan for this chapter focuses, however, on local governments and what CEC can do to work with companies outside our region to develop wave power in our county.

What can local governments do?

At this point, wave power is the only type of ocean power likely to be feasible in our region. Over the next few years, any wave energy projects will necessarily be pilot projects of a few megawatts or less.

CEC is investigating an opportunity with the Electric Power Research Institute (EPRI) to site a pilot wave power project at one of the oil platforms offshore from Vandenberg Air Force Base. The plan calls for using one of the platforms that is scheduled to be decommissioned as a mooring point for a number of different wave energy devices. It's possible, however, that a working platform could be suitable for a pilot wave power project. Essentially, the project would be a testing ground for the various manufacturers of wave power technologies, which would allow us to determine which technologies work best for our region.

In addition to the California Coastal Commission and various State and Federal agencies, the City of Lompoc would probably have to approve this project because the electricity substation that would be required to

supply electricity to the grid is located near the city. Accordingly, the City of Lompoc and the county government could do much to make this pilot project a reality by offering public support, holding hearings to debate its merits, and/or offering financial support.

Once a pilot project is installed, one or two years of evaluation will be required. On completion of testing, the best site(s) could be developed with commercial size projects. As discussed above, a 50 MW project is planned for Reedsport, Oregon. Projects of similar size could be developed along our county's shoreline over the next decade.

What will CEC do?

1. Support the development of a pilot wave power project.

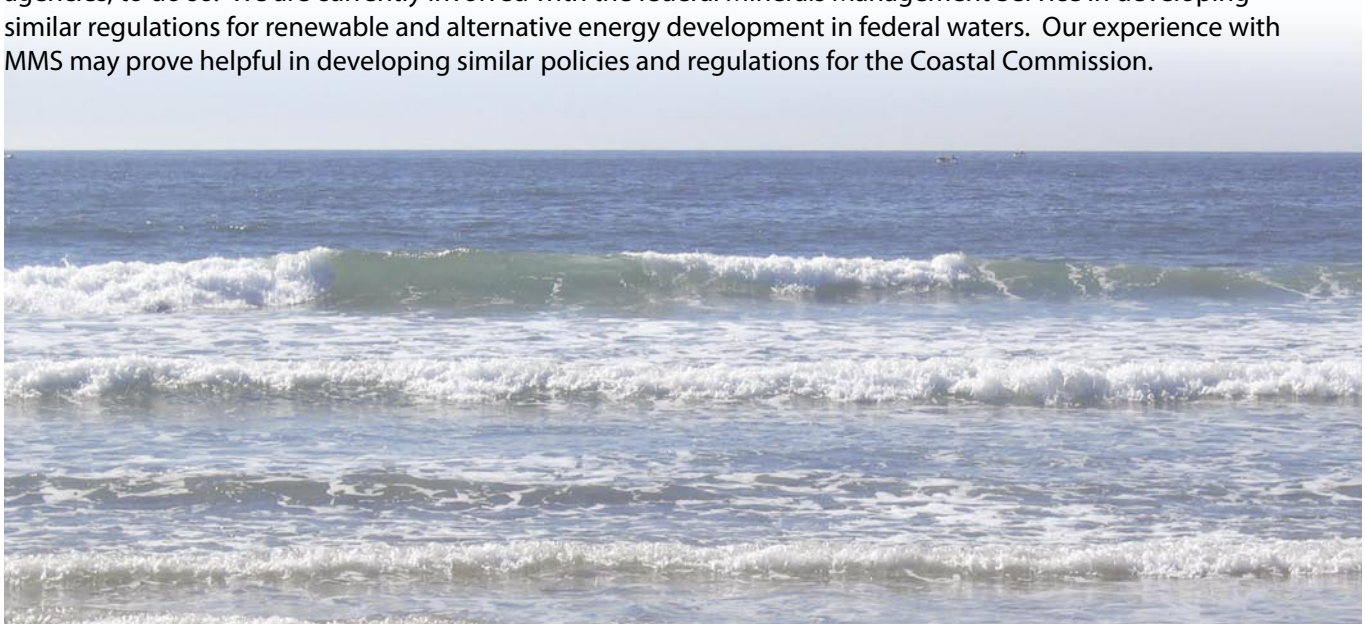
During 2007, CEC will work with EPRI and local governments to develop a pilot wave power project. Such a project will not be uncontroversial, but we hope that, with the public's growing awareness of the many problems stemming from our use of energy derived from fossil fuels, residents who might normally be opposed to such ideas will see the merit in our proposal. We will convene town hall meetings to discuss any proposals that are developed, and work with local policymakers throughout the process. We will also work with other non-profits with a stake in ocean protection and coastal protection to ensure that concerns are ameliorated.

2. Work with developers on commercial size wave power projects.

As mentioned above, the California Energy Commission consultant's report identified several good wave energy sites along the coast of Santa Barbara County and southern San Luis Obispo County, with a total potential for 3,357 MW. We are working with the report's author to provide detail on the exact locations , and will then work with wave power developers to determine which would be the most feasible sites in our region. We will also work with the environmental community to address potential concerns stemming from a commercial-scale project. With the recent designation of parts of our North County coastline as Marine Protected Areas, it will be necessary to be especially sensitive to marine impacts from any future wave energy development.

3. Work with California Coastal Commission and other state agencies to develop regulations for ocean power development

California Coastal Commission regulations don't currently include consideration of ocean power technologies. This is not surprising as these technologies are very new. It will be crucial as we move forward for the Coastal Commission to develop such regulations and we plan to work with the Commission, and other relevant state agencies, to do so. We are currently involved with the federal Minerals Management Service in developing similar regulations for renewable and alternative energy development in federal waters. Our experience with MMS may prove helpful in developing similar policies and regulations for the Coastal Commission.



Endnotes

[1] California Energy Commission, "California Small Hydropower and Ocean Wave Power Potential," April, 2005.

[2] Much of our information on wave power comes from reports completed by the Electric Power Research Institute in Palo Alto, California. EPRI's final report assessing wave power technologies for North American can be found online at: http://www.epri.com/oceanenergy/attachments/wave/reports/009_Final_Report_RB_Rev_2_092205.pdf.

[3] For more information on the Pelamis by Ocean Power Delivery, visit: www.oceanpd.com.

[4] More information can be found at Wave Dragon's website: http://www.wavedragon.net/index.php.

[5] California Energy Commission, "California Small Hydropower and Ocean Wave Power Potential," April, 2005.

[6] Verdant Power website: http://www.verdantpower.com/initiatives/currentinit.html.

[7] Email correspondence with Roger Bedard, EPRI's Ocean Power Program director, Feb. 14, 2007.

[8] Electric Power Research Institute, presentation to International Energy Agency, November 2005. Online: http://www.epri.com/oceanenergy/attachments/ocean/briefing/IEABriefingRB111705.pdf.

[9] Coble, Charles R., Elaine G. Murray, and Dale R. Rice. Earth Science, 3rd ed. Englewood Cliffs, NJ: Prentice Hall, 1987: 256–257.

[10] Elert, Glenn, ed. The Physics Factbook. Online: http://hypertextbook.com/facts/2002/EugeneStatnikov.shtml.

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[12] Catching the Wave: Renewable Power from the Sea (2004). Online at: http://depts.washington.edu/poeweb/gradprograms/envmgt/2004symposium/wavetext.pdf.

