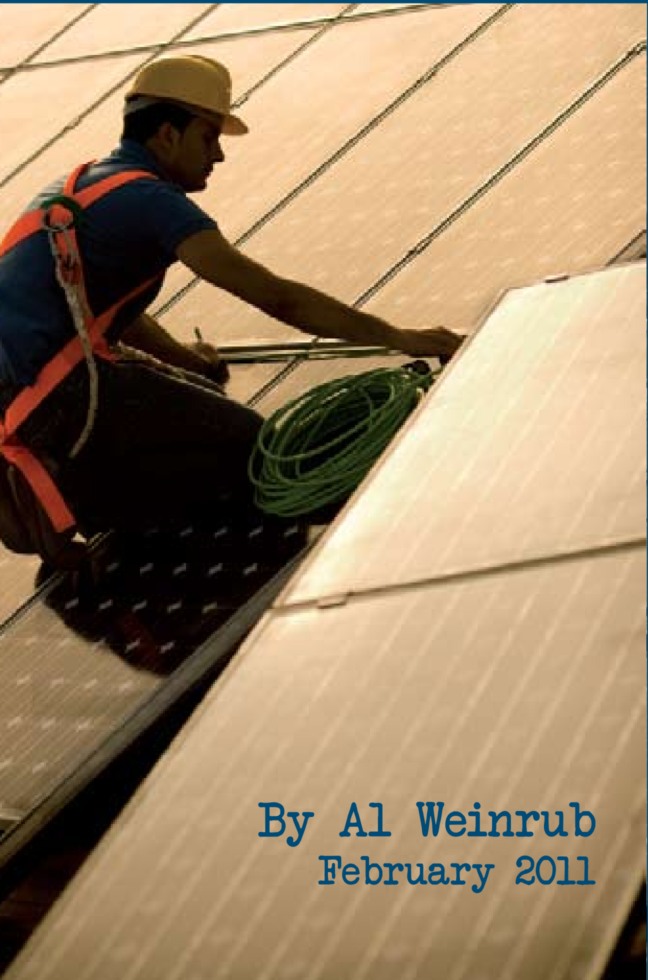
COMMUNITY POWER

Decentralized Renewable Energy in California



By Al Weinrub

February 2011

"Decentralized renewable energy generation represents the single most immediate and feasible means to produce renewable energy at a broad scale without reliance on long-distance transmission lines…"

In Our Backyard: How to Increase Renewable Energy Production on Big Buildings and Other Local Spaces[1]

"It's inevitable that we're going to create a greener economy in the U.S. The question is, will we make this transition fast enough, and fair enough. That's the challenge: to get as many jobs and as much justice out of this transition as possible. We have an ecological and economic crisis at the same time. When you try to resolve a crisis, you can try to resolve it on terms most favorable to rich people, or to ordinary people. You can try to resolve the crisis in a way that's most favorable to the status quo, or to real change."

Van Jones[2]

"No problem can be solved from the same level of consciousness that created it."

Albert Einstein

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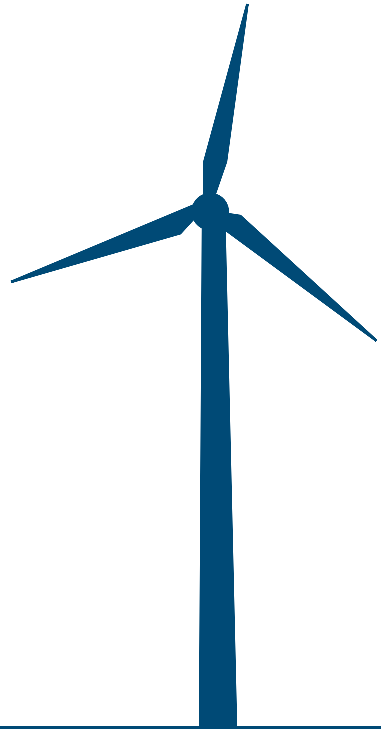

Local
Clean Energy
Alliance

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Decentralized Renewable Energy in California

By Al Weinrub

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Unit	Meaning
Watt (W)	The unit of electrical power Power rating of a typical incandescent light bulb = 25 to 150 W
Kilowatt (kW)	One thousand Watts Power rating of a typical residential solar PV system = 1 to 10 kW
Megawatt (MW)	One million Watts Power rating of a large distributed solar PV system = 1 to 20 MW Power rating of a typical remote, central-station solar or wind plant = 50 to 500 MW
Gigawatt (GW)	One billion Watts Power rating of a typical large coal or nuclear power plant = 1 to 2 GW
Watt-hour (Wh)	The unit of electrical energy (one Watt expended for an hour) Energy consumption of a 100 Watt bulb in an hour = 100 Wh
Kilowatt-hour (kWh)	One thousand Watt-hours Yearly electrical energy consumption of a clock radio = 40 kWh
Megawatt-hour (MWh)	One million Watt-hours Yearly average household electrical energy consumption in California = 7 MWh
Gigawatt-hour (GWh)	One billion Watt-hours Yearly California electrical energy consumption = 300,000 GWh

Table 1:

Units Used in This Paper

INTRODUCTION

Every day brings new urgency to ending our dependance on fossil fuels. The extraction of these fuels is increasingly undermining the ecosystem upon which we humans depend; and the consumption of these fuels is responsible for many harmful pollutants, including the greenhouse gas emissions that are already impacting the climate, the entire biosphere, and our communities. A transition from fossil fuels to renewable energy is necessary if human beings and many other species are to survive.

Our challenge is daunting. We must drastically reduce the amount of energy human society derives from carbon-based fuels. This is especially so in the United States, which ranks among the highest in total and per capita energy consumption, and which is responsible for the largest historical greenhouse gas emissions.

Nearly all the coal and about a quarter of the natural gas consumed in the United States are used for generation of electricity, giving off in the process about 40 percent of the nation's carbon dioxide emissions as well as many other harmful pollutants. Therefore, reducing the fossil fuel burned to produce electricity is a major imperative. The reduction can be achieved by substantially decreasing electrical demand and by rapidly transitioning to renewable energy sources for the electricity we continue to consume.

Transitioning From Fossil Fuel Electrical Energy

Reducing energy demand is by far the most cost-effective and broadly applicable approach to quickly transitioning from fossil fuel electrical energy. Energy reduction measures such as developing and using more energy-efficient consumer appliances (motors, lighting, and electronics), making new and existing buildings more energy-efficient, and simply being careful not to waste electricity (energy conservation) can all reduce the amount of electricity needed from fossil fuels. The Scoping Plan for California's Global Warming Solutions Act (AB 32) places high priority on such measures.[3]

Also, increasing the efficiency of fossil fuel electric generation is an important transition measure. The AB 32 Scoping Plan, for example, calls for the expansion of combined heat and power (CHP) systems. This technology uses the heat normally wasted in the production of electricity to heat commercial and residential buildings. Because this heat energy is more efficiently used, less fuel needs to be burned system-wide to achieve the same ends, thereby reducing the consumption of fossil fuels. Better use of energy storage technologies and development of demand response systems (to reduce peak demand spikes) are also important electric generation efficiency measures.

But far better than increasing the efficiency of fossil fuel electric generation is transitioning to energy technologies that do not rely on fossil fuels. The importance of this transition is recognized in 36 states that have passed laws setting specific targets for electricity to be generated from renewable energy sources.[4] These targets are either through mandates in the form of renewables portfolio standards (RPSs) or through voluntary renewable goals. There are a number of renewable energy technologies available to replace fossil-fuel electric generation. These make use of solar, wind, biofuel, geothermal, hydropower, wave, and tidal energies.

All these measures—energy conservation, energy efficiency in both electric generation and consumption, and the substitution of renewable energy sources for fossil fuels—are required to phase out our dependency on fossil fuels and meet our clean energy needs. The approach is illustrated in Figure 1. However Figure 1 also shows that the AB 32 Scoping Plan and California energy policy provide only a gradual reduction in fossil fuel electric generation.

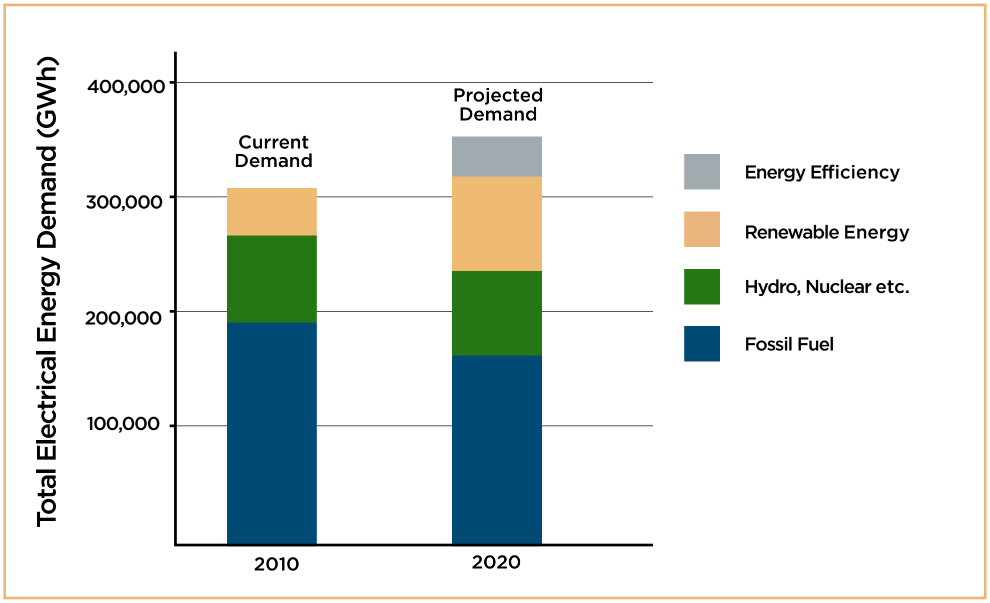

Figure 1:

Measures for Reducing Fossil Fuel Electric Generation in California[5]

A New Direction

To meet this historic challenge we have to change the way our local economies and communities function, how we utilize resources, and how our local, state, and federal governments address energy issues.

Energy conservation and energy efficiency measures are local, decentralized ("distributed") resources. They are readily available everywhere and need to be adopted everywhere if we are to be successful in reducing fossil fuel consumption. Renewable energy is likewise a distributed resource—it is available virtually everywhere.

Take the sun, for example, as a distributed renewable energy resource. It can be converted directly to electricity using photovoltaic technology. It can heat water or other fluids that warm buildings or drive electric generators (solar thermal technology), and the sun's warming of the atmosphere creates wind currents that can be harnessed to generate electricity (wind turbine technology). In addition, the sun's energy is the source of rivers and waves that can be harnessed to generate electrical power. It is also the source of biofuels.

Which of these locally-available renewable resources is most appropriate to develop depends on the geography, geology, weather, and other characteristics of a given location. Similarly, the optimal mix of renewable technologies for any given location depends on the resources available at that location. Generating electricity from decentralized renewable sources across the state of California is a flexible and efficient approach to replacing fossil fuel electricity. It is also the approach most compatible with the natural environment.

Nevertheless, there is significant debate today about the benefits and the feasibility of local, small-scale, decentralized renewable energy, as compared to remote, large-scale, central-station power plants—and their associated transmission lines. Some advocates of renewable energy promote a central-station model characteristic of the fossil-fuel power plants of the past century, and indeed, some industrial scale renewable energy facilities might be needed to reach California's energy goals.

However, this paper points in a new direction—one that emphasizes local decentralized energy resources.

Decentralized Generation of Electricity

In this paper, decentralized generation of electricity (also called distributed generation or DG) refers to electricity produced locally from dispersed, small-scale generators, usually rated at 20 megawatts capacity or less and situated on vacant land or existing structures close to the point of electricity consumption.

A variety of California programs offer the opportunity to develop decentralized generation. For example:

- The Renewable Electricity Standard (RES), also known as the Renewables Portfolio Standard (RPS), mandates that all utilities get 33 percent of their electricity sales from renewable sources by 2020.
- The Million Solar Roofs Program provides $3 billion to help fund 3,000 megawatts of customer-owned "rooftop" solar electric generation by 2016.
- The Self-Generation Incentive Program (SGIP) provides incentive payments to small energy projects, such as solar, wind, micro turbines, and fuel cells.

Energy conservation and energy efficiency are assumed to be essential parts of statewide decentralized renewable energy system. Combining these resources with renewable energy technologies is more economically beneficial, more rapidly achievable, and more broadly applicable than emphasizing any single resource alone.

This paper explores the merits of decentralized electric generation in California. Its focus is on solar photovoltaic and wind technologies because of their predominance in California; but the arguments are relevant to a broad mix of renewable technologies, all of which are essential to a clean energy future.

A section of the 5 megawatt solar system being installed atop San Francisco's Sunset Reservoir (Golden Gate Bridge can be seen in the background).

The workforce for this project consists of union labor and at least thirty percent economically disadvantaged residents of the City's most underserved communities.

Local decentralized power generation, exemplified by this project, is promoted by communities seeking to benefit from local energy resources. It represents a new community-based energy development model.

Photo Credit: SF Public Utilities Commission

This paper also describes obstacles to implementing decentralized generation in California and outlines several policies, such as feed-in tariffs and Community Choice energy programs, that would help overcome these obstacles.

Ultimately, what is at stake is our ability to meet challenges of a global scale through a new energy development paradigm. This paradigm centers on using local renewable power to create sustainable, equitable economies and healthy communities.

The 354-megawatt Solar Energy Generating System (SEGS) power plant at Kramer Junction, California in the Mojave Desert.

Remote central-station power plants such as this are promoted by large corporate investors, utility companies, and federal and state government agencies. It represents the large-scale energy development model of the past.

Photo Credit: Renewable Energy

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EXECUTIVE SUMMARY

This paper makes the case that local, decentralized generation of electricity, among the electric generation options available for meeting California's clean energy mandates, offers the greatest potential benefits while minimizing environmental degradation and other societal costs.

The implications of decentralized generation go well beyond California. While most of the data used is specific to California, the analysis applies more generally. Nor is the analysis limited to the state's current mandate of 33 percent renewables by 2020. Decentralized generation has potential far beyond that.

The paper argues that decentralized generation has many benefits as a source of renewable electrical power relative to large central-station solar or wind power plants in remote areas. The case for decentralized generation is based on the following factors:

- **Decentralized generation is increasingly cost-effective:** Electricity generated from decentralized sources is cost-effective compared to developing similar renewables in a remote location. For example, even though remote solar projects enjoy some economy of scale compared to smaller decentralized solar projects in urban areas, this advantage is relatively modest, and can be lost entirely when environmental and transmission costs are factored-in. At the same time, the recent large reduction in the price of solar panels makes solar energy much more economical than it was even a few years ago. Similarly, decentralized wind generation avoids transmission costs and is easier to connect to the grid, thereby offsetting a good part of the economy of scale of large wind farms.

- **Decentralized generation can meet California's new renewable energy targets:** There are enough potential sites for new decentralized renewable generation to meet California's 2020 renewable energy targets. There is large solar resource potential in California's urban areas and at substations, and good wind resources are available in most counties in the state. Similarly, manufacturing capacity has grown to the point where it can easily supply whatever amount of decentralized generation California would need.

- **Decentralized generation provides local, equitable economic benefits:** Decentralized generation is able to stimulate local economic development and clean-energy jobs. This is especially true in urban areas where unemployment and job loss due to the economic downturn have disproportionately impacted low-income communities and communities of color. Investments in local renewable generation, and local control of energy resources, are fundamental to sustainable and equitable economic development and to healthier communities.

- **Decentralized generation minimizes the environmental impact of renewable energy:** Decentralized solar generation can be installed on existing structures, and decentralized solar and wind generation can utilize disturbed and fragmented lands. No new transmission lines are required. For these reasons decentralized generation has few of the environmental costs associated with remote large-scale central-station power plants. In most cases, sensitive desert and mountain habitats are protected, and environmental injustice is minimized.

- **Decentralized generation can be brought on line quickly:** Because decentralized generation is relatively small scale and primarily installed in urban areas, there is less need for vast land acquisition, complicated financing arrangements, new transmission lines, exposure to litigation, and other risks associated with remote large-scale projects. California regulators, utilities, and renewable developers have all cited access to transmission as one of the biggest barriers to building renewable projects. New transmission lines, even if they do survive legal challenges, typically take 8 to 10 years to build. Such long lead times put the state's 2020 renewable targets at risk. Decentralized generation does not need transmission, can be installed in months rather than years, accelerates greenhouse gas reduction as a result, and makes rapid conversion to renewable energy possible.

- **Decentralized generation provides increased energy security:** Decentralized generation is deployed close to electrical load and throughout many urban areas. This widespread distribution of many smaller systems means there is less risk of a disruption to the regional power supply when compared to the failure of a single large generating station or transmission line, either of which can jeopardize the grid. Decentralized generation can provide a more resilient electricity supply because a multiplicity of small sources lessens the likelihood of a large amount of generating capacity going offline at once. In addition, decentralized generation provides a means of reducing the risk of market manipulations that have caused brownouts and power shortages in the not too distant past.