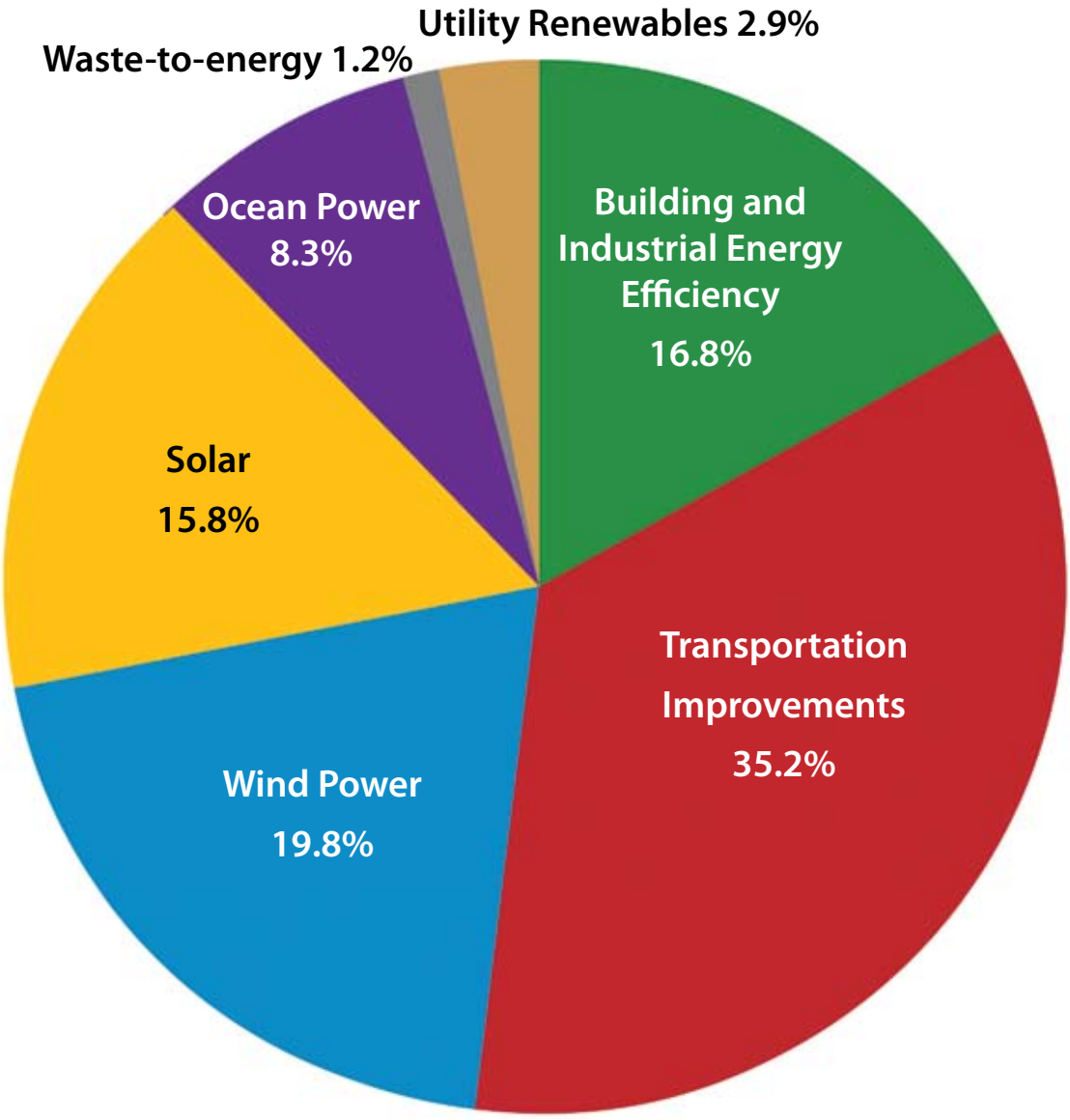
[13] EPRI Final Summary Report, Offshore Wave Power Feasibility Demonstration Project (2005). Online at: http://www.epri.com/oceanenergy/attachments/wave/reports/009_Final_Report_RB_Rev_2_092205.pdf.

[14] 42 USC § 13317, http://www.dsireusa.org/documents/Incentives/US33F3.pdf.

[15] DSIRE database: http://www.dsireusa.org/library/includes/incentivesearch.cfm?Incentive_Code=US33F&Search=Technology&techno=OceanThermal&currentpageid=2&EE=0&RE=1.

[16] California Public Utilities Code section 399.15.

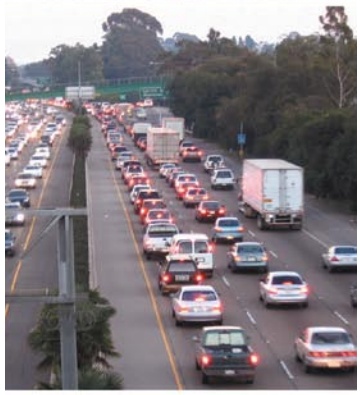
Chapter 8 | What Will it Cost?



Introduction

What will it cost? This is probably the most important question in this Blueprint. There are, of course, many different ways of measuring cost -- right now we pay for our fossil fuels not just in dollars at the pump but in the air we breathe and the water we drink, in our national security and, most importantly, in our ability to sustain ourselves on this planet. The good news is, however, that even when you exclude these other costs and boil it down to strict traditional economics, we will actually be in much *better* financial shape by adopting renewable technologies than continuing to burn fossil fuels. That's right: renewable energy will save money for the county of Santa Barbara, so we should make the switch based purely on economic reasons regardless of the many other benefits.

Our Blueprint is organized to highlight the most cost-effective solutions first, starting with energy efficiency in buildings, energy efficiency in transportation, then wind power, solar power, and wave power. We describe in this chapter the likely costs of reaching our goals, acknowledging the many uncertainties in any economic analysis extending through 2030.



Working with Professor Dan Kammen at UC Berkeley and Professor Peter Schwartz at Cal Poly San Luis Obispo (See Appendices online), we've concluded that, under a scenario in which our county produces the equivalent of 100 percent of the energy it uses[1] from renewable sources (and substantial energy efficiency savings), county residents will each save about $830 each year by 2020 and $3,015 each year by 2030, compared to our reference case. This amounts to $418 million in savings in our county each year by 2020 and $1.52 billion dollars by 2030 (all in 2007 constant dollars[2]). This is due to the fact that energy efficiency – in the electricity, natural gas and the petroleum sectors – saves consumers money and the fact that fossil fuel prices are projected to continue to rise, whereas many renewable energy technology costs are projected to continue to fall, or at least rise at a slower rate than fossil fuel prices.

CEC also commissioned a study from the UC Santa Barbara Economic Forecast Project, with three potential scenarios for future energy prices. The above savings are based on a "business as usual" scenario, in which current price trends are projected to continue. In a "low fossil fuel cost" scenario, net annual savings for county residents from becoming fossil free are projected to be $389 per person in 2020 and $1,487 per person in 2030. So even in a low fossil fuel price future, it still makes economic sense to make the switch to renewables.

In a scenario in which the cost of fossil fuels increases dramatically, net savings for county residents from becoming "fossil free" are projected to be far higher: almost $6,112 per year by 2020 and over $30,000 each year by 2030. Under this "high fossil fuel price" scenario, gasoline jumps to $14 a gallon by 2030 and electricity rises from 16 cents per kilowatt hour today to $2.43 per kilowatt hour in 2030. (We include these figures for the sake of completeness, but we acknowledge that such high prices would have a strong effect on reducing demand, so the total costs under such a high price scenario would surely be much lower.)