Decentralized generation represents a renewable energy strategy for California and the nation that addresses the compelling need to rapidly transition away from fossil fuels while promoting broad economic, environmental, and equitable community development. Emphasizing cost-effective local renewable energy resources departs from the business-as-usual paradigm of large, capital-intensive energy development that benefits narrow economic interests at the expense of broader community objectives, and exacerbates existing environmental, economic, and social inequities.

Decentralized generation provides an alternative to the conventional energy industry vision of paving thousands of square miles of desert with industrial-scale solar arrays, and erecting distant forests of wind turbines, that would send power across a vast superhighway of costly transmission lines.

This alternative vision—one that a growing number of states and communities are embracing—is the development of state and local renewable resources for the benefit of local communities.

Achieving this vision will require overcoming obstacles from the energy and utility industries, public agencies, and other interests vested in the century-old investor-owned utility model. These forces promote continued use of natural gas power plants and expanded construction of transmission infrastructure. They favor government policies and interventions that maintain the economic status quo.

In light of these significant obstacles, rapidly scaling-up local decentralized generation requires a new approach to energy development with different objectives and different electric power generation priorities, reflected in new energy policies and programs. Among these programs is Community Choice energy, which allows a city or county to aggregate the electricity demand of all customers in its jurisdiction, and contract with a commercial service provider to develop or purchase renewable electric power on their behalf. Another program, called a feed-in tariff (FIT) program, requires utilities to purchase wholesale renewable energy at standard, long-term, competitive rates. In Europe such programs have resulted in rapid growth of local renewable energy production.

Achieving the vision of local renewable resources for the benefit of local communities also requires a reorientation of state laws and regulatory agencies. They need to promote the development of local decentralized renewable power.

"In Europe, there has already been substantial development of decentralized renewable energy, and policy makers have moved on to discussions of 100% renewable energy. In the United States, by contrast, well-heeled interest groups tend to dominate renewable energy discourse, and American energy policy reflects their paradigm of centralized generation dependent on high-voltage transmission lines."

John Farrell, Institute for Local Self Reliance[6]

DECENTRALIZED RENEWABLE GENERATION as a Preferred Source of Power for California

A number of factors favor decentralized generation of electricity as a preferred alternative to remote, central-station energy development in California:

- It is increasingly cost-effective.
- It can meet California's new renewable energy targets.
- It provides local, equitable economic benefits.
- It minimizes the environmental impact of renewable energy.
- It can be brought on line quickly.
- It provides increased energy security.

These factors are discussed below, specifically with regard to California, but most are more generally applicable, depending on regional conditions and details.

Decentralized Generation is Increasingly Cost-Effective

Electricity generated from decentralized sources is increasingly cost-effective compared to developing similar renewables in remote locations. For example, even though remote solar projects enjoy economy of scale compared to solar projects in urban areas, this advantage is relatively narrow, and can be lost entirely when environmental and transmission costs are factored in. A continuing reduction in the price of solar panels makes decentralized solar generation much more economical than it was even a few years ago. Similarly, by avoiding transmission costs and being easier to connect to the grid, distributed wind generation offsets a good part of the economy of scale of large wind farms.

A 225-kilowatt solar photovoltaic system on the roof of the administration building of California State University, Long Beach. The 800 solar panels provide 80–90 percent of the building's peak demand.

A significant drop in the price of solar panels over the last two years has made local solar power much more economical and increasingly cost-effective compared to large central-station solar plants in the desert.

Photo Credit: Solarguy 1000

Basic Cost of Electricity Generation

An analysis of cost-effectiveness starts with the cost of energy of each of the major renewable, fossil fuel, and nuclear power generation technologies. The basis for evaluating energy generation options is the cost of new generating facilities.[7]

Figure 2 presents cost of energy generation data from California's Renewable Energy Transmission Initiative, a statewide effort that includes utilities, renewable project developers, and other stakeholders. The horizontal bars shown in Figure 2 represent the normal range of cost of electricity generation from different types of new power plants. The cost calculation is done by taking total life-cycle cost of utility-scale power plants, including construction, operation, owner profits, and fuel, if needed. The total costs are amortized over the financial recovery period of the generating source—usually 20 years—and divided by the amount of energy normally expected to be generated over that period. Transmission costs are not included.

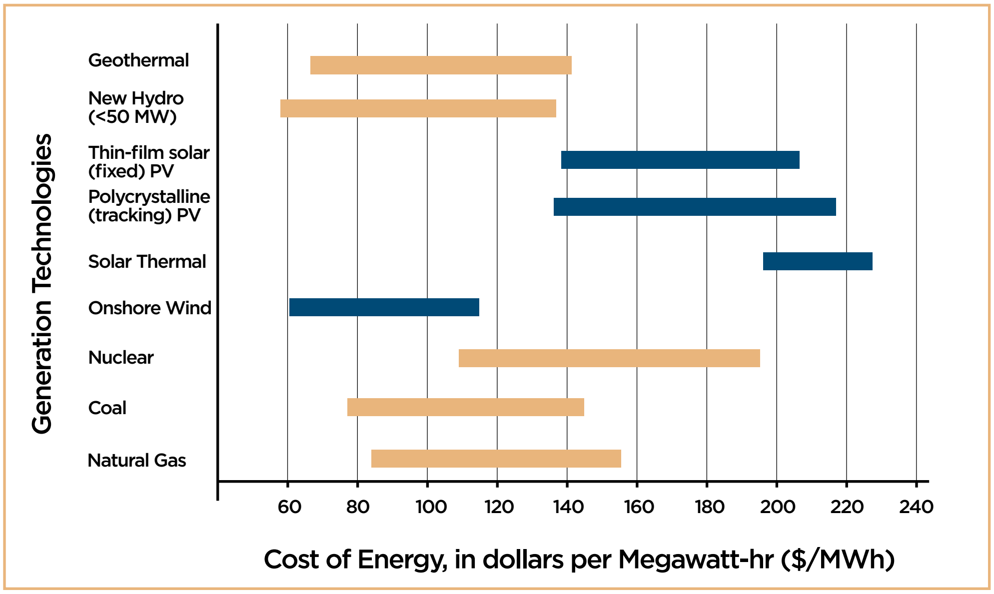


Figure 2:

Power Generation Technologies, Cost of Energy Generation Comparison[8, 9, 10] ($/MWh)

The ranges in cost of energy generation for each technology are the result of many factors: the cost of specific generation equipment, financing terms, the size of the power plants, risk factors, the performance of power plants, the quality of renewable or other resources at specific locations, fuel prices, and other variables.

Many people think that renewable energy costs more than conventional sources of power. Figure 2 shows that this is not true for new power plants; electricity generated from several renewable technologies clearly falls within the range of cost of electricity from new natural gas, coal, and nuclear plants. In fact, renewable energy from wind, geothermal and small hydroelectric power can often be the cheaper option. Even solar power generation, which is more expensive than the other renewable energy sources shown, actually overlaps the cost of new nuclear power, natural gas, and coal power.

Two types of solar power technologies are shown in Figure 2—solar photovoltaics (PV) and solar thermal. Solar PV directly converts light to electricity through specially engineered crystals made of silicon and other materials. Solar thermal plants use mirrors to concentrate sunlight on a collector that heats up oil or some other fluid that, in turn, heats up water to produce steam that powers a conventional electric generator. In general, solar thermal plants require consistent, high levels of sunshine to be economical, which is why they are generally sited in remote desert areas.

"…solar panel prices have plummeted so much as to make viable the prospect of generating gigawatts of electricity from rooftops and photovoltaic farms built near cities…Ryan Pletka, Black & Veatch's renewable energy project manager, told me last week [that] 'What we thought would happen in a five-year time frame has happened in one year."

Todd Woody, "Solar's rapid evolution makes energy planners rethink the grid.[11]

For many years it appeared that solar thermal plants would be more efficient and less costly than solar PV. For this reason, solar thermal plants located in remote desert regions were considered a preferred option. However, as a result of recent declines in the price of solar PV panels, the cost of energy generation from solar PV is now generally lower than that of solar thermal.

Decentralized Generation versus Remote Central-Station Power

The competitive cost of large-scale renewables is largely due to the fact that these projects benefit from economies of scale; there is an assumption that smaller-scale decentralized projects will necessarily be more expensive. To some extent this is true. However, the cost of new transmission lines required to access remote power plants is significant. As renewable technologies drop in price, transmission costs become an increasingly significant factor in the overall cost of energy, offsetting the advantages of scale offered by remote power plants.

According to the California Energy Commission, the cost of energy generation for solar PV declined from $740 per megawatt-hour ($740/MWh) in 2007 to $260/MWh in 2009, about one-third the earlier value.[12] An analysis of capital costs of various sized projects in the California Solar Initiative, a state rebate program to encourage installation of solar systems on residential and commercial properties, is shown in Figure 3.

The declining capital costs reflect the declining price in solar PV panels. The California Energy Commission projects that the capital cost of solar panels will drop in half by 2020.[14]

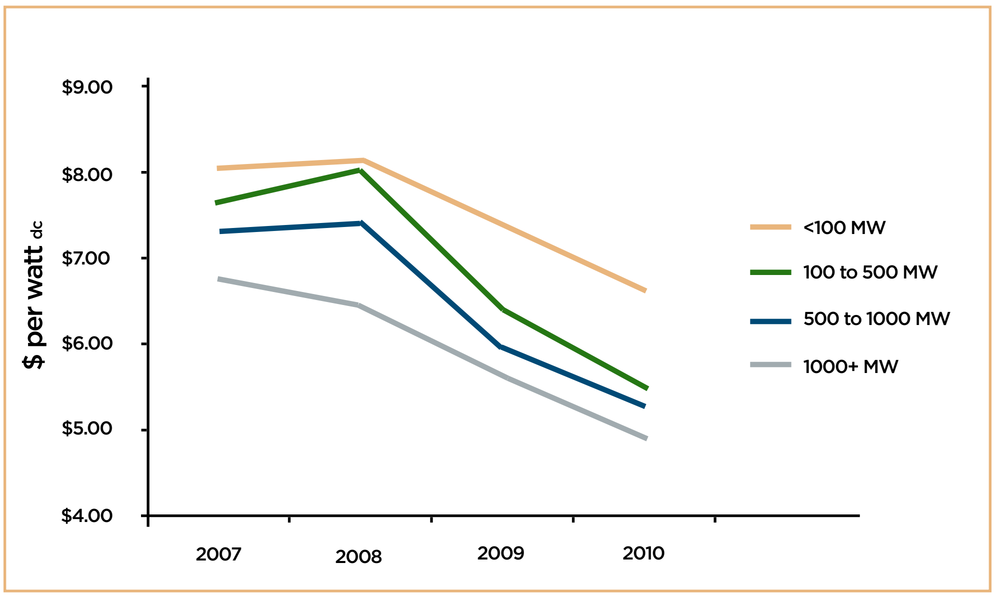


Figure 3:

Capital Costs of Solar PV - California Solar Initiative[13]

There are many reasons for the reduction in the price of PV panels. There has been an expansion of the international market and more competition. Large increases in manufacturing capacity have lead to economies of scale and overcoming supply bottlenecks. There has also been significant ongoing investment in research and development to increase panel efficiency and reduce costs, as well as cost reduction efforts on the part of system designers and installers. All these factors are expected to have significant impact for several years.

A detailed analysis of the cost-effectiveness of decentralized solar PV compared with remote central-station solar generation is presented in Appendix A and summarized in Figure 4 on page 14. It shows that decentralized solar PV has clearly become cost-competitive compared to remote central-station solar generation. The analysis also shows that as the price of PV panels declines, and the cost of transmission infrastructure increases, decentralized solar PV will become increasingly cost-effective.

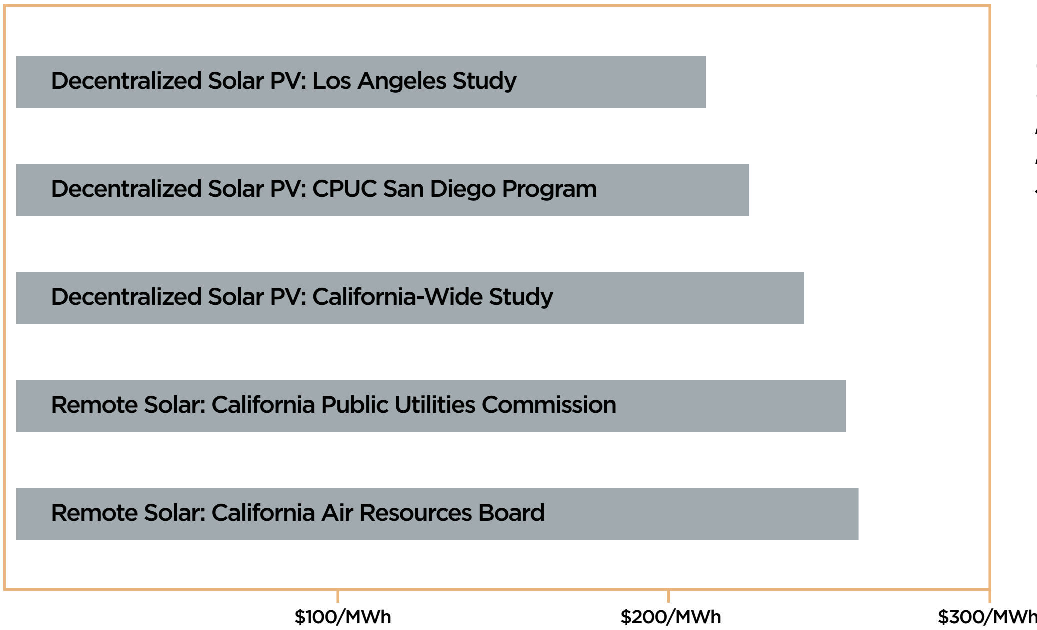


Figure 4:

Cost of Energy Comparison: Decentralized Solar PV vs. Remote Solar, September 2010

For example, in June 2009, Southern California Edison won approval for an $875 million 500-megawatt project to generate electricity with solar PV systems of one to two megawatts in size on urban commercial rooftops.[15] In April 2010, Pacific Gas and Electric won approval for a similar 500-megawatt project,[16] and in September 2010 San Diego Gas and Electric followed with a 100-megawatt project.[17]

It is clear that the competitive terrain of renewable technologies has shifted qualitatively. As a result, the old rationale for remote, utility-scale solar power plants and the new transmission lines they require is now being challenged by increasingly cost-effective decentralized solar PV generation technology.[18]

The cost-effectiveness of decentralized wind generation is a bit more difficult to analyze than that of solar PV. The cost of energy of smaller-scale decentralized wind generation generally depends on the height of wind turbines, the length of blades, the average wind speed, and wind reliability at turbine locations. However, if individual turbines are at or near utility size and if the wind resource level is similar, decentralized wind generation at sites with good to excellent wind can be a cost-effective alternative to remote large-scale wind farms.

While lacking the economy of scale of large wind farms, decentralized wind generation has the advantage of being geographically close to energy demand, so transmission costs and energy losses can be avoided. Also, electric generation is less costly to interconnect to the electrical grid at the (low voltage) distribution system level than at the (high voltage) transmission level.

The evaluation of the cost-effectiveness of decentralized solar and wind generation, as discussed above, is based on costs that are relatively easy to quantify. However, a more meaningful analysis of cost-effectiveness needs to consider additional costs that are harder to quantify: environmental costs, costs resulting from delays in the reduction of carbon emissions, costs associated with system failure, and so forth. Equally important is consideration of the economic benefits to local communities of decentralized generation. Other sections of this paper take up these important issues.

Decentralized Generation Can Meet California's Renewable Energy Targets

A sufficient number of siting locations and sufficient manufacturing capability exists to supply the new renewable generation needed to meet California's 2020 renewable energy targets, and possibly much more, using decentralized renewable generation. The following sections present the data that point to this conclusion.

How Much New Renewable Generation Is Needed to Meet California's 33 Percent Requirement?

How much new renewable energy is actually needed to meet California's Renewables Portfolio Standard (RPS)? The RPS, established by Governor Schwarzenegger through Executive Order S-14-08, calls for 33 percent of commercially sold electricity to come from renewable sources by 2020. The difference between the 33 percent target and the current amount of renewable energy is referred to as the *renewables net short*.