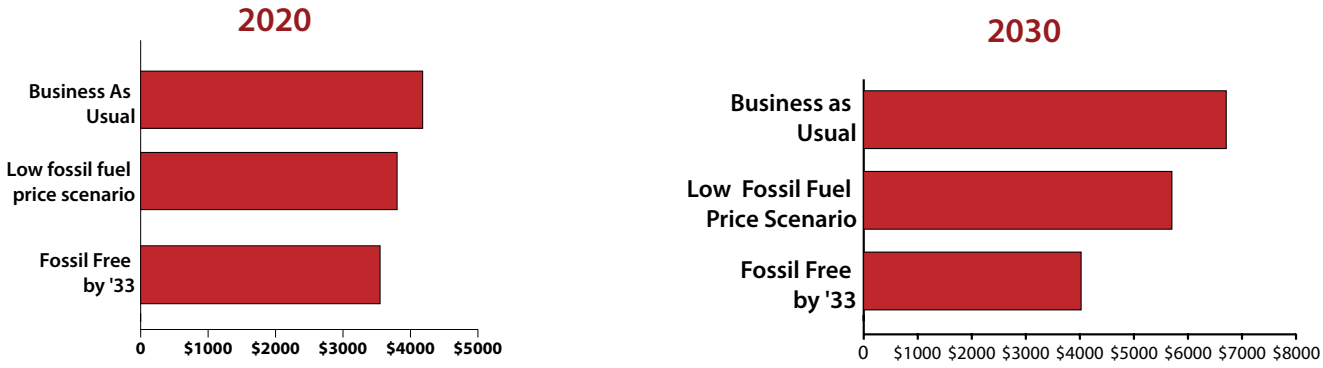
We do not fully consider the cost of carbon emissions from fossil fuels (such as global warming, air pollution, etc.) due to future state and/or federal regulation of carbon because projecting the actual costs to companies and consumers would be highly speculative. Even without this consideration, the numbers are very favorable to renewable energy and energy efficiency.

Cost Assessment

Economic concerns are necessarily front and center when it comes to tackling climate change, energy security and all the issues stemming from our current energy use. Aspects of this Regional Energy Blueprint -- such as wave power or solar photovoltaics -- are currently more expensive than fossil fuels. However many other technologies are not only affordable today, but will become even more affordable in the long run. For example, energy efficiency has historically been highly cost-effective but not publicized enough to gain deeper penetration, and wind power, geothermal and biomass power are competitive in 2007.

The following graphs summarize the costs and savings of a "business as usual" scenario for 2020 and 2030.

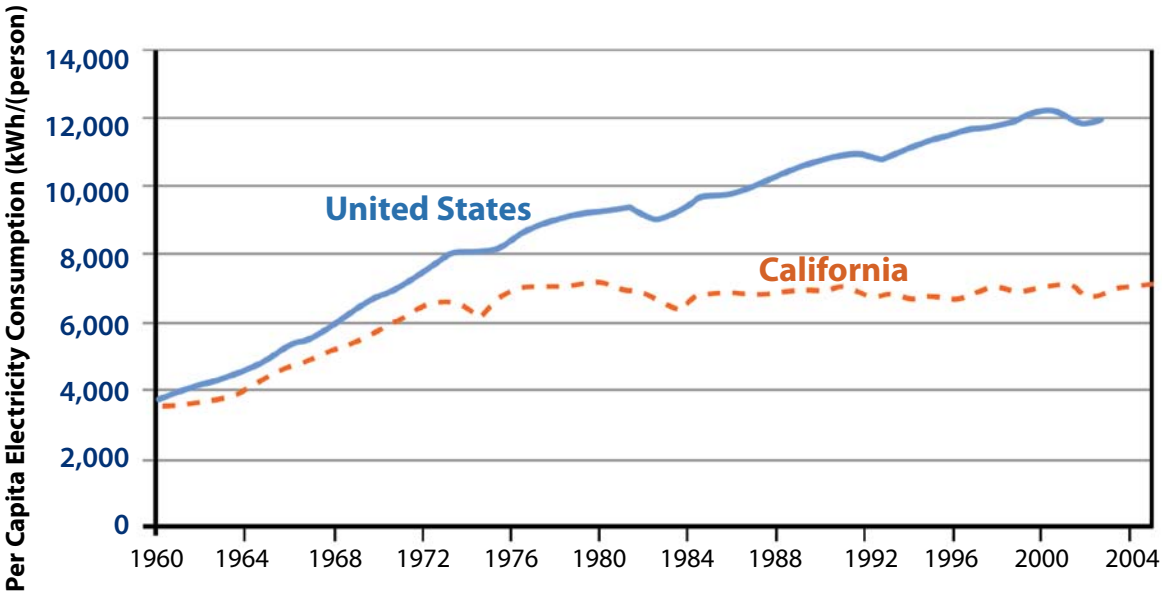
Figure 8-1. Annual per capita costs of achieving Fossil Free By '33 (in 2007 dollars.)[1]



Costs of Energy Efficiency

As a result of California's sustained commitment to building energy efficiency, per capita electricity consumption has remained essentially the same since the early 1970s (see Figure 8-2). In fact, in 2007 California tied for the top spot (with Vermont and Connecticut) in the annual American Council for an Energy-Efficient Economy national survey of state energy efficiency programs.[3]

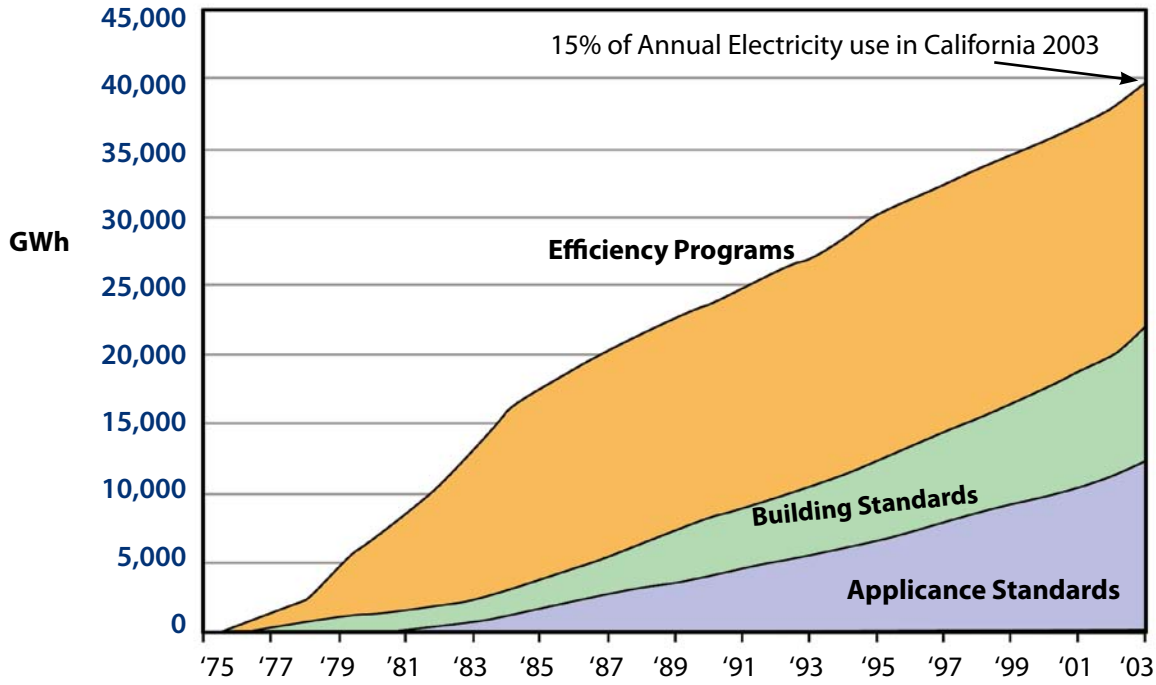
Figure 8-2. Per capita electricity consumption in the U.S. and California.[4] Source: California Energy Commission



[1] For a detailed explanation of how our economic figures were calculated, see our consultant report at www.fossilfreeby33.org.