An exact value of the renewables net short is difficult to determine. This is because California regulatory agencies and energy initiatives use different assumptions, different scenarios, different data, and different calculator tools, to project their different values of the renewables net short. These bodies include the California Energy Commission (CEC), the Renewable Energy Transmission Initiative (RETI), the California Public Utilities Commission (CPUC), the California Independent System Operator (CAISO), and the California Air Resources Board (CARB). *See Appendix B for an overview of these bodies and their initiatives.*

While there is currently no standardized approach, the estimation of the renewables net short would start with estimating total electrical load (or demand) for 2020, diminishing that value by the electrical power generated privately (meaning behind the meter of residential and commercial customers), and then subtracting line losses and electricity used for pumping water (that is, electricity not sold to customers) to calculate how much electrical power is needed for retail sales to customers. According to the RPS, 33 percent of the retail sales amount must be from renewable sources. If we subtract from this renewable energy requirement the existing renewable energy currently being sold, what remains is the amount of new renewable energy needed by 2020 (the renewables net short).

The net short value is sensitive to a number of assumptions. Among these are a forecast of electricity demand projected to 2020, the impact of energy efficiency programs and the California Solar Initiative, and the effect of other energy policies.

Also affecting the net short value are assumptions about the implementation of new measures mandated by the Scoping Plan for implementing the state's Global Warming Solutions Act (AB 32). The Scoping Plan calls for significant reductions in electrical demand through new energy efficiency programs (for example, residential and commercial building energy retrofits), and increased use of Combined Heat and Power or CHP (capturing waste heat created by the generation of electricity).[19]

Various estimates of the renewables net short value have been made by various state energy agencies. In January 2010, for example, RETI calculated the net short at 56,385 GWh/year.[20] RETI also calculated an alternative net short of 47,022 GWh/year by assuming implementation of about 60 percent of the AB 32 requirements.[21] A CEC staff report, assuming full implementation of the AB 32 Scoping Plan, calculated a net short value of 45,000 GWh/year.[22] An

A 675-kilowatt flat roof solar PV system on the Moscone Convention Center in San Francisco, California.

Effective use of urban solar rooftops to produce energy close to demand centers, when combined with programs to cut energy consumption, can drastically reduce greenhouse gas emissions and also the need for large central-station solar power plants in the desert.

Photo Credit: Eddie Codel

October 2010 presentation to the CPUC, which compared the renewables net short estimates of various state agencies, reported a range of 45,000 GWh/year to 65,000 GWh/year.

To date, no California agency has produced a net short calculation utilizing the most recent demand forecast and assuming full implementation of AB 32. However, the Sierra Club California's Energy-Climate Committee (ECC), incorporating the most recent state forecasts for electricity and assuming full implementation of AB 32 targets, has calculated a renewables net short of about 40,000 GWh/year. Assuming a 60 percent implementation of AB 32 targets, the Sierra Club calculated a renewables net short of about 47,000 GWh/year. *The details of these calculations are provided in Appendix C.*

The Sierra Club calculation reveals a number of important points about implementing the full range of AB 32 measures:

- It will cut the amount of renewables needed to reach the 33 percent RPS target.
- It will make it much more feasible to achieve the 33 percent target by 2020.
- It will make it much easier to meet most of the net short with decentralized generation.
- It will save utility customers tens of billions of dollars compared to the original forecast.

A number of these points will be expanded upon in this paper.

The Potential for Decentralized Solar Power

State agencies and electric utility companies are examining various combinations of technology to determine how to meet the RPS target. One option is to use decentralized solar PV generation. However, questions have been raised about whether there is enough area on "rooftops" to provide a major portion of California's energy needs.

A September 2007 Navigant study prepared for the CEC[24] estimated the solar PV capacity potential for both residential and commercial rooftops in California for 2006, 2010 and 2016. A PV access factor was applied to the square footage roof space data to estimate how much roof space is actually available for solar PV. The PV access factor takes into account variables such as shading, building orientation, and roof structural soundness. Solar power density data is then used to calculate the potential installed capacity in California. The results for 2010 and 2016 shown in Table 2 assume growth in rooftop area as well as increases in the efficiency of solar panels.

Year	Residential	Commercial	Total
2010	30,932	19,323	50,255
2016	42,181	25,708	67,889

Table 2:

PV Rooftop Capacity in California (in megawatts)

More recently, in December 2009, Black & Veatch and Energy and Environmental Economics, Inc. (E3), consultants to the CPUC, teamed up to analyze current decentralized generation potential.[25] The study attempted to quantify the readily available decentralized solar PV potential in California. It used a Geographic Information System (GIS) to identify sites for solar PV, both ground-mounted near transmission substations and on large urban rooftops near distribution substations. For example, it found 11,543 megawatts of large urban rooftop capacity (compared to Navigant's 19,323 megawatts of commercial rooftop capacity), however it only counted rooftops larger than 1/3 acre located within three miles of a distribution substation. The study also found 27,000 megawatts of ground-mounted capacity near rural transmission substations.

Using this information, and data on substation peak load capacities, the study estimated the readily available solar PV potential. In making these estimates, the study screened out urban and rural solar PV potential that would exceed 30 percent of distribution substation peak loads (citing a concern for distribution network stability) and assumed that only 33 percent of remaining potential would actually be realized. For example, the 11,543 megawatts of large urban rooftop capacity resulted in only 3,810 megawatts of readily available potential. Based on these screening assumptions, the study reported a readily available decentralized solar PV potential of 17,300 megawatts. Without these screening assumptions the solar PV potential would be roughly three times as large—about 52,000 megawatts. The larger number reflects potential that could be realized with appropriate measures to stabilize the distribution network and favorably price solar PV generation.

Based on the December 2009 study, Black & Veatch recommended a scenario for meeting new renewable electricity generation which would "replace central-station solar and wind with 15,000 megawatts of mostly decentralized solar PV,"[26] corresponding to about 30,000 GWh/year of decentralized generation. Such a scenario would utilize only a portion of the decentralized solar PV potential indicated in the study.

A 2-megawatt solar PV system, one of the largest corporate solar power installations in the U.S., covers the Applied Materials parking lot in Sunnyvale, California. The 8,000 panels change their tilt to track the sun's position.

While most studies of urban solar PV potential focus on rooftop areas, a significant amount of paved or disturbed land is also available for commercial solar PV development.

Photo Credit: Applied Materials

In June 2010, Black & Veatch and E3 updated their earlier study to report a readily available decentralized solar PV potential of 18,424 megawatts,[27] corresponding to an unscreened potential of about 55,000 megawatts capacity. This potential equates to an electrical energy generation of over 100,000 GWh/year. This figure is somewhat less than that estimated in the Navigant rooftop solar PV potential cited above, which would yield about 136,000 GWh/year in electrical energy generation in 2016. These figures suggest that there is more than sufficient physical siting potential for decentralized solar PV alone to supply the estimated renewable energy needed to meet the 33 percent 2020 target (a renewables net short ranging from about 40,000 to 65,000 GWh/year).

The potential for decentralized solar generation goes well beyond the numbers cited in these studies, which represent only the most accessible commercial solar PV installations. Other, smaller rooftops are available for commercial PV power in urban areas, as are carports, parking lots, other disturbed land, rail and highway right of ways, and so forth.

PV Manufacturing Capacity Could Easily Meet Califofornia Demand

Another question raised about decentralized solar PV is whether there is sufficient manufacturing capacity and a sufficiently growing market to meet California's need for new renewables. To meet the 33 percent target with solar PV generation would require about 20,000–25,000 megawatts of PV capacity installed over a ten-year period—about 2,000–2,500 megawatts of PV capacity installed in California per year.[28]

By comparison, more than 5,000 megawatts of solar PV capacity were installed worldwide in 2008[29] and between 6,000 and 7,300 megawatts in 2009.[30] In 2010, the world appears on track to install between 9000 and 12,000 megawatts—about double what was installed only two years earlier. Such exponential growth is typical for the solar PV industry, which has gone into an almost vertical ascent in the past few years. As Figure 5 shows, the solar market has shifted away from "off the grid" locations to PV systems that are attached to the power grid. This has opened up a vast market for solar PV, which is driving manufacturing capacity.

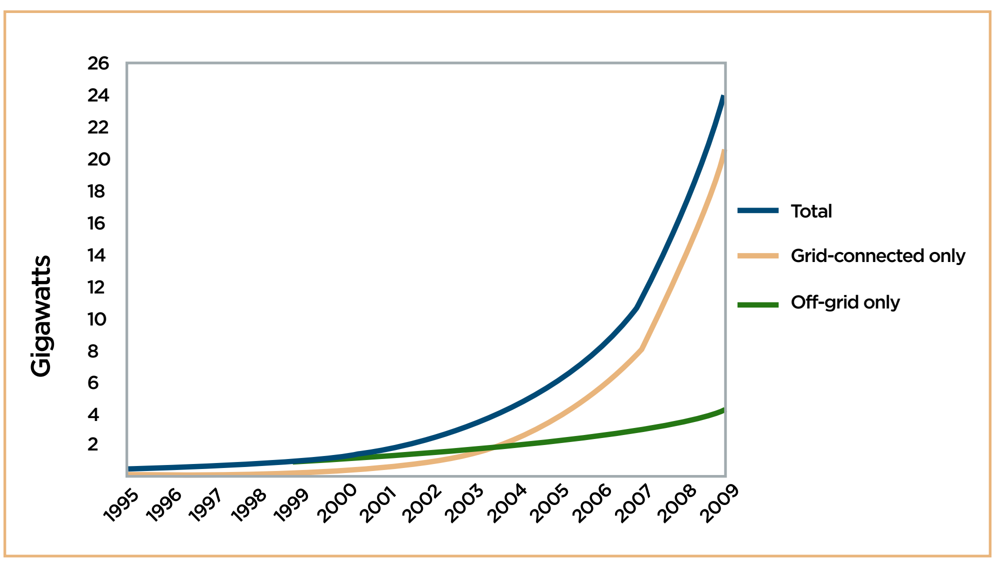


Figure 5:

Solar PV, Existing World Capacity, 1995 to 2009[31]

A few national markets have taken the lead. Germany, approximately the same size as California and with considerably lower insolation (solar intensity), was reported to have added 3,800 megawatts of mostly decentralized PV resources in 2009 and is projected to add a comparable amount of PV in 2010.[32] Spain, with a smaller economy than California, added 2,700 megawatts of primarily decentralized ground-mounted PV resources in 2008.[33]

Between 2005 and 2008, photovoltaic manufacturing had a difficult time keeping up with rapid growth in demand. However, PV panel manufacturing capacity has greatly expanded worldwide in the last two to three years to the point where manufacturing capacity far exceeds the rate of installation of solar photovoltaic systems. Estimates range from 10,000[34] to 21,000[35] megawatts of production capacity by the end of 2009. Actual global production reached a record 10,700 megawatts in 2009—a 51 percent increase from the year before.[36] One current estimate for oversupply of PV panel manufacturing capacity in 2010 is 8,000 megawatts.[37]

With PV installation rates lower than those already achieved in Spain or Germany, California could meet its entire renewable energy target for 2020. Worldwide PV manufacturing could readily supply the necessary 2,000 to 2,500 megawatts per year of PV demand over the next decade.[38]

In fact, there are factories with significant unutilized capacity that would be very eager for California to develop a much larger solar market.

The Potential for Decentralized Wind Power

The potential for decentralized wind generation (defined here as projects up to 20-megawatt capacity that can be connected to the electrical distribution system) is more difficult to estimate than that of decentralized solar because wind patterns and wind speeds are dependent not only on location but also on altitude, varying greatly in the first several hundred feet above ground level. Nevertheless, much of coastal California, the Bay Area, and the state's numerous highlands have sufficient wind for commercial generation.

A recent study estimates that California can generate about 94,000 GWh/year (31 percent of its 2007 electricity consumption) with onshore wind generation.[39] RETI found in-state wind power potential suitable for central-station power generation of over 32,000 GWh/year, based on potential individual projects over 20 megawatts.[40] These figures suggest that about two thirds of California's wind potential (about 62,000 GWh/year) could be in smaller-scale projects.

In 2005, the CEC issued a staff report of wind potential in the state.[41] The analysis of geographic distribution of wind power throughout California shows

A 225-kilowatt windmill in Cleveland, Ohio is the first utility-scale wind turbine to generate electricity in the heart of a city in the United States. Cleveland was the site of the first large windmill to generate electricity in the United States. The windmill was built by Charles F. Brush in 1888.

Much of coastal California, the Bay Area, and the state's numerous highlands have sufficient wind for commercial decentralized wind generation.

Photo Credit: Paul Gipe

significant wind resources can be found locally in most counties in the state, including those with a large population base.

While comparisons with other countries where wind power is more developed than California are only suggestive, Germany generates nearly 38,000 GWh/year from wind generation,[42] over five times the amount of wind generation currently produced in California. A large amount of this generation, if not the majority of it, is connected at distribution voltages (rather than high transmission line voltages) in small clusters of wind turbines. Almost 50 percent of the turbines are owned by farmers and cooperatives of people living in nearby communities.[43] Similarly, in France the average wind project size is 12 megawatts, and in 2009 this decentralized wind generation accounted for nearly 8,000 GWh, twice the output of California.[44]

This comparative data clearly shows that distributed wind generation could be built at a scale and pace that is equivalent—or even superior—to building large central wind farms.

Decentralized Generation Provides Local, Equitable Economic Benefits

Decentralized electric generation means local development projects. These can be projects of 20 megawatts or less in industrial areas, on disturbed land, or on large urban rooftops, as well as smaller-scale projects at residential or commercial sites. They can create local clean-energy jobs in manufacturing, building, and servicing the power generating systems.

Local Investment Impacts

Meeting a renewables net short of about 40,000 to 60,000 GWh/year in new renewable electric generation by 2020 (the range of current renewables net short estimates) would require a capital investment of about $10 to $15 billion per year if all the generation capacity is solar PV.[45] A more diverse portfolio of wind and biomass, together with solar PV, can reduce the cost to about $7to $10 billion per year.[46]

A commitment to spending $7 billion to $10 billion per year on renewable infrastructure in California could be a large economic opportunity to strengthen

Trainees at Solar Richmond install a solar PV system on a low-income homeowner's residence in Richmond, California.

The program provides solar installation training to Richmond residents and to youth in the East San Francisco Bay area. Solar Richmond works with the local solar industry to connect its graduates with family-supporting green-collar career jobs.

The program complements union training and apprenticeship programs, attempting to create a more inclusive job market and opportunities for low-income and underemployed local residents.

Investments in local commercial renewable energy provide the economic basis for an expanded local workforce. In addition, project labor agreements can provide jobs for both union workers and graduates of local job training programs such as Solar Richmond.

Photo Credit: SolarRichmondBUILD

local communities in the state. Local investments of this type have a strong multiplier effect: when those who invest in local renewable power generation enterprises buy local materials and when those employed in such enterprises spend their earnings locally, it stimulates other local enterprises, creating more jobs and more economic activity. Thus local investments not only create *direct* jobs, but also create *indirect* jobs (employment by suppliers) and *induced* jobs (employment due to increased local spending).

"Distributed generation provides new roles for communities to preserve and increase social equity, environmental quality, energy independence, and wealth."

Center for Social Inclusion, Energy Democracy: Community-scale Green Energy Solutions[47]

An example of the potential benefits of local renewable energy investment was presented in a study that compared two options for San Diego County to meet its future electricity requirements:

- A local, decentralized generation option (Net-Meter Option): Ratepayer dollars are invested into increasing the county's efficiency of electricity use by 40 percent and installing photovoltaic systems on 20.5 percent of its roofs and parking lots, with the goal of putting as many kilowatt hours into the electrical grid each year as the county uses from the grid.

- A remote, central-station option (Power Link Option): Ratepayer dollars are invested by San Diego Gas and Electric (SDG&E) into building the Sunrise Powerlink transmission line and the County purchases imported electricity from SDG&E. This is essentially a continuation of the County's dependence on imported electricity (or imported natural gas or nuclear fuels to produce electricity in the County).

Figure 6 shows the dramatically greater number of jobs (almost twenty times greater) created in San Diego County over forty years by local decentralized power compared to remote central-station power.