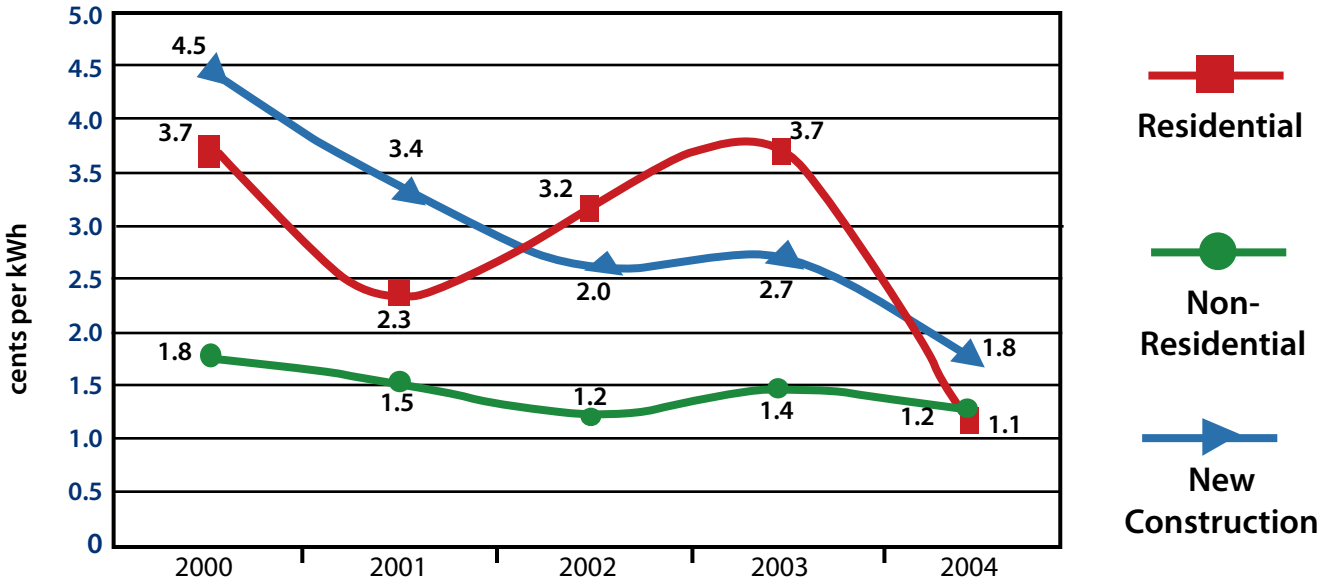
Much of the credit for this success can be given to good state policies, which are responsible for about 40,000 gigawatt hours (GWh) of savings per year, from robust energy efficiency programs administered by the Public Utilities Commission as well as building and appliance standards administered by the Energy Commission and the federal Department of Energy's Energy Star program (Figure 8-3).

Figure 8-3. Cumulative energy savings from California's energy efficiency programs since the 1970s.[5]



In 2004, the costs of electricity energy efficiency measures in California averaged 1.4 cents per kW — about one-sixth the wholesale cost of new generation (see Figure 8-3).[6] Accordingly, achieving further reductions in electricity use through energy efficiency and conservation shouldn't be hindered by economic concerns for the foreseeable future; it's clear that such measures would save significant amounts of energy and money in the future.

Figure 8-4. Cost-effectiveness of California utility energy efficiency measures (cents per kWh).[7]



For this reason, energy efficiency is the state's foundation for achieving greenhouse gas reductions pursuant to the 2006 Global Warming Solutions Act (AB 32). But increased penetration of energy efficiency measures will require alerting the public, businesses and agencies to the potential savings by increased energy efficiency. Our action plan for seizing those opportunities in the building sector is described in Chapter 2.

Similarly, the costs of increased energy efficiency measures in the transportation sector have been very competitive. An extensive review by the Union of Concerned Scientists (UCS) found that an increase in the federal corporate average fuel economy (CAFE) standards from 13.1 miles per gallon (mpg) in 1975 to 20.6 mpg in 2000 *saved consumers $92 billion in 2000*.[8] Amazingly, the prevailing cost of gasoline at the time of this study in 2000 was $1.54 per gallon. With national prices in mid-2007 at $3.11, savings literally double -- to about $180 billion each year. When we factor in the 23 percent additional savings from improvements in the average mpg from 2000 to 2005, consumers currently enjoy about $221 billion savings each year due to the existing CAFE standard.

There are numerous bills pending in Congress that would raise the standard significantly by 2020, with most calling for 35 to 40 mpg, up from today's 27.5. Based on the record, such a change would lead to large additional savings for consumers, all else being equal.

The Cost of Electricity and Natural Gas

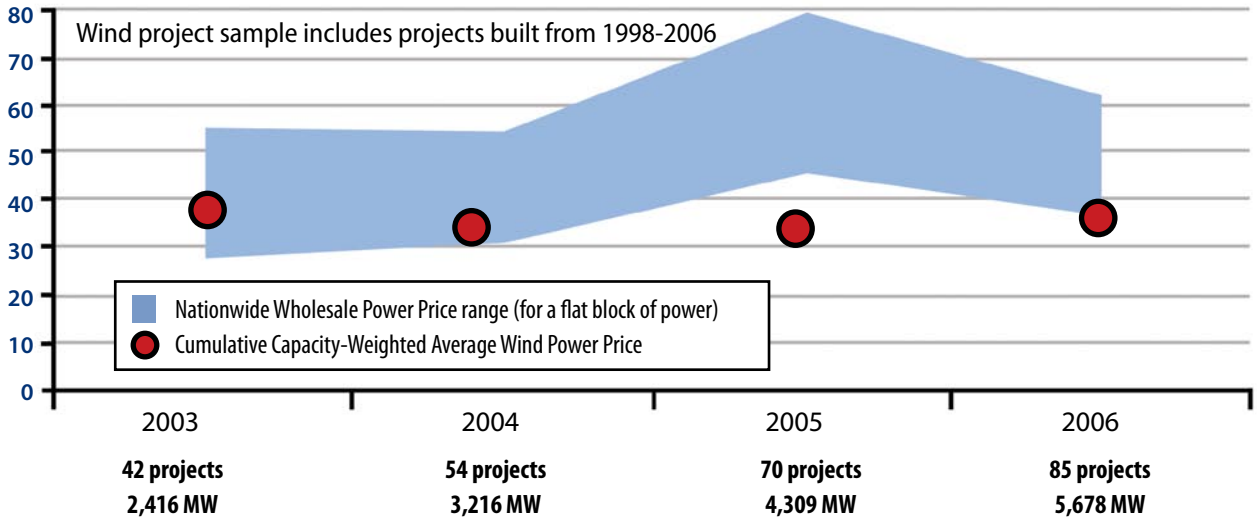
The picture is also generally favorable when we consider the economics of renewable electricity and biofuels.

Renewable electricity technologies vary widely in terms of their costs. However, wind power, hydroelectric power, geothermal and biomass can be quite cheap, particularly in light of recent increases in fossil fuel costs. A 2007 report from the California Energy Commission analyzed the "levelized cost" of various electricity generation technologies, including fossil fuels, nuclear and renewables, shown in Figure 8-5. Levelized cost is a measure that considers all costs over the lifetime of a project, including capital costs and operating costs -- and averages those to a level per kWh price.