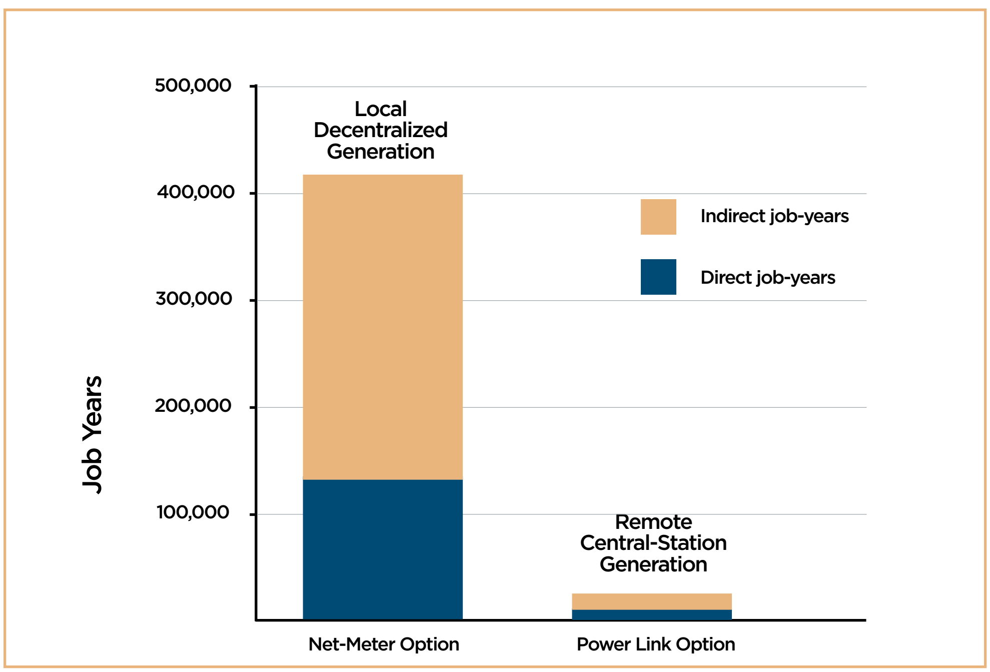


Figure 6:

Decentralized Generation Jobs Compared to Central-Station Jobs for San Diego County 2010 to 2050[48]

The study also indicated that the decentralized generation (Net-Meter) option provided superior benefits to the community in terms of its contribution to economic security and opportunity, energy security, public and environmental health, and the social good:

> *"In summary, the Net-Meter Option generates significantly greater cash flow into the local economy than the Power Link Option. It eliminates negative cash flow out of the economy for imported energy and instead develops local energy production assets, PV and efficiency. Investment in these assets generates more direct job-years*

of employment than the Power Link Option and the proposed financial model provides a consumer rebate. The income from the employment and consumer rebate multiplies through the local economy."[49]

In a similar vein, recent studies regarding wind power have found substantial increases in net economic benefits to rural communities when wind turbines are owned locally rather than by absentee owners. The studies (see Figure 7) found that the economic benefit of local ownership was more than triple that of an absentee-owned wind farm, and nearly twice as many local jobs—in financing, maintenance, etc—were created when turbines were locally owned compared to when they were controlled by an absentee owner.[50]

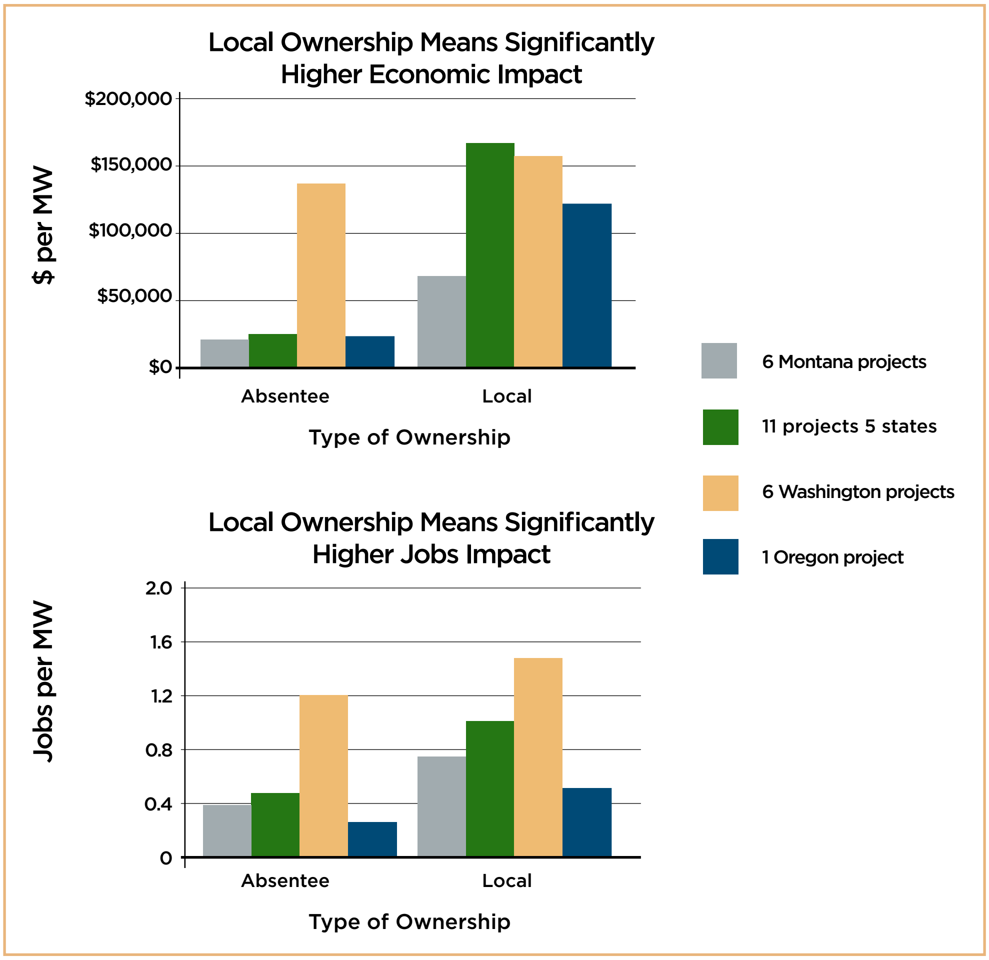


Figure 7:

The Effect of Ownership on Economic Impact and Jobs Impact

Similar conclusions were reached in another study of distributed wind generation:

"Wind projects are a source of jobs and economic development, and community wind projects are shown to have increased impact both during the construction and operations-period of a wind power plant. The extent of increased impact is primarily a function of local ownership and return on investment. As such, policies that prioritize higher levels of local ownership are likely to result in increased economic development impacts."[51]

In urban areas, where the economic downturn has created disproportionate unemployment, where job losses have hit poor communities and communities of color especially hard, and where economic recovery is dependent on new economic initiatives in those communities, the creation of new jobs through local investments in community-scale power is especially important.

Community Power: A New Business Model

Decentralized generation means that local residences, businesses, and communities become electric power producers. Homeowners and small businesses produce the power they need for their own consumption. Rather than paying ever increasing energy bills to finance remote transmission lines and central-station power, consumers become the direct beneficiaries of the power they produce. In five to fifteen years, through savings on energy bills, they pay off the cost of a solar PV system that will thereafter provide very low cost power for a total of 25 to 40 years (the expected lifetime of a solar PV system). The choice is pretty clear: pay for the ongoing cost of remote central-station renewable power or pocket the savings of locally-generated renewable power.

Businesses with large rooftops or parking lots can become small power companies that feed electricity into the grid. Their profits on electricity sales are a steady source of revenue that can supplement their business. Community cooperatives can pool the rooftop area of their neighborhoods to form, for example, an East Oakland Power Company, which could use the revenues generated from selling electricity to provide dividends to the members of the cooperative, or to fund local development projects, or to bankroll new clean-energy businesses in the community.

A survey of nine community solar projects in seven different states observes that ownership in community energy projects "provides a tangible sense of investment in energy production, shifting the owner's mindset from energy consumption to the balance between consumption and production. It also builds a constituency for distributed renewable energy in a way that buying solar-derived electricity as a commodity may not."[52]

Local renewable power systems allow a community to use an important local natural resource—the sun (and the wind and other renewable resources it produces)—to benefit the community, both for electric power needed locally and also for the economic growth and vitality that come from circulation of earnings and wages within a community. Community-scale decentralized generation allows more local control over energy and over how the expanded revenue base from that energy (and resultant tax base) is used, for example, in implementing a city's climate action plan or economic development plan.

By contrast, an urban community relates to electricity from remote central-station power plants as an imported commodity that results in the export of wealth from the community. The remote power plant is funded by large capital investors, and profits from the sale of the electricity to customers are returned to those investors. The workforce building the remote power plant (or

"Building clean energy infrastructure in communities most impacted by climate change is the best way to create thriving local economies. If we do this, ratepayer funds go back into the communities where they are urgently needed. We believe that the Renewable Portfolio Standard should include a carve-out of at least 20 percent for renewable power in local energy load centers. Such a carve-out is a way to protect and benefit under-served communities."

Strela Cervas, Co-Coordinator, California Environmental Justice Alliance[53]

A 22-kilowatt community solar system installed on Church of the Brethren in University Park, MD. The system is collectively owned by 36 private investors who formed a limited liability company, University Park Community Solar. The company sells power to the church, and investors expect a 5-year payback on their initial investments, which averaged $3,600.

Community investment in local renewable energy represents a new business model in which energy consumers become electric power producers. The result is that the community reaps the benefits of local solar resources.

Photo Credit: University Park Community Solar transmission line) is shipped in for a brief period and then let go. The power plant owners have little relationship to any local community, other than to see that community as an opportunity for capital accumulation. The economic relationship is best characterized as extraction of wealth from communities, rather than the development of communities.

Local generation of electricity offers a new relationship between energy and the economic development of a community. There are literally thousands of local initiatives in cities across California to harness local resources such as land, rainwater, sun, and labor power to create more livable, more sustainable, and more equitable communities: projects for better land use and public transportation, urban agriculture and food processing, water capture and recycling, building and neighborhood restoration, and so forth. All are starved by a lack of financial resources and the external control exercised through the commoditization of vital resources.

In the new energy paradigm and its new business model, decentralized electric generation is not simply a more cost-effective way of using the energy from the sun. Decentralized electric generation becomes a local financial resource that can be used to enrich our communities, and provide more sustainable and equitable economic development: clean energy and healthy communities.

Decentralized Generation Minimizes the Environmental Impact of Renewable Energy

Decentralized electric generation is generally installed on existing structures or already disturbed or fragmented land, and does not require building new transmission lines. Sensitive desert and mountain habitats and important ecosystems are protected.

Decentralized generation therefore has almost none of the detrimental environmental impacts associated with large-scale renewable sources located hundreds of miles away in the desert or in other remote regions. These impacts could include scraping hundreds of thousands of acres of open or undisturbed land clean of vegetation and consuming significant amounts of precious and limited water resources.[54]

In addition, decentralized generation minimizes the historically disproportionate impacts of central-station power plants on poor communities and communities of color. Native Americans in particular have suffered health, economic, environmental, and cultural impacts from energy extraction industries and

One of five 30-megawatt parabolic mirror solar thermal power plants at Kramer Junction, California in the Mojave Desert. These power plants, each covering about 130 acres, were built in the late 1980s, They are part of the 354-megawatt Solar Energy Generating System (SEGS), one of the largest solar generating facilities in the world. The shadows in the center foreground are human beings.

Projects like these not only destroy desert ecosystems, but also require huge amounts of scarce water.

Photo Credit: Desertec-UK

power plants in remote areas. Remote central-station renewable power plants and new transmission lines disrupt habitat and wilderness that are critical parts of the way of life in the impacted areas. Decentralized generation avoids this environmental degradation and the attendant environmental injustice.

The proponents of remote large-scale renewable power plants generally discount the environmental harm of remote, central-station projects. They often downplay environmental impacts, conduct inadequate environmental reviews, and invoke "overriding considerations"—instead of choosing environmentally preferable alternatives.

Renewable Energy Transmission Initiative: Downplaying Environmental Impacts

California's Renewable Energy Transmission Initiative (RETI) was established on the premise that California's energy policies require a major statewide effort to build new transmission lines to support large, remotely-located renewable energy power plants. The RETI mission is to "identify the transmission projects needed to accommodate these renewable energy goals."[55]

A key part of the RETI process was to identify Competitive Renewable Energy Zones (CREZs) and to rank the economic and environmental costs of the different zones. The environmental ranking of the CREZs was performed by an "Environmental Working Group" which had only two voting members representing environmental organizations and a large majority of developer, utility, and state agency representatives.

Commenting on the RETI process, six major environmental organizations stated in November 2009 that,

> *"The bottom line is that RETI's environmental ranking system fails to indicate the relative environmental cost of the CREZs as it purports to do... [The] environmental ranking criteria are not robust, do not reflect conservation biology principles, and do not reflect the conservation community's input."*[56]

According to these environmentalists, one of the largest problems is that the Environmental Working Group did not identify maximum use of disturbed lands as the most important environmental criterion to consider when ranking a CREZ. As a result, pristine wilderness received high ranking for development of major energy projects.

The RETI effort mischaracterized the environmental impacts of developing some areas. For example, two CREZ areas found to be especially sensitive by environmentalists, wildlife agencies, and California Energy Commission (CEC) staff were ranked by RETI as having a very low environmental concern.[57] By contrast, a CREZ that is in an already heavily disturbed area with ample transmission, and which was chosen by environmentalists as very suitable for renewable energy development, was given the second to worst environmental ranking by RETI.

Expedited Large-Scale Renewables: Inadequate Environmental Review

Many remote, large-scale renewable power projects have attempted to use the cover of being "renewable" to sidestep adequate environmental review of these projects. This is done using an "expedited" and seriously inadequate environmental review and permitting process.

On October 12, 2009, Secretary of the Interior Ken Salazar and California Governor Arnold Schwarzenegger agreed to what they called "a model of federal-state initiative and cooperation" using expedited review and processing and Recovery Act funding to spur the development of "environmentally appropriate" renewable energy on public lands (under the jurisdiction of the Bureau of Land Management) in California.[58] This cooperation is in line with Salazar's Secretarial Order 3285, which encourages the development of renewable energy and associated transmission lines.[59]

President Obama and Congress have made $41 million available through the American Recovery and Reinvestment Act (ARRA) of 2009 to facilitate what they call a rapid and responsible move to large-scale production of renewables on public lands. ARRA directs economic stimulus funding (including up to 30 percent tax credits or cash grants) to qualified renewable energy projects that begin construction by December 1, 2010.

Under this arrangement, the Department of the Interior and California state agencies will not only expedite the siting, permitting, and processing of renewable energy projects, but they will also develop a timeline that provides these projects with permitting schedules that can meet the recovery act's December 1, 2010 deadline for beginning construction.[60]

Fifteen California solar, wind, and transmission projects on public lands totaling 62,000 acres fall into the fast-track program.[61] The scale of the projects is so large that cumulatively (if not individually) they pose species-level and ecosystem-level threats to California's fragile desert. The large number of projects and their expedited schedules also mean that adequate public review of the associated environmental impact studies is almost impossible.

A number of deficiencies in meeting legal requirements of the California Environmental Quality Act and National Environmental Protection Act have been called out by major environmental organizations. These include the following:[62]

- Inadequate or completely lacking biological surveys
- Failure to adequately assess indirect impacts of the project
- Failure to consider a reasonable range of project alternatives
- Narrow purpose and need statements
- Absence of baseline visual resource analysis
- Inadequate cumulative impacts analysis
- Abuse of overriding considerations
- Deficient underlying planning documents that never contemplated this scale of development and have no relevant guidelines that limit acceptable change

The fast track process places pressure on responsible agencies that are unprepared to consider—within the accelerated time constraints—land conversion of this magnitude, most of it in natural undisturbed desert with high environmental resource values.

> "It is now apparent to us that not even the best of the environmental documents being produced for the fast track projects and/or the best projects should be models or precedents for the future..., we urge the BLM and the Interior Department to acknowledge publicly the deficiencies of the current process and to commit publicly to improving it. More specifically, we urge both entities to affirm that neither the current process, nor any of the project sites, nor any of the environmental documents, establish any legal or procedural precedents for future decision-making, siting or environmental review."[63]

Large-Scale Renewables: Abuse of "Overriding Considerations"

Another twist to environmental review of remote large-scale renewable energy plants is the claim that the role of these plants in reducing greenhouse gas emissions overrides their negative environmental impacts. This approach has been taken by the CEC on several occasions. For example, in the case of the Imperial Valley Solar Project:

> *"The Energy Commission staff believes that the direct project impacts to biological resource, and soil and water resources, and visual resources, and the cumulative impacts associated with biological resources, land use, soil and water resources, and visual resources for the Imperial Valley Solar (IVS) Project will be significant. There is no feasible mitigation that would reduce the impacts to a level that is less than significant given the scale of the project, and other projects that were cumulatively considered. In addition, staff has concluded that the project will not be able to comply with Imperial County several laws, ordinances, regulations and standards, also referred to as "LORS." Finally, staff recognizes that due to a lack of information regarding the long-term performance of this new technology, it is uncertain whether the applicant's claims regarding reliability will be met."*[64]

While noting multiple unmitigated environmental impacts, the CEC staff nevertheless goes on to conclude:

> *"Notwithstanding the unmitigable impacts, consideration needs to be given to the fact that the project is a solar power plant that will help California meet its renewable portfolio standard (RPS) of 33 percent in 2020 and AB 32 greenhouse gas emission reduction goals. As such, it will provide critical environmental benefits by helping the state reduce its greenhouse gas emissions, and these positive attributes must be weighed against the project's adverse impacts. It is because of these benefits and the concerns regarding the adverse impacts that global warming will have upon the state and our environment, including desert ecosystems, that staff believes it would be appropriate for the Commission to approve the project based on a finding of overriding considerations…"*[65]

The basis for this position (and an almost identical finding for the Ivanpah power plant[66]) appears to be quite subjective. Claiming to meet general—and admittedly important—public goals, the responsible agency apparently did not perform a thorough analysis of the potential benefits compared to the potential harm.

A relatively small (14-megawatt) desert solar PV project at Nellis Air Force Base covers 140 acres and makes use of 72,000 PV panels that track the position of the sun.

Large central-station desert solar projects result in many forms of environmental destruction. They destroy habitat, kill and displace wildlife, threaten endangered species, and permanently disfigure desert landscapes, Large-scale solar projects proposed for the California desert would result in the destruction of 1,200 square miles of desert land (the size of the state of Rhode Island).*

****http://www.usnews.com/science/articles/2010/01/03/solar-showdown-in-calif-tortoises-desert-home.html***

Photo Credit: Sirusthedruid

For example, researchers at the University of Nevada, Las Vegas have been monitoring CO_2 uptake in Mojave Desert ecosystems for the past seven years and have consistently found substantial uptake, processing, and sequestration of carbon, rivaling or exceeding that of some forested and grassland ecosystems.[67] In short, the desert is a greenhouse gas sink.

Also, sulfur hexafluoride (SF_6) is one of six greenhouse gases regulated by the EPA and the most potent, with a global warming potential 23,900 that of CO_2. One pound of SF_6 has the same global warming impact as eleven tons of CO_2.[68] It has a half-life of 3,200 years, and nothing sequesters it. Its global concentration increased seven percent each year from 1980 to 1999, quadrupling in concentration.[69]

The most common use for SF_6 is as an electrical insulator in high voltage equipment that transmits and distributes electricity. Since the 1950s the U.S. electric power industry has used SF_6 widely in circuit breakers, gas-insulated substations, and other switchgear used in transmission lines to manage the high voltages carried between generating stations and customer load centers. The electric power industry uses roughly 80 percent of all SF_6 produced worldwide. Ideally, none of this gas should be emitted into the atmosphere. In reality, according to the EPA, significant leaks occur from aging equipment, and gas losses occur during equipment maintenance and servicing.[70]

The sequestration of carbon by the desert and the global warming impact of SF_6 are indications that construction and operation of remote power plants and transmission lines could be a significant source of greenhouse gas emissions. Without a comprehensive life-cycle greenhouse gas assessment, the CEC's claims that desert power plants "provide critical environmental benefits" (see previous page) are unfounded. In the name of generalized goals, the CEC is failing to take the required "hard look" at the real project impacts. Likewise, it is failing to consider the required reasonable range of project alternatives.[71]

In cases like the Imperial Valley Solar Project and the Ivanpah power plant, where significant environmental damage cannot be mitigated, the law requires consideration of feasible alternatives that provide the same greenhouse gas reduction benefits without these projects' severe adverse impacts. Decentralized generation is exactly that alternative.

Decentralized Generation Can Be Brought On Line Quickly

Because decentralized generation is relatively small-scale and often installed in urban areas, there is no need for vast land acquisition, complicated financing arrangements, new transmission lines, exposure to litigation, or other risks associated with remote large-scale projects. Decentralized generation can therefore be installed in months rather than years, speeding up the conversion to renewable energy and its associated greenhouse gas reductions.

The potential for speedy deployment and growth of decentralized generation is demonstrated by the rapid expansion of photovoltaic installation in Germany, which has enacted policies to encourage the development of renewable energy. As a result of these policies, as shown in Figure 8, the amount of installed photovoltaic capacity rose from virtually nothing in year 2000, to 2,000 megawatts in 2005, to nearly 10,000 megawatts in 2010.[72] Eighty percent of this capacity is installed on rooftops.[73]

The comparison with the U.S. and Japan in Figure 8 shows how government policy can greatly affect the deployment speed of decentralized electric generation, and can achieve rapid results in just a few years.

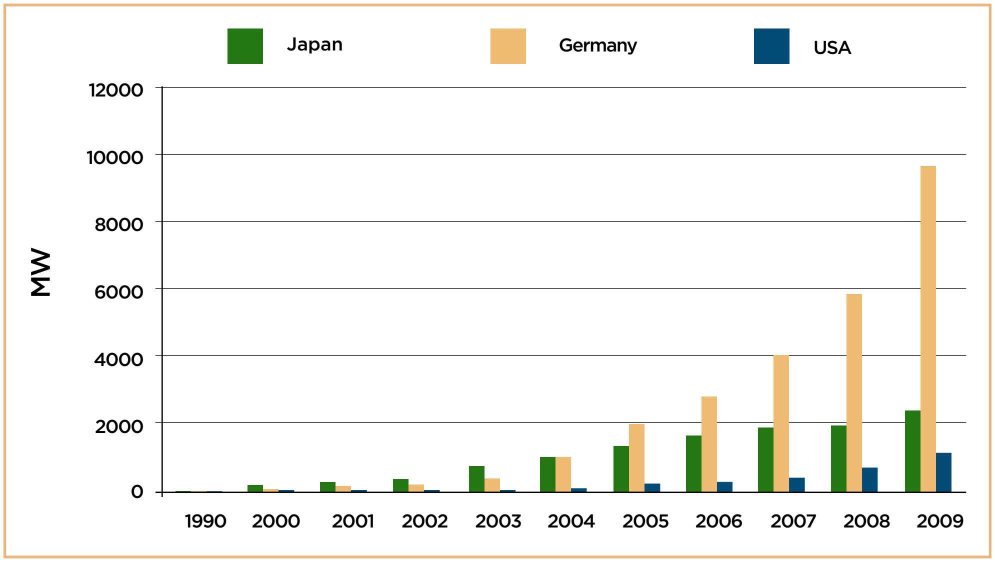


Figure 8:

Installed Photovoltaic Capacity in Germany Compared to the U.S. and Japan

In the case of California, there are substantial barriers to the approval of decentralized generation proposals, not the least of which is the high cost of making such proposals given that the state's utilities reject most of them. Even for large renewable energy projects the rejection rate is stunning: out of 139,000 MWh/yr proposed in 2007 and 2008, only 9 MWh/yr (roughly six percent) were accepted by the utilities for California Public Utilities Commission (CPUC) approval.[74]

In citing the quick project development timelines associated with "small to medium scale renewable generation (<10 megawatts) that is interconnected to the utility's distribution system," the CPUC states that this is "a valuable market segment that is not well served by the state's existing renewable energy policies and programs."[75]

Nevertheless, decentralized solar PV generation in California has been quickly expanding in recent years. Between the California Solar Initiative (3,000 megawatts), the urban rooftop projects of two California utilities (800 megawatts), two existing feed-in tariff programs (1,750 megawatts), and other smaller programs, California will add approximately 5,650 megawatts of solar PV capacity by 2016.[76]

In contrast to the rapid development potential of decentralized generation, remote central-station renewable plants can take up to 10 years to come on line. The longest delay is the time required to develop transmission lines when they are needed. In this regard, the CPUC estimates that meeting California's 33 percent RPS Reference Case by 2020 (using central-station power plants) would require building eleven new transmission lines at a cost of approximately $16 billion.[77]

The CPUC comments that, "Because of its longer development horizon, transmission is nearly always the critical path item in the development of [renewable generation resources in a contained geographic area]."[78] In addition, the CPUC assumes an additional two and a half year delay between transmission line completion and full generation build-out.

Typically, transmission lines require a multi-year planning and construction cycle. For example, according to a timeline tool used by the CPUC for planning the 33 percent renewables program, development of new transmission from planning to completed construction is assumed to range from 4.25 to 8.5 years (51 to 102 months).[79] This excludes construction of renewable generation that would not even begin until completion of transmission was reasonably assured.

There are a number of reasons to expect that the CPUC transmission timeline may be too short. Environmental challenges, regulatory delays, financial barriers, or litigation can significantly extend this period. Some in the electric power industry think that 8 to 10 years is a more realistic timeframe for developing a transmission project, as shown in Figure 9.

Recognizing the relatively long timelines required to bring remote central-station power on line, Southern California Edison (SCE) stated in its March 2008 application to build a local decentralized 500 megawatt urban PV project, “Because these installations will interconnect at the distribution level, they can be brought on line relatively quickly without the need to plan, permit, and construct the transmission lines.”[80]

This perspective was repeated and expanded upon in the CPUC’s June 18, 2009 press release regarding approval of the SCE project:

> *“Added Commissioner John A. Bohn, author of the decision, “This decision is a major step forward in diversifying the mix of renewable resources in California and spurring the development of a new market niche for large scale rooftop solar applications.* ***Unlike other generation resources, these projects can get built quickly*** *[emphasis added]… and without the need for expensive new transmission lines. And since they are built on existing structures, these projects are extremely benign from an environmental standpoint, with neither land use, water, nor air emission impacts.”*[81]

The CPUC made a similar observation with its approval of a Pacific Gas and Electric (PG&E) distributed PV project in April 2010. The 500-megawatt project will ramp up at a rate of 100 megawatts per year: According to CPUC President Michael Peevey, “[Distributed generation] projects can avoid many of the pitfalls that have plagued larger renewable projects in California, including permitting and transmission challenges.”[82]

The SCE and PG&E projects will provide 1,000 megawatts of renewable energy within the next several years, as compared to remote central-station power projects, most of which, might not come on line before 2020, if construction depends upon building new transmission lines that have not yet received approval by regulators.

Figure 9:

Minimum Timeline for Transmission Build-out[83]

ID	Task Name	Duration	Start	End	2006	2008	2010	2012	2014	2016	2018	2020
1	Generic Timeline	126 mons	9/1/09	4/29/19								
2	RFO Process for Generation Resources	20 mons	9/1/09	3/14/11								
3	Interconnection Queue	25 mons	9/1/09	8/1/11								
4	System Impact Studies to Generator Financial Commitment	13 mons	9/1/09	8/30/10								
5	Develop Transmission Plan for Buildout and Upgrades	12 mons	8/31/10	8/1/11								
6	Prepare PEA/CPCN	24 mons	8/2/11	6/3/13								
7	CEQA/NEPA Review	30 mons	6/4/13	9/21/15								
8	CPUC or CEC Decision Process	5 mons	9/22/15	2/8/16								
9	Transmission Line Final Design & Construction	42 mons	2/9/16	4/29/19								
10	Generation and Tie Lines to Renewable Resources	42 mons	2/9/16	4/29/19								
11	Supply Chain Time Requirement	0 days	4/29/19	4/29/19								4/29/19

A transmission substation in the Imperial Valley, California.

The transmission lines upon which new remote renewable power plants depend, typically take at least ten years to build. By contrast, decentralized generation of power near population centers requires no new transmission lines and can be brought on line relatively quickly.

Photo Credit: Craig Deutsche

Decentralized Generation Provides Increased Energy Security

Because decentralized generation would be deployed throughout many urban and suburban areas, there is less risk of a disruption of the decentralized power supply, as compared to an equivalent amount of centralized remote generation and the associated transmission lines, which are subject to single points of failure. If designed to do so, decentralized generation can provide backup power for emergencies and natural disasters. In addition, the distribution of energy sources provides for improved grid stability and resilience as individual sources come on line or are shut down.

Several distributed storage technologies are available to complement the power production profiles of solar and wind power sources. Some of these storage solutions afford additional electric grid benefits in stabilizing voltage and frequency, relieving transmission congestion, and providing additional reserve capacity.[84]

Decentralized generation can pose challenges for grid operators as the number of generating sources increases. Better management of distribution networks is required, but work in this direction is already taking place in building the first elements of the Smart Grid.[85]

Beyond these considerations, the greatest threat to energy security is not technological in nature. Remember back to 2000-2002:

> *"As a result of the false scarcity of electricity and the rising prices created by Enron, people throughout the West encountered rolling blackouts—the first in California since World War II—and high electricity bills that many could not afford to pay. The blackouts closed down schools and businesses and threatened the health of the young, elderly, and infirm, who lost access to electricity and air-conditioning as temperatures exceeded 100 degrees Fahrenheit. Across the West, businesses closed down because their owners were unable to pay their energy bills, tens of thousands of people lost their jobs, California alone lost tens of billions of dollars, and the state's two largest public utilities declared bankruptcy. In 1999 Californians paid $7.4 billion for wholesale electricity; one year later, these costs rose 277 percent to $27.1 billion."*[86]

Following its filing for bankruptcy in 2001, California's largest utility, Pacific Gas and Electric (PG&E) was granted two rounds of ratepayer bailouts that amounted to a total of $16 billion. By the time PG&E's bankruptcy related debts are paid off in 2012, the utility's 5 million ratepayers will each have shelled out around $1,500 to keep the company from collapsing.[87]

This history shows that protection from market manipulations, artificial energy shortages, blackouts, and inflated prices is one of the important benefits afforded by decentralized electric generation.

OBSTACLES TO DECENTRALIZED GENERATION

It would seem self-evident that solar and wind energy, which by their nature are geographically distributed, would be perfect candidates for locally produced electricity. How could it make economic sense to take solar energy, for example, from the desert and ship it hundreds of miles through transmission lines (in the form of electricity) to bring it to where it already exists in plentitude? It would be like bottling air in Topeka and shipping it to Monterey for breathing.

One might argue that solar radiation in the desert is more intense than in other parts of California, but this 10 to 15 percent resource advantage is typically dissipated by electrical power loss of 7.5 to 14 percent over hundreds of miles of transmission and distribution lines. Or one might argue that lower cost technologies for capturing solar energy are only feasible in the desert; but that is not the case, as has been pointed out in the earlier sections of this paper.

Why is it, then, that decentralized generation is marginalized in California while remote central-station solar projects, and the new, expensive transmission lines needed to deliver their electricity, are receiving most of the attention of state regulatory and planning agencies?

The reasons are not principally technical. They stem from entrenched economic interests and the influence they have over state agencies and energy policy.

> **"The greatest barriers to the expanded use of distributed renewable energy systems in the United States stem not from technical obstacles, but from financial, political and social hurdles."**
>
> *Network for New Energy Choices, Taking the Red Tape out of Green Power*[88]

Emphasis on Natural Gas

Over the last eight years, California's investor-owned utility (IOU) companies[89] have failed to increase the percentage of renewable energy sources in their energy mix sufficiently to meet the targets mandated by state law. In 2002, California put into law a requirement (the Renewables Portfolio Standard) that these utilities add a minimum of one percent renewables each year to their electricity sales, until a target of 20 percent was achieved by 2010 (the original date of 2017 was advanced to 2010).

Figure 10 shows that for most of the period beginning in 2002 while energy sales were increasing, the percentage met by renewables actually declined.[90]

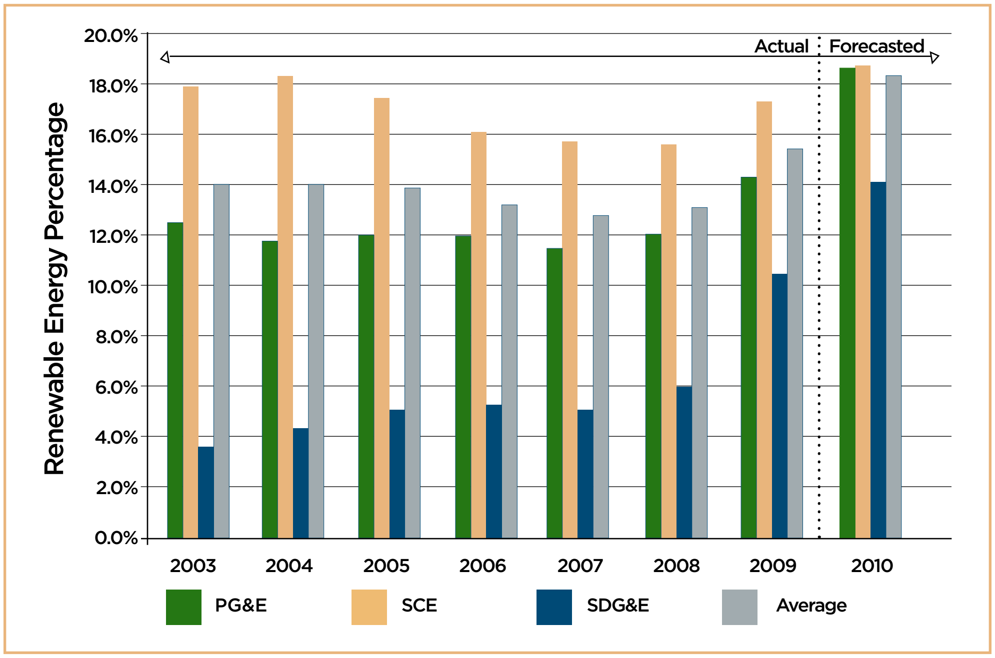


Figure 10:

Progress toward California's Renewable Energy Goals[91]

The 2,560-megawatt Moss Landing natural gas powered electric generating plant near Monterey, California. The units with the tall stacks are newer 540-megawatt combined-cycle generators. The plant's older, less efficient units are only operated during the peak period between June and September. The plant releases upwards of a million tons of greenhouse gases per year.