Figure 8-5. Costs of electricity generation in California in 2007[9], 2020[10] and 2030[11] (cents per kWh).

Technology	Cost in 2007	Cost in 2020[12]	Cost in 2030[13]
Biomass (landfill gas)	4.4	4.4	4.4
Geothermal	6.6	5.5	4.5
Wind (class 5)	6.6	6	6
Advanced nuclear	7.4	9.3	11.4
Baseload natural gas (combined cycle)	9.4	13.22	17.66
Coal w/ gasification	9.6	10.9	12.1
Biomass gasification	10.7	7.0	6.0
Small hydro	11.95	11.95	11.95
Concentrating solar (PV)	18.6	9.01	6.92
Concentrating solar (parabolic trough)	21.9	10.6	8.15
Solar PV	39.6	9.38	7.21
Peak natural gas (simple cycle)	46.0	52.63	59.77

Figure 8-6. Average cumulative wind and wholesale prices in the U.S.[14]



Real world experience with wind power finds it to be competitive with fossil fuels throughout the U.S. A 2007 survey of numerous wind farms around the nation, by Lawrence Berkeley National Laboratory, found that costs were competitive with wholesale costs in all markets. The 2007 survey's conclusions are summarized in Figure 8-6.

Moreover, wholesale costs are not the best comparison. A better comparison would be new wind farm electricity versus new natural gas or coal-fired electricity because the wholesale costs in each market may represent facilities with capital costs already retired, reducing the net wholesale cost, which produces an unfavorable comparison to new wind projects that have not paid off their capital costs.

Natural gas and integrated gasification coal plants were the only fossil fuel generation technologies considered in the Energy Commission levelized cost of electricity report because all baseload power plants serving California customers must meet the "emissions performance standard" of SB 1368. This standard requires all new baseload electricity generation to be at least as clean as a modern combined cycle natural gas plant. Under this standard, natural gas and integrated gasification coal plants are probably the only fossil fuel technologies that will pass muster.

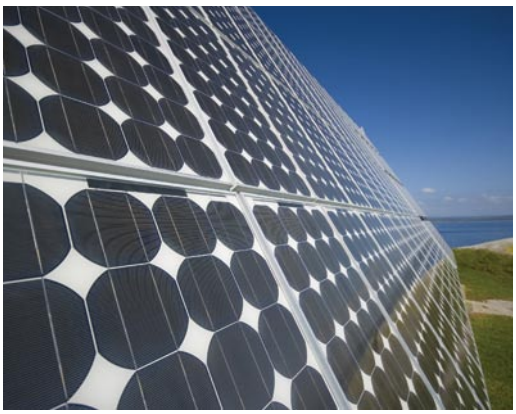
There are no plans to build more coal plants in California itself — although there are plans to build many coal plants outside of the state that would serve California customers, as well as a few small experimental power plants in-state that will sequester carbon dioxide.

It's helpful to note the differences between the Energy Commission's 2003 levelized cost analysis and its 2007 analysis, in Figure 8-7. (Figures are slightly different in this table than in Figure 8-5 because of different ownership and tax assumptions for each technology).

Figure 8-7. Comparison of Energy Commission 2003 and 2007 levelized cost estimates (cents per kWh).[15]

Technology	2003	2007	% increase
Baseload natural gas (combined cycle)	6.0	10.3	72
Peak natural gas (simple cycle)	18.3	58.6	220
Geothermal (binary)	8.3	9.2	11
Geothermal (flash)	5.2	8.9	71
Concentrating solar (parabolic trough)	24.6	29.5	20
Concentrating solar (Stirling dish)	17.6	54.4	209
Solar PV	48.9	60.6	24
Wind (Class 5??)	5.3	9.9	87

The cost for natural gas baseload generation rose from 6 cents per kWh in 2003 to 10.1 cents per kWh in 2007 – equivalent to $60 per MWh to $101 per MWh, or a 72 percent increase in just four years. Even more remarkable, the cost for simple cycle peak natural gas plants increased by 220 percent, due to increases in natural gas prices and more accurate information about the capacity factor of peak plants. As can be seen from Figure 8-7, all costs increased, with some renewable technology costs also increasing remarkably. However, the clear conclusion from the 2007 Energy Commission analysis is that many renewable energy technologies are now highly competitive with fossil fuels.



Also, the costs for natural gas generation do not include "externalities" — the environmental costs of fossil fuel generation. As mentioned earlier, the 2006 California Emissions Performance Standard (SB 1368) prohibits new contracts for baseload power sources that emit greenhouse gases above the level of a combined cycle natural gas plant. This is a step in the right direction, but still doesn't consider the environmental costs of greenhouse gases from combined cycle natural gas plants or from peak power plants like simple cycle natural gas turbines. An analysis by Prof. Dan Kammen at UC Berkeley found the full environmental cost of combined cycle natural gas turbines to be an additional 8 cents per kWh more than the total levelized cost in the above analysis.[16] We don't include the cost of externalities in the main findings of this report, although they are highly relevant to ongoing economic and environmental discussions. If we had included externalities -- or simply the likely cost of carbon under state or federal regulation in the future -- our economic analysis would become far more favorable to renewable energy and

energy efficiency. For example, if we add 8 cents per kWh for electricity, as the cost of all environmental externalities, the total cost of electricity under our "business as usual" scenario rises $277 million, to $1.3 billion annually.

A 2006 report from the Edison Foundation attributed 95 percent of the recent customer cost increases to increasing fuel prices and increased costs for power purchased by the utility in the open market.[17] The same report found a number of startling price increases:

- Natural gas prices jumped by 300 percent since 1999.
- Coal prices are up 20 percent since 2004.
- Uranium ore costs 40 percent more than it did in 2001.
- Spot market prices for uranium have increased even more rapidly, from $7 a pound in 2000 to more than $135 a pound at the middle of 2007. That's a whopping 1,928 percent increase.[18]

Most importantly for California and our region is the current and projected cost of natural gas. A 2002 projection indicated that prices would rise from $4.55 per thousand cubic feet (mcf) to $5.83 mcf by 2013. These figures are significantly lower than the prices we've already seen on a sustained basis since the projection was made. In 2005, industrial natural gas prices averaged about $8 per mcf[19] and wholesale prices spiked to $14 per mcf later that year after Hurricanes Katrina and Rita. In the first six months of 2007, wellhead natural gas prices were $7.50 to 8.00 per mcf.[20]

The report we commissioned from the UC Santa Barbara Economic Forecast Project found that in the "business as usual" scenario, natural gas prices would rise to $19 per mcf by 2020 and to $34.60 per mcf by 2030 -- an increase of 163 percent and 380 percent, respectively, over 2007 prices. Much of our projected county savings results from the fact that fossil fuel prices are projected to rise significantly through 2030. At the same time, energy efficiency should remain very competitive and some renewables will become cheaper, or at least not rise in price as fast as fossil fuel prices.

Types of Electricity Generation

It's important to identify the different modes of electricity production. "Baseload" plants can essentially run all the time. "Load-following" plants are those that can be brought online when needed. "As available" plants are those, like wind or solar power, that are used when they are available. Finally, "peak" plants are those that are used only when demand spikes. For example, geothermal and hydropower are baseload power sources that are also very competitive with the 9.4 cents per kilowatt hour for combined cycle natural gas plants, another baseload power supply. In other words, we need to compare apples to apples when discussing types of electricity generation.