Despite having a generating capacity that exceeds 2009 peak demand by 40 percent, PG&E is still procuring new gas-fired power plants. The latest argument for this procurement is that fossil fuel plants are needed to back up renewable generation during off-peak hours. Using this line of reasoning, utilities suggest that the more renewable energy is installed, the more fossil fuel energy is needed!

Photo Credit: mythlady

The failure of utilities to significantly increase the percentage of renewables is directly tied to the expansion of natural gas plants during this same period of time. As the state's utility companies slipped year-after-year on meeting renewable energy targets, there was a spree of construction and major investment in new natural gas electric generation in California, beginning in 1999 and costing billions of dollars. While 7,500 megawatts of old natural gas plant capacity had been retired by 2008, over 18,000 of new capacity has been built, or will be built, by the end of 2010.[92]

State agencies allow procurement and licensure of natural gas power plants even when these plants are not needed and their operation would violate environmental protection laws. As recently as May 2010, the California Public Utilities Commission (CPUC) approved a PG&E permit for a 760-megawatt Marsh Landing Generating Station in Contra Costa County, even though PG&E already had generating capacity 44 percent higher than its service territory's peak summer demand in 2009. The proposed plant is in an area that houses the majority of the Bay Area's power generation, whose air quality is in the worst ten percentile in the nation, and which has higher than average rates of cancer and asthma and other adverse health effects associated with poor air quality.[93] To make matters worse, the California Energy Commission (CEC) is attempting to expedite the licensing of this plant.

Add to this situation the fact that state regulators have not imposed any monetary penalties on the IOUs, despite their failure to meet their renewable energy targets year after year. In fact, the state is utilizing the "escape clauses" in the legislation and allowing the 20 percent requirement to slip to 2013.

Preference for New Transmission Lines

Despite the many advantages of decentralized generation as outlined in the first section of this paper, decentralized generation is widely under-appreciated. Following the lead of the state's investor-owned utilities (IOUs) and large capital investors, state agencies have approved heavily-capitalized renewable power plants in the desert.

A number of factors are at play, not the least of which, according to energy expert Bill Powers, is the question of new transmission lines:

> *"The IOUs have a strong financial incentive to see new transmission built to transmit renewable energy instead of phasing-out fossil power capacity agreements on existing lines to accommodate new renewable energy generation. The primary mechanism available to an IOU to increase its revenue stream is the construction of new*

infrastructure in the form of power plants, transmission lines, and meters. Transmission projects are typically the most lucrative projects an IOU can build, with a guaranteed rate of return to the IOU in the range of 11 to 12 percent. The costs of IOU transmission projects are borne collectively by all California IOU ratepayers."[94]

Over the past 10 years (1999-2009), as shown in Figure 11, the California IOU transmission rate base—the amount of transmission investment recovered at a guaranteed profit from ratepayers—has increased 84 percent, at a cost of $5 billion. By contrast, in that same time period, growth in energy demand (energy load) has only been about 9 percent.[95]

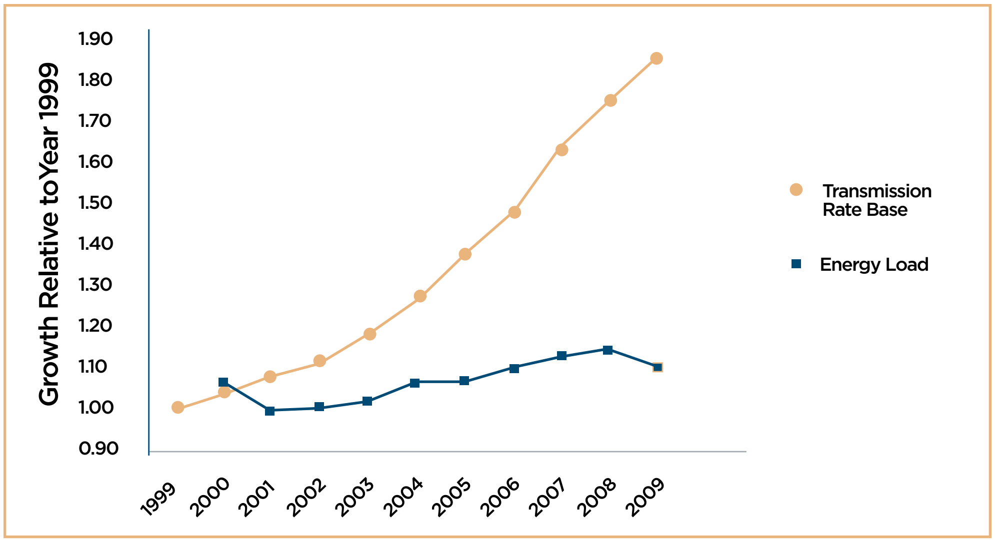


Figure 11:

Transmission Rate-Base Growth Compared to Energy Load Growth

Jaleh Firooz, a licensed electrical engineer in California with 30 years of utility project management experience, explains how new transmission becomes the driving force for large-scale remote renewables:

"When transmission additions cannot be justified based on a comparison of economic benefits to the costs of the transmission, project proponents have found other creative ways to justify their projects. 'Access' to renewable generation is a driving factor behind many of the recent transmission initiatives in California and elsewhere."[96]

The effort by utilities and renewable project developers to justify new transmission lines was reflected in the creation of the Renewable Energy Transmission Initiative (RETI) as a special initiative of the CEC. RETI's goal is to identify new transmission projects needed for development of renewable energy projects in remote Competitive Renewable Energy Zones (CREZs). In projecting the need for new transmission lines, RETI makes calculations of how much new renewable energy—requiring new transmission lines—is needed to meet California's 33 percent renewables requirement by 2020.

In making these (RETI net short) calculations, RETI has made three assumptions that increase the apparent need for transmission to meet the state's renewable energy target in 2020:

- Excluding goals in the Scoping Plan for California's Global Warming Solutions Act (AB 32) and California Energy Commission analyses[97] regarding home retrofitting and other energy saving measures, as well as for residential/commercial solar energy and combined heat and power technologies.

- Minimizing the amount of decentralized renewable generation that will be in place by 2020.

High voltage transmission lines south of Dagget, California in the Mojave Desert. These 500,000-volt lines carry power from remote power plants to substations near urban centers, where the voltage is stepped down to the distribution system.

California agencies propose building eleven new transmission lines at a cost of about $16 billion to meet the state's 2020 renewable energy targets. Utilities get a guaranteed rate of return on such investments, whether the lines are utilized or not.

Photo Credit: Craig Deutsche

- Ignoring the effect of freed-up transmission capacity that will result from reduced fossil fuel generation that will occur by meeting state clean energy requirements. For example, the L.A. Department of Water and Power contract for 475 megawatts of coal power from Navajo Generation Station expires in 2019 and, because of a state law that limits greenhouse gas emissions from coal, the contract cannot be renewed.[98] Reduced reliance on fossil fuel generation as renewables are scaled up will free up transmission capacity, and reduce the need for new transmission lines.

By inadequately considering the above factors, which reduce the need for new transmission, RETI has estimated that about 53,000 GWh/year of renewable energy needed to meet California's goal of 33 percent renewables by 2020 will require new transmission lines. A report by RETI's own consultant indicates that the freed-up transmission capacity from reduced fossil fuel generation would reduce this value to 26,000 GWh/year. Furthermore, in a scenario which uses conservative forecasts for the three factors above, the same consultant estimates that there would actually be an excess transmission capacity of 8.000 GWh/year.[99]

The combination of AB 32 energy efficiency measures, new decentralized generation capacity, tradable renewable energy credits,[100] and reduced fossil fuel generation could therefore result in surplus transmission capacity by 2020, at least for the purpose of meeting the 33 percent renewables target.

A study for the California Public Utilities Commission (CPUC) by Black & Veatch[101] shows that under a low decentralized generation scenario, 14 new transmission lines would be needed, as shown in Figure 12 below.

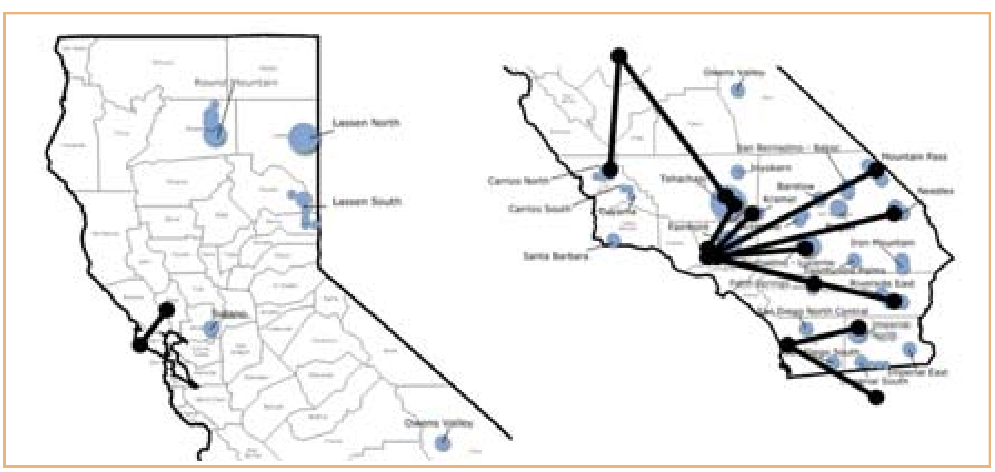


Figure 12:

New Transmission Lines by 2020 in a Low Decentralized Generation Scenario

However, according to this study, under a high decentralized generation scenario, only four new transmission lines would be needed, as shown in Figure 13 (including one that has already been approved by the CPUC—the Sunrise Power Link near San Diego, which is being litigated by environmental groups).

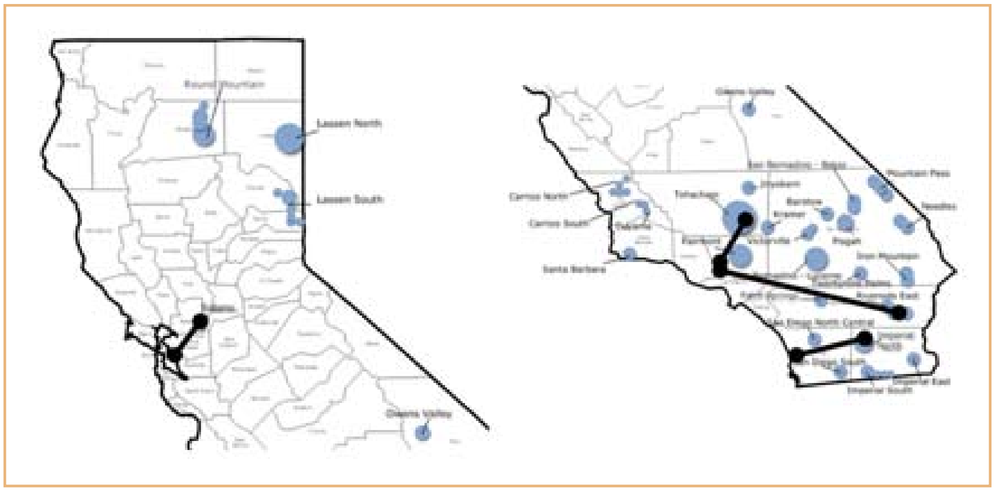


Figure 13:

New Transmission Lines by 2020 in a High Decentralized Generation Scenario

Because of the freeing up of existing transmission line capacity by 2020 through the retirement of old fossil fuel contracts and power plants as well as the use of renewable energy credits to meet the Renewables Portfolio Standard requirements, it is likely that the RETI net short (new transmission needed) could be less than zero, meaning that by 2020 California could have overall excess transmission line capacity for renewable energy sources without constructing any new transmission lines.

As noted by Bill Powers, the impact of spending on transmission lines instead of on decentralized generation is stark:

> *"If it is conservatively assumed that only 10,000 megawatts of new high voltage transmission will be built by 2020 to realize the RETI net short target of 68,000 GWh[102], the estimated cost of this transmission will be in the range of $20 billion in 2008 dollars based on SDG&E's projections for the Sunrise Powerlink. How much thin-film PV located at IOU substations or at the point-of-use on commercial buildings or parking lots could the IOUs purchase for this same $20 billion? … This equals an installed thin-film PV capacity of 14,000 to 18,000 megawatts for a $20 billion investment."*[103]

A solar PV capacity of 14,000 to 18,000 megawatts is equivalent to 28,000 to 36,000 GWh/year electrical energy production, which would fulfill a major part of the renewables net short estimates of the Sierra Club (40,000 to 47,000 GWh/year) and recent estimates of state energy agencies (45,000 to 65,000 GWh/year).

Despite the diminishing validity of arguments in favor of new transmission capacity, the IOUs and big power plant developers continue to press for new transmission line construction.

The Legacy Model of Big Power

Another factor at play—besides the priority afforded natural gas and new transmission lines—in creating pressure for centralized rather than decentralized power generation is the legacy model that has dominated electric power production for the last half century. Fossil fuel, nuclear, and hydropower generation have favored large-scale power plants and a transmission and distribution infrastructure appropriate to a central-station generating model. This model is heavily capitalized, with high rates of return on investment. It is an electric power generation model that does not focus on system efficiency, sustainable economic development, the health of urban communities, equity, or social justice.

This model holds strong sway within California's state energy agencies, where public interest groups simply do not have the resources to compete with the utilities and other large vested energy interests that promote this legacy model.[104]

The influence of this model is also seen in the significant public subsidies provided to large remote central-station power projects:

- Federal loans: The federal government provides enormous loans to private, for-profit consortiums. For example, in February 2010, it was announced that BrightSource Energy's 400-megawatt Ivanpah solar thermal project in the Mojave Desert received a $1.37 billion loan "guarantee" from the Department of Energy.[105] The loan will be provided by the U.S. Treasury's Federal Financing Bank, a division of the Treasury Department, and "guaranteed" by the Department of Energy[106] BrightSource investors include BP, Chevron, Morgan Stanley, and Google. This is one of fifteen such loan "guarantees" amounting to $6 billion earmarked for large-scale renewable projects in 2010.

- Federal grants: The American reinvestment and Recovery Act (ARRA) is providing cash grants equal to 30 percent of project costs to large-scale renewable projects under construction by December 31, 2010. Many of these would otherwise not be competitive.[107]

- State permitting fee waivers: The CEC has waived several million dollars in permit-processing fees for utility-scale solar development projects, with no provision made for reimbursement. In other words, the public is absorbing these permitting costs on behalf of large power plant developers.[108]

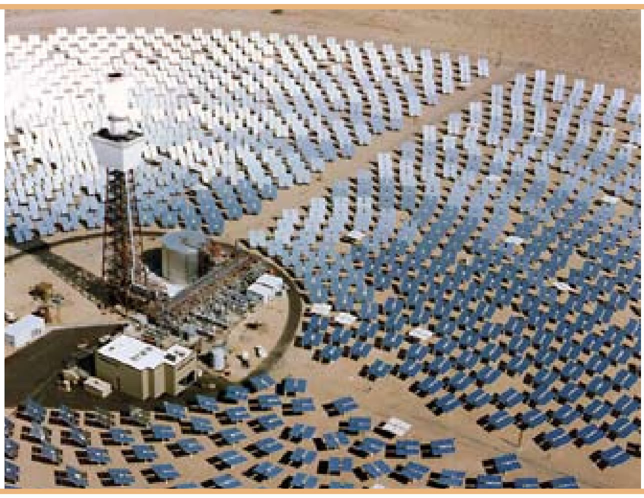
- Externalization of environmental costs: The impact on intact ecosystems and the ecological processes they provide, and their conversion to single use, constitute costs that are passed on to the public. The power plant operators are given an almost free ride on the environmental damage they cause.

These public subsidies to large capital interests present a significant obstacle to decentralized generation by placing it at a distinct economic disadvantage to utility-scale development. Virtually none of the above subsidies are available to or beneficial to community-based power developers.

Overcoming the obstacles to decentralized generation requires a new paradigm. Decentralized power generation offers the possibility of community-scale, renewable power—power that can be locally owned and that can promote local economic development. Local electrical power is a resource that can meet the needs of communities. In this way it presents the possibility of community power in more ways than one.

"In the U.S., community-based, decentralized renewable energy projects are stymied time and again…Americans get centralized renewable energy dominated by corporate owners because our policy favors such developers, not for any inherent economics."

John Farrell, Institute for Local Self Reliance[109]



A 10-megawatt demonstration solar thermal power plant similar in design to the 400-megawatt Ivanpah solar plant planned in the Mojave Desert in San Bernadino County, California. Solar rays are focused on a central tower by mirrors (heliostats) that track the position of the sun. The tower converts the concentrated solar power to electricity.

The Ivanpah plant, proposed by Brightsource Energy, would incorporate seven towers and 214, 000 heliostats and occupy 4,073 acres of public land. The proposal has received fast-track processing and $1.37 billion in federally guaranteed loans. The principal investors include Chevron, BP, Morgan Stanley, and Google.

Photo Credit: Sandia National Laboratory

IMPLEMENTING DECENTRALIZED GENERATION

Implementing decentralized generation will take a multi-faceted effort to overcome the institutional obstacles described in the previous section of this paper. To succeed, it must involve municipal governments, local businesses, working people, communities of color, homeowners, and others in a collective struggle to democratize electric power and use this vital resource for local economic development.

There are three main energy policy legs upon which this effort stands: Community Choice energy, effective feed-in tariff programs, and accountability to public interests from regulatory agencies.

Community Choice Energy

Community Choice energy, provided for in California Community Choice Aggregation legislation in 2002 (AB 117), allows a city, or county, or a combination of these in an invester-owned utility (IOU) service area to combine the electricity demand of all customers in its jurisdiction, and contract with a commercial service provider to purchase electric power on their behalf. The IOU is nevertheless required to deliver the power to customers over its wires, and provide standard services such as line maintenance, meter reading, and billing.

Community Choice is in part a response to the failed deregulation program in California and the market manipulation that precipitated electrical energy chaos in the state ten years ago. The wide interest in Community Choice among cities and counties across the state is due to their desire to provide more renewable energy and better priced electricity than is offered by the IOUs. This is especially the case in light of the IOUs' failures to meet the state's 20 percent renewable energy target for 2010 and the rate hikes that follow increased natural gas prices. To date, Marin County is the only entity in California to successfully establish a Community Choice program (Marin Clean Energy) against the determined efforts of Pacific Gas and Electric (PG&E) to block such initiatives. Other Community Choice programs have been operating for years serving several million people in Ohio, Massachusetts, and Rhode Island.

Community Choice programs offer the potential for more than simply purchasing greener power on an open market. Community Choice can be a community development enabler. A Community Choice program can promote local decentralized generation as a source of renewable power. Using revenues from utility bills, the program can invest in locally generated electricity, energy efficiency retrofit programs (which reduce ratepayer bills), and in urban developments that reduce greenhouse gases and stimulate green jobs.

Because the Community Choice programs are local, decisions about rate structures and investments can be made democratically, with all sectors and communities represented. Under Community Choice, an IOU provides electrical services, but does not make decisions about community electricity resources. As one example, the public goods charge on electricity mandated by the state to pay for energy efficiency programs is currently administered by the IOUs. How much of these funds are used in specific neighborhoods and for what purposes, is not readily available. Hence there is limited accountability to the public of the public goods charge. Under Community Choice law, local jurisdictions can petition the CPUC to be administrators of their fair share of these funds.

As a public non-profit entity, a Community Choice program does not need to provide private shareholder dividends or outlandish executive salaries, and can use revenue bonds to invest in energy projects at reduced costs of capital. A

> **"Now is the time for Energy Democracy. Its goal is to create community-owned or controlled renewable energy and to invest that capacity with democratic principles that foster interdependence, conservation, wealth-building, political autonomy, and economic opportunity. This vision of Energy Democracy has the power to transform neglected and isolated communities, often poor, often communities of color, into energy generators able to add power to the grid [and] meet the energy needs of their own communities…"**
>
> *Center for Social Inclusion, Energy Democracy: Community-scale Green Energy Solutions*[110]

San Francisco Supervisor Ross Mirkarimi speaks at demonstration protesting Prop 16 on March 17, 2010 outside California Public Utilities Commission headquarters.

Prop 16 was paid for solely by PG&E and was meant to quash Community Choice energy programs and strengthen PG&E's energy monopoly. Protestors objected to the CPUC's granting free rein to PG&E to use ratepayer funds for such political purposes. Despite being outspent 500 to 1 by PG&E, clean energy advocates defeated the proposition in the June 2010 election.

Photo Credit: Local Clean Energy Alliance

Community Choice program is in an ideal position to promote and develop local power resources.

Community Choice is structured so as not to threaten the fundamental profit structure of the state's IOUs, whose profits—under a system called "decoupling"—are only determined by the assets they own and are not affected by the sales volume of electricity. Nevertheless, not all utilities view Community Choice in a positive light, as demonstrated by PG&E's determined efforts to block all such initiatives.

Community Choice provides a new paradigm in which energy becomes a democratically controlled resource developed and used by a local community, rather than a commodity brokered by an IOU for the benefit of its shareholders.

Feed-In Tariff (FIT) Programs

One of the largest barriers to expansion of renewable energy is regulatory, pricing, and contract policies that make development of renewable energy problematic. As a result, California's IOUs are not even close to meeting the state-mandated 20 percent renewable energy requirement by 2010.

Even though IOUs sign many renewable energy contracts, most of these projects fail to move forward, whether or not they obtain regulatory approval. As of October 2009, the California Public Utilities Commission had approved 129 contracts that would contribute 10,271 megawatts of installed capacity toward the state's renewable energy goal.[111] Yet little actually has been built.

The IOUs are in the position of being able to arbitrarily pick from among the renewable energy contracts they have signed and to choose those that provide the most favorable financial advantages for the IOUs, primarily in the form of new infrastructure and transmission projects.

What is needed to promote decentralized generation are price structures and policies that require IOUs and publicly-owned utilities to purchase wholesale renewable energy at standard, competitive rates, rather than through individually negotiated contracts. These standard-offer contracts and their associated rates are referred to as feed-in tariffs: prices established by law for energy fed into the electricity distribution grid.

In June 2009, the U.C. Berkeley Center for Law, Energy & the Environment and the UCLA Environmental Law Center studied the immediate and longer-term actions that government leaders, private industry, and public agencies must take to address the barriers to promoting widespread decentralized generation on large buildings and other local spaces. The key finding was that "*policy makers must expand and improve ... feed-in tariff incentive programs* [emphasis in original]."[112]

"[The feed-in tariff] not only allows for development big and small, but it also means governments don't need big budget incentive programs or subsidized financing. Renewable energy development costs are borne by ratepayers, and those costs are minimal."

John Farrell, Institute for Local Self Reliance[113]

At least 50 countries and 25 states and provinces have adopted feed-in tariffs,[114] and they have proven to be highly successful. An analysis by a European Union commission found that feed-in tariffs achieve greater growth in renewable energy, at a lower cost, than other policy approaches.[115]

In just seven years from 2000 to 2007, using feed-in tariffs, Germany's share of electricity from renewable energy more than doubled, from 6.3 to 14.2 percent, making Germany the world leader in installed capacity for solar PV and wind. Germany installed ten times more wind in 2008 than California.

In March 2009, the local public utility in Gainesville, Florida implemented feed-in tariffs for solar PV. Ten days after the offering was announced, its Web site reported: "We have already received enough completed applications to reach our 2009 and 2010 target of 4 megawatts each." In less than ten days, Gainesville achieved its goal for 2009 and 2010.

Based on the experience in countries such as Germany, Denmark and Spain, and independent research, a well-constructed feed-in tariff program will have the following characteristics:

- Contracts are standardized and "must take."
- Contracts are long term—20 years or more.
- Grid interconnect is guaranteed for all projects meeting defined objective standards.
- Payment rates are based upon the costs of each renewable technology plus a reasonable profit.[116]
- Payment rates are set for each technology type and project size.
- Payments may also be differentiated by resource levels to widen participation and control costs.
- Payment rates are periodically adjusted up or down for new contracts based on changing cost and market conditions.
- Different payment rates are set for profit-making entities that enjoy tax incentives and for non-profit entities that don't.
- The tariffs have no arbitrary caps or have high caps.
- Government, rather than investor-owned utilities, sets the required price and contract terms.
- The tariffs apply to all investor-owned utilities.
- Local publicly-owned utilities design and administer their own programs.
- The program does not have significantly adverse effects on low-income consumers.

A 743-kilowatt solar PV system installed at an air conditioning distributor company in City of Industry, California. Using only a portion of the available rooftop area, this system brought the owner's electricity bill down to zero.

A feed-in tariff program would encourage investment in a larger system—one that could supply excess energy to the grid at an attractive price. Note the significant commercial rooftop area available for solar PV power generation on nearby buildings.

Photo Credit: Kahn Solar

A feed-in tariff with the above characteristics is simple, stable, and fair. It can broaden participation in decentralized generation by allowing non-taxable entities—cities, counties, states, cooperatives, nonprofits—or those with little tax liability to pursue renewable energy projects. Most current incentives are in the form of tax credits, which are only valuable to individuals or businesses with sufficient tax liability, reducing the pool of potential renewable energy investors and dollars. Compared to the byzantine array of incentives and rules governing renewable energy, a feed-in tariff decreases the economic and legal costs of doing business and increases the social and economic benefits.[117]

In addition, a feed-in tariff policy can be designed to encourage public or cooperative ownership of decentralized generation. For example, the feed-in tariff program in Ontario, Canada, provides a bonus of up to $.015/kWh for projects with a minimum of 10 percent community or Aboriginal (Native American) investment.[118]

California is far short of creating an economic climate for massive, equitable growth of renewable energy, in general, or decentralized generation, in particular.[119] Feed-in tariff legislation is currently stalled in the California Assembly, while the California Public Utilities Commission is implementing feed-in tariffs with weak pricing methods and restrictive program caps set by law. The Los Angeles Business Council has called for the City of Los Angeles to create the largest feed-in tariff program in America, adopting a policy that would generate 600 megawatts of electricity within ten years. This program, which would meet only three percent of the city's energy needs, would nevertheless create about 11,000 local green jobs, and produce some long-term cost-savings for the Los Angeles public power utility.[120]

Clearly a more aggressive statewide approach is needed.

The California FIT (Feed-In Tariff) Coalition is proposing statewide feed-in tariff legislation, the Renewable Energy and Economic Stimulus Act (REESA). According to a recent study, the feed-in tariff program being proposed would stimulate the development of wholesale decentralized solar PV generation, resulting in three times the number of new jobs from 2011-2020 than is forecast for the two 33 percent Renewables Portfolio Standard scenarios developed by the California Air Resources Board (CARB). The study projects an additional 28,000 direct jobs per year and 27,000 indirect and induced jobs per year over this time period, as compared to the CARB scenarios.[121]

An effective, comprehensive, feed-in tariff program in support of decentralized generation, both for wholesale and for residential/commercial customer use—tariff rates based on cost plus reasonable rate of return and spanning zero to 20 megawatts—would be the fastest way to accelerate renewable energy development in California.

A 78-kilowatt solar PV system in El Jebel, Colorado owned by the Clean Energy Collective, a group of 18 customers of the local utility. The Collective purchased the 340-panel system and signed a 50-year power purchase agreement with the utility. The system is located on disturbed land leased from the local wastewater treatment plant.

A feed-in tariff program can broaden participation in energy investment by providing private, public, and cooperative investors a guaranteed rate of return on investments in local renewable power production. Such a guarantee is similar to that offered to large utility companies.

Photo Credit: Clean Energy Collective

Demanding Accountability to Public Interests from State Agencies

The economic stability provided by an effective statewide feed-in tariff program combined with the local control afforded by a Community Choice program can transform decentralized generation into a driving force for the revitalization of urban communities.

However, these policies, as beneficial as they might be at the local level, need support at the state level to have significant impact.

Community Choice legislation has already been enacted at the state level, and at this point needs local governments to follow Marin County's lead and actually design and implement their own effective programs. Feed-in tariffs need to be enacted at the state and local public utility levels. Getting there will require organizing different constituencies that have a stake in community revitalization, especially given the powerful economic interests that have a stake in maintaining the status quo.

The effort to achieve such policies will need to engage state regulatory agencies. As this paper has shown, state agencies play a key role in the formulation and implementation of California energy policies. Their actions will strongly affect the success or failure of Community Choice and feed-in tariff programs.

Some critics have argued that these agencies have been too accommodating to the IOUs and cite instances where utility interests get priority over the public interest. This includes implicit acceptance of economic and business approaches that mainly serve industry interests,[122] and works to the detriment of many California communities, especially low income communities and communities of color.

Decentralized generation—advanced through Community Choice and a statewide feed-in tariff program—requires the support of state agencies. These agencies perform long-term energy planning, regulate energy efficiency programs and standards, approve power plant licensing, set rate structures for utilities, implement renewable energy standards, enforce (or fail to enforce) state law, and so forth. (An overview of their jurisdictional authorities is provided in Appendix B.) These agencies are key to successful implementation of decentralized generation.

For the most part, communities have not mounted enough pressure on these agencies to support decentralized generation. If there is going to be a shift of policy and action, communities must ensure that state agencies become a real vehicle for economic and social progress. The time has come to demand accountability to public interests from state energy agencies.

CONCLUSIONS

This paper explains why local, decentralized generation of electricity, among the electric generation options available for meeting California's clean energy mandates, offers the greatest potential benefits while minimizing environmental degradation and other societal costs. It makes the case for giving decentralized generation a major role in achieving a state-mandated 33 percent Renewables Portfolio Standard by 2020.

Decentralized generation is not only cost-effective and feasible, but has the potential to stimulate local/regional economic development, create clean energy jobs, and help revitalize local communities. In addition, decentralized generation minimizes environmental degradation and maximizes energy security. By eliminating licensing delays it can expedite the transition to renewable energy sources needed to reduce greenhouse gas emissions that cause global warming and ocean acidification.

Despite the advantages that decentralized generation offers, there is significant opposition to its development from entrenched economic interests. Utilities and project developers push for capital-intensive renewable energy development in remote areas and new transmission lines, and they believe that long-term profits depend on continuing this economic model. However, remote, centralized energy supply pulls economic resources out of urban and even many rural communities. For local communities to prosper, the flow of economic resources must be reversed or redirected.

In the effort to democratize energy so that communities relate to energy in a qualitatively different way—as a vital local resource—a few energy policies are key. Community Choice energy and feed-in tariff programs can—if properly designed and implemented—provide the local ownership, control, and economic stability needed by communities to develop their energy resources. These energy resources, in turn, provide the financial resources to meet local community needs. Support from state and local government, including state energy agencies, is needed to give needed impetus to these policies and help promote effective program design for their successful implementation.

APPENDIX A:
Cost Effectiveness of Decentralized Solar PV

Electricity from decentralized solar PV generation is now more cost-effective than remote central-station solar energy sources due to substantial reduction in the price of solar PV panels[122] over the last couple of years and the substantial transmission cost to move remote solar power to the point where it is used. Data from a number of sources is presented in this appendix to compare the cost of energy from decentralized solar PV to that of remote solar sources and demonstrate the cost advantage of a decentralized solar PV strategy.

Data: Decentralized Solar PV

In general, the cost of energy from a solar PV system depends on several factors: gross capital cost, financing terms including loan interest rate and solar tax credits, the output of the system compared to its rated capacity (which depends on the solar intensity of the site), and ongoing operations and maintenance costs.

Capital Costs of Solar PV Installations

The capital cost of a solar PV system includes the cost of solar panels, inverter(s) which convert direct current electricity produced by the panels to alternating current for delivery to the grid, wiring and junction boxes, labor to install the system, and permitting fees. Table 3 summarizes current solar PV capital costs from a number of sources for commercial rooftop PV systems in the one- to two-megawatt size range. Table 3 provides current capital cost data for 20-megawatt distributed ground-mounted PV systems.

Tables 3 and 4 show capital costs in both dollars per watt$_{dc}$, reflecting the direct current (dc) peak output power of a PV panel, and dollars per watt$_{ac}$, reflecting the usable power supplied to the grid after conversion to alternating current (ac). Sources of capital costs provide data in one or the other of these units. In Table 3 and 4, the units of the PV pricing from the referenced source are shown in bold.

Table 3:

Solar PV Capital Costs for 1-megawatt Systems

Data Source	Capital Cost ($/W$_{dc}$)	Capital Cost ($/W$_{ac}$)
Southern California Edison, 2008: for 500 MW project consisting of 1 to 2-megawatt rooftop PV systems (PV technology not specified)[124]	**3.50**	4.38
U. S. Department of Energy, 2010: for commercial rooftop (thin-film PV)[125]	**3.59**	4.49
U. S. Department of Energy, 2010: commercial rooftop (polycrystalline PV)[126]	**4.04**	5.05
San Diego Gas and Electric, September 2010: for 100-megawatt project consisting of mostly 1to 2-megawatt PV systems (PV technology not specified)[127]	**3.50**	4.38
Black & Veatch, June 2010: selectively filtered analysis of 2010 California Solar Initiative applications for 1-megawatt rooftop systems (fixed-tilt polycrystalline PV)[128]	**5.00**	6.25

Table 4:

Solar PV Capital Costs for 20-megawatt Systems

Source	Capital Cost ($\$/W_{dc}$)	Capital Cost ($\$/W_{ac}$)
Black and Veatch, May 2010: for the Renewable Energy Transmission Initiative (RETI), Phase 2B (fixed tilt, thin-film PV):[129]	3.04	**3.80**
U. S. Department of Energy, 2010: (fixed-tilt, thin-film PV)[130]	**2.80**	3.50
Black & Veatch, June 2010: for the California Public Utilities Commission (CPUC) ground-mounted (fixed-tilt PV)[131]	**3.70**	4.63

To allow for consistent comparisons, all data has been converted to dollars per $watt_{ac}$ using an average 80 percent power conversion factor (since the efficiency in converting solar PV direct current to alternating current is 77 to 85 percent).[132] When converting from $watt_{ac}$ to $watt_{dc}$, the inverse of this conversion factor was used.