Transmission and Integration Costs

The cost of transmission for renewable energy facilities can also be significant. However, transmission costs are generally included in a project's cost when it is built to sell power to a utility. For example, the 120 MW wind farm planned for a site near Lompoc will sell power under contract to PG&E at a price that includes the cost of the necessary new transmission lines.

As more remote sites are tapped for wind power development, consumer costs may rise because of the additional transmission lines required. However, if large offshore farms are built in the area off the coast of Vandenberg Air Force Base, or between San Nicolas Island and Santa Rosa Island in waters not visible

from shore, they will be large enough to justify the costs of lengthy transmission lines – otherwise, they won't be built. The cost to the consumer will, accordingly, still be competitive with fossil fuel generation unless there are heavy subsidies that don't also apply to fossil fuels.

A number of studies have analyzed the additional cost to consumers required to balance grids using higher levels of "intermittent" renewables such as wind or solar power – allowing for an apples to apples comparison across generation types. Figure 8-8 is a summary compiled by the National Renewable Energy Laboratory, finding that balancing costs amount to no more than 0.5 cents per kWh, with up to 31 percent intermittent renewable penetration – comprising generally much less than 10 percent of the total cost of electricity to consumers.

Figure 8-8. Key results from major wind-integration studies, 2003-2006.

Date of study	Study	Wind penetration	Cost ($/kWh)
2003	Xcel – UWIG	3.5%	0.185
2003	We Energies	4%	0.19
2003	We Energies	29%	0.292
2004	Xcel-MNDOC	15%	0.46
2005	Pacificorp	20%	0.46
2006	CA RPS	4%	0.045
2006	Xcel-PSCo	10%	0.372
2006	Xcel-PSCo	15%	0.497
2006	MN-MISO	31%	0.441

Costs of Alternative Transportation Solutions

More efficient transportation options are economic winners as well as environmentally more beneficial. If any of the pending federal bills regarding improving fuel economy for cars and trucks pass in 2007 or 2008, consumers will very likely save substantially on fuel costs. Alternatives to driving, such as buses, carpooling, car sharing, etc., are also clear economic winners.

The UC Santa Barbara Economic Forecast Project study also found that gasoline costs will, under the reference case, rise from $2.90 per gallon in 2007 (we are at $3.35 in mid-2007 already) to $6 per gallon in 2020 and $12.10 in 2030. This is an increase of 107 percent and 317 percent, respectively. Again, these figures are constant 2007 dollars, so they do not include inflation, which will add another two to three percent each year to the actual cost.

However, next generation vehicles that will use electricity as a transportation fuel will probably cost significantly more, in terms of capital costs, than internal combustion gasoline vehicles for at least the next decade, after which time they may approach the cost of traditional vehicles. As discussed in Chapter 4, a key part of our plan to move away from fossil fuels is to use electricity as a transportation fuel in electric vehicles, plug-in hybrid electric vehicles, and possibly hydrogen vehicles. All three of these vehicle types can use renewably generated electricity as the primary energy source (hydrogen can be created through electrolysis of water using renewable electricity).

Operational costs

"An electric vehicle will cost consumers about half the cost of a gas-engine car to operate – even less if the electric vehicle is charged during off-peak hours."

The cost of using electricity as a transportation fuel will, in itself, save money because electric motors are far more efficient than gas or diesel engines at converting energy into motion, primarily due to less heat loss. In fact, the conversion efficiency of an electric motor is about 2.5 times that of a gas engine.[21] In other words, if the cost of energy from electricity and gasoline is equivalent, using electricity to fuel a car would be 2.5 times cheaper than using gasoline. However, electricity is more expensive, on a BTU basis, than gasoline, by about 80 percent.[22] Accordingly, an electric vehicle, at 2.5 times better conversion efficiency, will cost consumers about 50 percent less than a gas engine car[23] to operate – a substantial benefit by any measure, assuming the cost ratio between gasoline and electricity doesn't change remarkably in the future. Moreover, if off-peak electricity is used for charging, as it likely will be, the cost comparison is even more favorable to electricity.

It's also likely that electricity will become less expensive relative to gasoline over the next decade or two because renewable sources will become more dominant in our electricity mix, leading to eventual cost declines, whereas fossil fuel prices are projected to continue their upward climb.

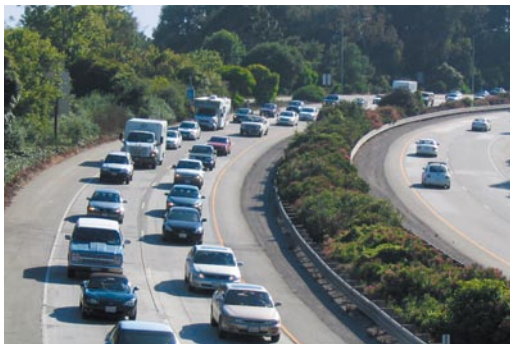
Capital costs

Operational costs are not the only relevant costs in this analysis. We must also consider the capital cost impacts of alternative fuel vehicles. It is important to note, initially, that many of the solutions we propose for reducing petroleum demand don't require any direct capital cost expenditures by consumers, such as buses, carpooling, car sharing, etc. However, next generation vehicles -- and even today's hybrid electric vehicles -- will likely require a significant cost premium over traditional vehicles, at least for the foreseeable future.

A recent report from Intellichoice.com found that even though capital costs are higher for today's hybrid electric vehicles, the savings from fuel, insurance and depreciation over a five year period of ownership entirely offset the additional capital cost for every hybrid on the market in 2007.[24]

Similarly, if added capital costs for plug-in hybrids, EVs, and hydrogen vehicles are not too high, we can expect a similar offset over the life of the vehicle. However, if capital cost increases are much more than $3,000, this analysis will likely change, possibly leading to a net cost increase for consumers.

We project that electric vehicles and plug-in hybrids will cost $4,000 more than standard gas engine vehicles beginning in 2010, falling to $3,000 more by 2030. For hydrogen vehicles, a $26,000 premium is assumed, starting in 2016, falling to $5,000 in 2030. These assumptions lead to an $11.8 million net capital cost increase by 2020, and $44 million by 2030 net cost for consumers in our county by 2030. These figures are included in our analysis and we still find a large net savings for our county by 2020 and by 2030 from transitioning away from fossil fuels.



Job Creation from Investments in Renewable Energy and Energy Efficiency[25]

The renewable energy industry generates more jobs than the fossil fuel industry for every kilowatt hour produced. According to the Worldwatch Institute, the natural gas sector requires 0.1 to 0.2 person-hours per kilowatt hour produced; biomass requires 0.1 to 0.5 person-hours; wind power 0.1 to 1.2 person-hours and solar photovoltaics 0.8 to 2.1 person-hours.[26] This means that more human labor is required to generate power from renewable sources. This makes sense because renewable energy generally has no fuel cost, making the cost of capital and operations relatively more important.

Another analysis found that if U.S. wind energy capacity increased from 10,000 MW to 50,000 MW, 150,000 manufacturing jobs would likely be created and $20 billion would be pumped into our economy.[27]

More specifically, under a different scenario for aggressive but realistic development of wind, solar, biomass and geothermal power throughout the nation, the Renewable Energy Policy Project found that almost 500 jobs would be created in Santa Barbara County.[28] This analysis is conservative, however, as we are already witnessing strong job growth in our county in the renewable energy industry. For example, Clipper Windpower, Inc., employed in mid-2007 almost 200 people in its Carpinteria office, in addition to 250 more in its Iowa manufacturing center. The solar energy industry is also booming in our county, with more than 20 installation companies now operating, employing approximately 50-100 people in our county.

These employment figures show that estimates of future employment in our county in the renewable energy and energy efficiency industries are probably very conservative. As the renewable energy transition continues to accelerate, we can expect job growth in our county in these industries to accelerate in a similar way.

Job creation will be even stronger if our region succeeds in becoming a Mecca for renewable energy. We are ideally suited for such a role when we consider we have a world class university in our community, abundant renewable resources and a significant investor community – as well as a growing awareness among the populace that we need to make the renewable energy transition as quickly as possible.

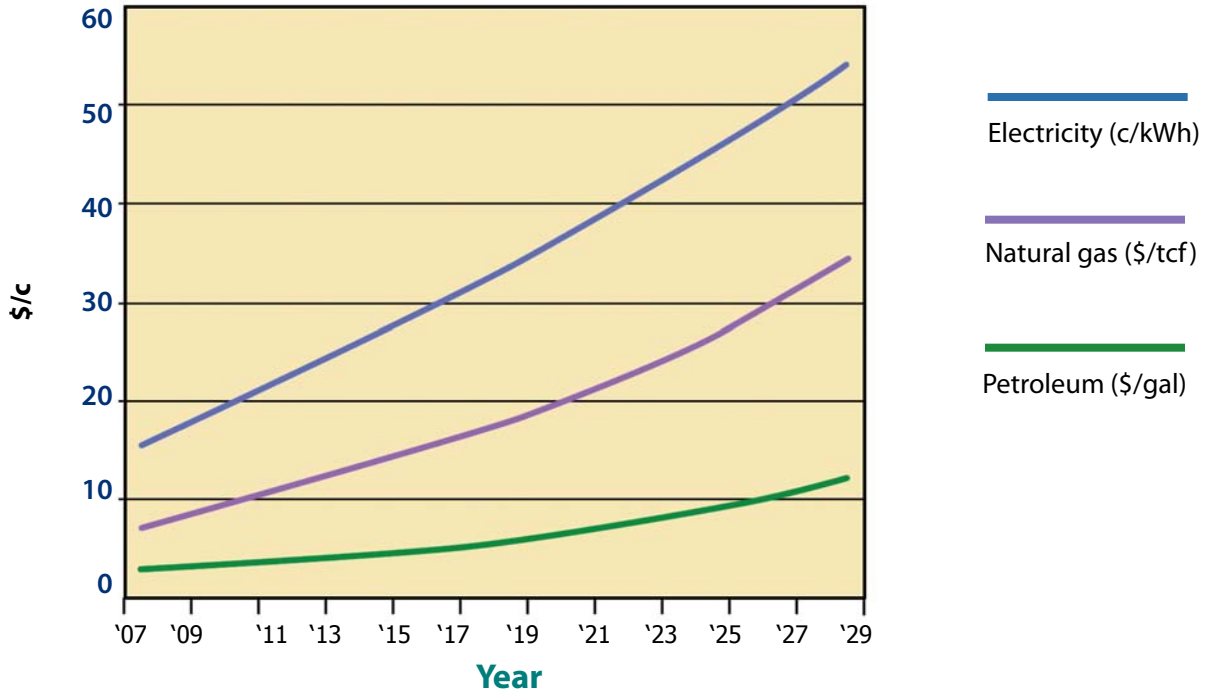
Areas of Uncertainty

Fossil fuel prices

Predicting the future is an endeavor fraught with uncertainty. When projections extend 23 years into the future, it is guaranteed that many aspects of the projection will be proved wrong over time. In our projections, fossil fuel prices set the tone because savings stem from the difference between a continued fossil fuel future and a renewable energy future. Accordingly, if fossil fuel prices are lower than our projection, or higher, our predicted savings will change substantially.

We use the UC Santa Barbara Economic Forecast Project's "business as usual" projections for energy consumption as our baseline. This report contains the following prices for the three primary fossil fuels.

Figure 8-9. UC Santa Barbara Economic Forecast Project's "business as usual" fossil fuel price projections.



However, the report includes high and low price scenarios. Under low fossil fuel prices, our county will likely use more fossil fuels as we move forward, and vice versa: under a high price scenario, our goals become easier to achieve.

Commodity prices for renewable energy technologies

Steel, concrete and other commodities have increased in price significantly over the last few years. A 2007 analysis by Lawrence Berkeley National Laboratory (LBNL) of recent wind turbine cost increases states:

> **Recent increases in turbine prices have likely been caused by several factors, including the declining value of the U.S. dollar relative to the Euro, increased materials and energy input prices (e.g., steel and oil), a general move by manufacturers to improve their profitability, shortages in certain turbine components, and an up-scaling of turbine size (and hub height) and sophistication.[29]**

An additional report from LBNL on this issue is pending. The new report will attempt to separate the various factors behind recent wind turbine cost increases.

Subsidies

Almost all energy technologies receive subsidies of some sort. The 2005 U.S. Energy Policy Act, the first major energy legislation in a decade, provided billions in tax relief to many technologies, including offshore oil production, nuclear power, wind power and solar power. Studies differ in their conclusions, but a good case can be made that fossil fuels and nuclear power have received more subsidies, on a proportionate basis, than renewables. Nuclear power, in particular, has received very large subsidies – the 2005 Energy Policy Act provided about $13 billion to 6,000 MW of new nuclear plants, according to an analysis by Public Citizen.

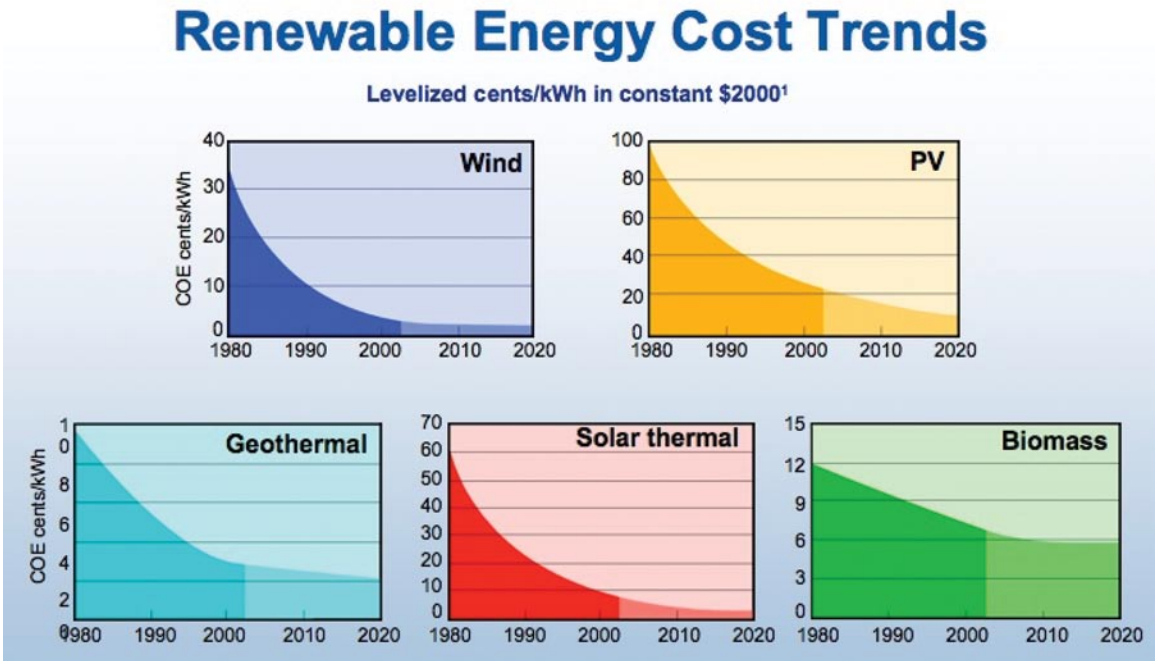
Subsidies are currently very important to the continued market growth of many renewables, particularly wind and solar power. The federal production tax credit for wind power is about 1.9 cents per kWh and is set to expire at the end of 2008. If it does, the wind industry will likely suffer a setback because history has shown that when the tax credit lapses, the industry slows down considerably, awaiting renewal of the credit. It seems, however, that subsidies at the state and federal level are likely to continue and/or be increased over the next few years due to concerns over fossil fuel prices, national security and climate change.

Increased profit-taking by renewable energy companies

As mentioned in the LBNL report on wind power prices, wind power companies and other renewable energy companies are seeking to maximize profits. It is highly likely that energy from renewable energy companies will closely track fossil fuel prices because fossil fuel prices still define the market, and renewable energy companies are trying to earn a profit. As fossil fuels decline further in percentage terms, we expect non-fossil energy sources will create their own price levels and we anticipate further cost savings at that point.

The long-term trends for renewable energy costs are very encouraging (Figure 8-10, projected costs are shaded). There are many indications that most renewable energy technologies will continue to drop despite some recent cost increases for wind and solar power, for example.

Figure. 8-10. Renewable energy cost trends, 1980-2020 (National Renewable Energy Laboratory). [30]



The cost of carbon emissions regulation

California is currently drafting regulations to implement AB 32, the Global Warming Solutions Act. The final regulations will probably include a cap and trade system, which will impose emissions allowances on emitters and allow emitters to either achieve reductions themselves or purchase reductions from others. It is too early to say what the cost of carbon will be under this system. It is sure to change over time, similar to the experience in the European Union Emissions Trading Scheme, which has witnessed great volatility over the first years since its creation.

Moreover, a number of bills have been proposed at the federal level that include a cap and trade. At least one bill calls for a carbon tax on a national basis. It is likely that some scheme for regulating carbon dioxide emissions will be in place at the federal level over the next five years.

Due to these activities at the state and federal level, it is almost certain that carbon emissions will be regulated in California in some manner over the course of the next five years. However, it is too early to state what the costs will be, but they likely will start out quite low.

Our low fossil fuel price and high fossil fuel price alternative scenarios should capture these areas of uncertainty. And the good news is: under all three of our scenarios, Santa Barbara County consumers will save substantially through a wholesale shift to renewables and energy efficiency.

Endnotes

[1] In our planning, "fossil free by '33" doesn't mean no fossil fuels will be used in our county by 2033. Instead, it means that we will produce as much energy from renewable electricity and biofuels in or near our county by 2033 to equal the fossil energy demand in our county projected in our "business as usual" scenario. In other words, we will be "fossil free" on a net basis and don't expect to literally have no fossil fuels being used in our county by 2033 or at any time in this century.

[2] This means that we are not considering inflation for future costs, allowing us to better compare our projected savings as "net present value" rather than a much larger figure that would include inflation through 2020 or 2030.

[3] American Council for an Energy-Efficient Economy, The State Energy Efficiency Scorecard for 2006 (2007), online at: http://aceee.org/pubs/e075.pdf?CFID=3075610&CFTOKEN=15250704.

[4] California Public Utilities Commission, Energy Efficiency: California's Highest-Priority Resource (2006), online at: http://www.electricitydeliveryforum.org/pdfs/CPUC_calif_cleanenergy508.pdf.

[5] California Energy Commission, Options for Energy Efficiency in Existing Buildings, CEC-400-2005-039-CMF, p.

[6] The California Public Utilities Commission recently found that the average cost of new natural gas-fired generation in 2007 would be about 9 cents/kWh (D.06-06-063, June 29, 2006).

[7] California Energy Commission, Funding and Energy Savings From Investor-Owned Utility Energy Efficiency Programs in California for Program years 2000 Through 2004, CEC-400-2005-0042-REV, p. 9.

[8] Union of Concerned Scientists, Drilling in Detroit (2000), p. 8, online at: http://www.ucsusa.org/assets/documents/clean_vehicles/drill_detroit.pdf.

[9] California Energy Commission, 2007 Integrated Energy Policy Report levelized cost analysis, p. 7, CEC-200-2007-011-SD ("CEC Levelized Cost Analysis"). We show only the investor-owned utility cost; merchant-owned generation and publicly-owned generation costs are slightly different.

[10] Community Environmental Council projection based on UC Santa Barbara Economic Project forecasts for fossil fuel generation and various other sources for non-fossil generation.

[11] Ibid.

[12] Assuming a three percent annual inflation for fossil fuels and nuclear, a one percent annual inflation for mature renewables and a three percent annual deflation for non-mature renewables.

[13] Ibid.

[14] Lawrence Berkeley National Laboratory, Annual Report on Wind Power Installation, Cost, and Performance Trends: 2007, online at: http://eetd.lbl.gov/EA/EMP/reports/ann-rpt-wind-06.pdf.

[15] CEC Levelized Cost Analysis, p. 39, Table 25.

[16] Dan Kammen and Sergio Paca, "Assessing the Costs of Electricity," (2004), page 328.

[17] Edison Foundation, "Why Are Electricity Prices Increasing? An Industry-Wide Perspective" (June 2006), page 2. Available at: http://www.eei.org/industry_issues/electricity_policy/state_and_local_policies/rising_electricity_costs/Brattle_Report.pdf

[18] Visit www.uxc.com for up to date uranium spot market prices.

[19] Energy Information Administration 2007 Annual Energy Outlook Table A3 (Dec., 2006), available at http://www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf.

[20] New York Mercantile Exchange (NYMEX) Henry Hub Future price, available at http://www.bloomberg.com/markets/commodities/energyprices.html. NYMEX lists their prices per million British Thermal Units (mmBTU), but a thousand cubic feet equals 1,020,000 BTU, so a thousand cubic feet and a million BTUs are approximately equal units.

[21] California Air Resources Board, Fuel Cycle Energy Efficiency Conversion Analysis, p. 10 (2000), online at: http://www.arb.ca.gov/msprog/zevprog/2000review/efficiency.pdf.

[22] In June, 2007, a gallon of gasoline cost about $3.30 and a kilowatt hour of electricity cost about $0.16. Each gallon is equivalent to 36.6 kilowatt hours, so 36.6 kilowatt hours costs an average consumer $5.86 (36.6 x .16), which is 78 percent more than $3.30.

[23] 80 percent higher cost for electricity reduces the financial benefits of the 250 percent higher efficiency of an electric vehicle to a 50 percent reduction in costs.

[24] Intellichoice.com survey of full ownership costs and benefits, Jan., 2007, available online at: http://home.businesswire.com/portal/site/google/index.jsp?ndmViewId=news_view&newsId=20070108005692&newsLang=en.

[25] For a more complete job creation analysis, see Appendix __ to the Blueprint, available at: ____.

[26] Worldwatch Institute and Center for American Progress, "American Energy: The Renewable Path to Energy Security," (2006), page 10.

[27] Renewable Energy Policy Project, Wind Turbine Development: Location of Manufacturing Activity (2004).

[28] Renewable Energy Policy Project, "Renewable Energy Demand: A Case Study of California," (Oct., 2006).

[29] Supra, note 14.

[30] National Renewable Energy Laboratory Energy Analysis Office, 2002.