Several trends in the data presented in Tables 3 and 4 are worth highlighting. The first is that 1-megawatt systems are in the range of 20 to 25 percent more expensive than the larger 20-megawatt systems. The second is that the June 2010 Black & Veatch data in Table 3 shows significantly higher PV capital costs than other sources. The third is that Black & Veatch data in Table 4 shows a nearly $\$1.00/W_{ac}$ jump (22 percent) in capital cost for the same 20-megawatt system between the value provided in May 2010 for the Renewable Energy Transmission Initiative ($\$3.80/W_{ac}$) and the value Black & Veatch provided in June 2010 for the California Public Utilities Commission ($\$4.63/W_{ac}$).

Decentralized Solar PV Cost of Energy

Current information about the cost of energy for decentralized solar PV in California is available from three sources.

- A July 2010 study performed by the Luskin Center at University of California Los Angeles (UCLA), on behalf of the Los Angeles Business Council, provides a cost of energy analysis of decentralized solar PV generation in the Los Angeles basin.[133] The essential data is shown in Table 5, where values in the last column represent the current price points at which, according to the study, tens of thousands of megawatts of profitable solar PV power would be installed.

Table 5:

Cost of Energy for Decentralized Solar PV in Los Angeles Basin

Category	Description	Total Capacity (MWh)	Energy Price Point ($/MWh)
Small rooftop	Installations of less than 50 kilowatts on single family homes, small office and retail buildings, and apartment buildings	100	340
Large rooftop	Installations of greater than 50 kilowatts on warehouses, distribution facilities, and light manufacturing/industrial structures	300	220
Ground-mounted	Large systems installed for optimal efficiency and cost-effectiveness	200	160

This data represents an up-to-date analysis of costs of solar PV energy using categories of locally-based power that are representative of an urban/suburban California metropolitan area. The price points are based on an analysis of recent PV capital costs for California Solar Initiative projects and modeled PV pricing projections.

• A June 2010 study conducted by Energy and Environmental Economics, Inc. (E3) on behalf of the California Public Utilities Commission[134] provides cost of energy for potential decentralized solar PV projects in California. These projects are broken down by capacity and by configuration[135] for the various geographical regions of California. The summary results are shown in Figure 14.

Figure 14 shows the levelized cost of energy for 0.5 to 2-megawatt commercial rooftop installations to be significantly higher than that for 0.5 to 20-megawatt ground-mounted installations. The E3 costs of energy projections were based on the June 2010 capital costs provided by Black & Veatch shown in the last rows of Table 3 and Table 4. As previously noted, these costs are much higher than PV costs identified in other evaluations, especially for rooftop PV.[136]

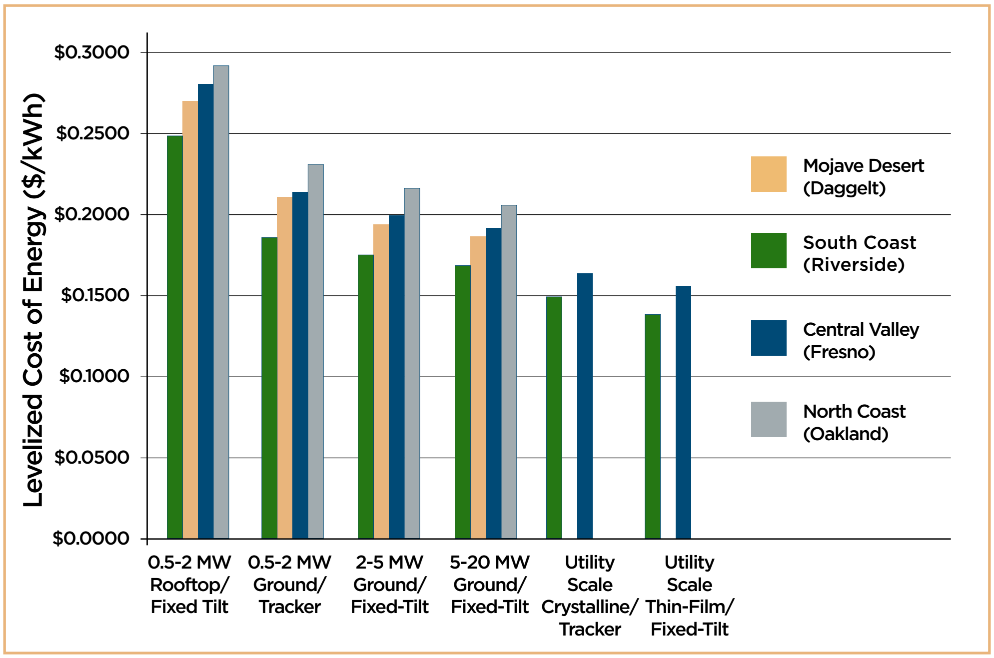


Figure 14:

E3 Cost of Energy Estimates for Decentralized Solar PV in California[137]

Also, it is worthy of note that the variation in PV cost of energy between different California regions is relatively small, amounting to less than 10 percent variance from the South Coast region. Also, the values for remote utility-scale generation systems (150 megawatts) are artificially low because they do not include cost penalties associated with new transmission lines or transmission line losses.

• A September 2010 decision in which the CPUC adopted a 100-megawatt solar PV program for San Diego Gas & Electric Company (SDG&E) as part of a broader effort to promote renewable generation in California. The adopted program authorizes 26 megawatts of utility-owned generation and 74 megawatts of power purchase agreements with independent power producers. The projects are to be primarily 1–2 megawatts, but projects of up to 5 megawatts also allowed with some restrictions. The CPUC authorized SDG&E to spend up to $100 million for capital costs based on $3.50/W and adopted a cost cap of $235/MWh for the power purchase agreements under the program.

Data: Remote Renewable Energy

The overall cost of energy for remote solar power generation and transmission is calculated by summing the cost of energy generation of the solar power plant and the cost associated with the new transmission line or transmission line upgrade necessary to move that solar power to users in coastal urban centers. These cost elements are discussed in the following paragraphs.

Cost of Electricity Generation

The California Renewable Energy Transmission Initiative (RETI) has published estimates of the cost of energy, in dollars per megawatt-hour, or $/MWh, from solar thermal, solar PV, wind, geothermal, and other remote utility-scale renewable energy projects being considered for California.[138] This data is shown in Figure 2 on page 12. This is part of a state-funded effort to identify and evaluate competitive renewable energy zones and to identify the transmission projects needed to move the electricity from these zones to population centers. The May 2010 RETI cost of energy projections for solar thermal and solar PV are used in this study to estimate the cost of energy of the solar component of California's current utility reference strategy for meeting its 33 percent by 2020 renewable energy target.

Transmission Line Cost Penalties

To compare locally-based decentralized generation with remote utility-scale generation, it is necessary to estimate the cost of building new transmission lines or of upgrading existing transmission lines to accommodate new remote sources of renewable power. Transmission costs also include the cost of electrical power losses in the transmission and distribution system, estimated by the California Public Utilities Commission (CPUC) as averaging 7.5 percent in California.[139] The combined cost of transmission line infrastructure and transmission losses constitutes a cost penalty for remote renewable generation that plays a decisive role in the relative cost competitiveness of remote utility-scale solar power and local distributed solar PV.

A June 2009 CPUC preliminary assessment[140] of incremental costs to reach 33 percent renewable energy by 2020 is used as the reference to estimate the cost of new transmission lines to serve remote solar generating plants. The CPUC assessment projects a new transmission penalty of $1.27 billion per year to transmit 36,870,000 megawatt-hours per year (MWh/year) of new remote renewable resources by 2020. This is equivalent to a cost of $34.45/MWh for energy going over the lines. However, the transmission capital expense is assumed to be paid off over 40 years, while renewable generation cost is amortized over 20 years. To level the investment cost recovery period between generation and transmission projects and therefore allow an "apples-to-apples" annualized cost comparison, the new transmission costs can be adjusted to a 20-year amortization, resulting in a transmission penalty of $46.34/MWh.[141]

California renewable energy studies to date have assumed that generation is paid for over 20 years and transmission is paid for over 40 years. The cost recovery period is unrelated to how many years either the generation asset or transmission line will actually operate. Use of a 40-year cost recovery period for transmission and a 20-year cost recovery period for generation in the California studies creates the impression of relatively low transmission costs.

However, as is shown in Table 6, the total lifecycle cost of a 20-year cost recovery period is much lower than the lifecycle cost of a 40-year cost recovery period. The 40-year transmission cost recovery period increases the lifecycle cost $17 billion—from $34 billion to $50.8 billion in real dollars—compared to a 20-year cost recovery period.

Table 6:

Energy Cost of New Transmission Amortized over 20 Years and 40 Years

Financing Term	Energy Transmitted per Year	New Transmission Cost per Unit of Energy	Annual New Transmission Cost	Lifecycle Capital Cost of New Transmission
40 years	36,870,000 MWh	$34.45/MWh	$1.27 billion	$50.8 billion
20 years	36,870,000 MWh	$46.34/MWh	$1.70 billion	$34.0 billion

The average new transmission penalty of $46.34/MWh applies to the CPUC reference case scenario for achieving California's 33 percent by 2020 renewable energy target. In practice, individual transmission line cost will vary considerably, from $15/MWh to more than $55/MWh,[142] depending on the length and technical complexity of specific lines, and how much power will be delivered over the line. However, the larger point is that new transmission adds significantly to the cost of energy from renewable energy sources that require new transmission lines. Conversely, energy sources that do not require new transmission lines have a significant economic advantage over energy sources that do.

Decentralized Solar PV Compared to Remote Solar Generation

Table 7 on page 50 presents cost of energy data for decentralized solar PV and for remote utility-scale solar. The decentralized solar PV data in Row 1 is from the UCLA Los Angeles study (Table 5) the data in Row 2 represents the CPUC's cost of energy cap for the SDG&E program, and the data in Row 3 is from the E3 California study (Figure 14).

The remote utility-scale solar data in Table 7 consists of the solar component of the 33 percent reference cases of the CPUC and California Air Resources Board (CARB), Row 4 and Row 5, respectively. The reference cases are composite cost of energy values that reflect the percentage of solar thermal and solar PV energy production in these two reference case scenarios. RETI data for solar PV and solar thermal, on which the composite scenarios are based, are shown in Row 6 and Row 7, respectively,

The decentralized solar PV cost projections in Table 7 do not require adjustment for new transmission cost, as decentralized solar PV power is generated at or near the point-of-use and generally does not require high voltage transmission lines. However, the cost of generation for remote renewable sources must be adjusted for new transmission line cost unless these resources can take advantage of underutilized existing transmission capacity. For comparative cost estimate purposes in Table 7, the transmission cost penalty is based on a 20-year cost recovery to normalize it to the 20-year cost recovery period assumed for solar generation plants. An average cost penalty of 5 percent is also included to account for power losses that will occur from the point of generation to the transmission substation where the power is reduced in voltage for delivery to customers along the lower voltage distribution system.[143]

Bars are superimposed on Table 7 to provide a visual indicator of the relative cost of energy of the distributed solar PV scenarios and remote utility-scale solar scenarios.

Table 7:

Cost of Energy Comparison: Decentralized PV Generation Compared to Remote Solar Generation[144]

Scenario	Cost of Generation range and average ($/MWh)	Transmission Penalty ($/MWh)	Total Cost of Energy ($/MWh)
Los Angeles Decentralized Solar PV[145]	160 to 340 Avg: 220	N/A	220
CPUC San Diego Decentralized Solar PV[146]	up to 235	N/A	235
E3 California Decentralized Solar PV[147]	168 to 290 Avg: 248	N/A	248
CPUC 33% Reference Case: solar component[148]	70% solar thermal, 30% solar PV 0.7 (268) + 0.3 (230)		257
CARB 33% Reference Case: solar component[149]	80% solar thermal, 20% solar PV 0.8 (268) + 0.2 (230)		260
RETI Remote Solar PV[150]	135 to 214 Avg: 175	New lines: 46 Line losses (5%): 9	230
RETI Remote Solar Thermal[151]	195 to 226 Avg: 211	New lines: 46 Line losses (5%): 11	268

$100/MWh $200/MWh $300/MWh

Table 7 shows, that within the limits of the data, decentralized solar PV is clearly cost-effective with respect to the solar component of the CPUC and CARB reference case strategies for achieving 33 percent renewable energy target by 2020. The heavy reliance on expensive solar thermal projects in the CPUC and CARB reference cases—70 percent and 80 percent, respectively—is a major reason the reference case strategies are more costly than the distributed solar PV alternative. Despite the relatively high cost of energy associated with solar thermal projects, ten of the twelve California desert solar projects being fast-tracked by the U.S. Department of the Interior are solar thermal and only two are solar PV.

The Los Angeles study, the CPUC San Diego program cap, and the E3 California study all show decentralized solar PV to be more cost-effective than the CPUC or CARB solar composites. The relatively large cost of energy for the E3 California study is an artifact of the high capital costs E3 is using compared to other capital cost evaluations, as previously noted, especially in the case of rooftop solar PV (where E3 capital costs are roughly 40 percent higher than other evaluations). With a downward adjustment in capital costs, the E3 California study would show decentralized solar PV costs to be even more competitive with the CPUC and CARB reference cases.

A further indication of the cost competitiveness of decentralized solar PV is the CPUC's adoption of a cost of energy cap of $235/MWh for decentralized solar PV approved for the SDG&E program. The $235/MWh value lies about half way between the values of the Los Angeles study ($220/MWh) and the E3 California study ($248/MWh) shown in Table 7.

As the capital costs of solar PV continue to drop, transmission line costs appear to be inexorably rising. Take, for example, the 1,000-megawatt Sunrise Powerlink transmission line proposed by San Diego Gas & Electric (SDG&E). The high cost of this line will result in an additional renewable energy transmission penalty in the range of $100/MWh.[152] It is the additional cost of new transmission that makes decentralized solar PV cost-superior to remote central-station solar power. The combination of rising transmission costs with falling solar PV capital costs, will make decentralized solar PV even more cost-competitive in the future.[153]

APPENDIX B:
California State Energy Agencies and Initiatives

The following table describes the California state energy agencies and initiatives that relate to this policy paper.

Agency	Description
California Energy Commission (CEC)	The state's leading energy policy agency. It also collects data, forecasts energy needs, licenses thermal power plants over 50 megawatts, sets appliance and building efficiency standards, supports energy research, provides incentives for renewable energy projects, and will have a role in enforcing the renewable energy requirements.
Renewable Energy Transmission Initiative (RETI)	A statewide planning process to identify and evaluate renewable energy resource zones and the transmission projects needed to accommodate the state's renewable energy goals. RETI is based on the premise that these goals "will require extensive improvements to California's electric transmission infrastructure."[154]
California Public Utilities Commission (CPUC)	The state agency that regulates the three investor-owned electric utilities (IOUs) that serve over two-thirds of electricity demand of California. Activity areas include: • Long Term Procurement Plan (LTPP) that determines utility resource needs • Approval of utility rates, contracts, and project costs • Implementation of the Renewables Portfolio Standard (RPS) • Oversight and planning for energy efficiency programs. • Environmental review for transmission lines The CPUC in 2009 developed a High Distributed Generation case to analyze implementation of the 33 percent renewables requirement. This case assumes limited need for new transmission, and relies on many modest-scale solar plants (10 to 20 megawatts) connected to the distribution system near substations on the assumption that "Dramatic cost reductions in solar PV could make a solar DG strategy cost-competitive with central station renewable generation."[155]
Renewable Distributed Energy Collaborative (Re-DEC)	A project formed by the CPUC to identify challenges and solutions to high penetration of decentralized generation into the electricity distribution system. Re-DEC focuses on wholesale renewable projects up to 20 megawatts.
California Independent Systems Operator (CAISO)	A quasi-governmental agency that manages the California electricity grid to ensure safe and reliable operation. Although utilities own transmission lines, the CAISO ensures equal access to these lines in accordance with federal law. The CAISO is the link between power plants that sell power on the wholesale market, and the utilities that resell that electricity to customers; it matches the demand for electricity with the amount of power generation. It acts as a clearinghouse for nearly 30,000 market transactions every day.
California Air Resources Board (CARB)	A part of the California Environmental Protection Agency, CARB sets and enforces air quality standards. CARB wrote the AB 32 Scoping Plan that describes actions and requirements for reducing California's greenhouse gas (GHG) emissions; the Plan establishes targets for energy efficiency, combined heat and power, and renewable energy. CARB has defined two scenarios for meeting the 2020 33 percent Renewables Portfolio Standard requirement.

APPENDIX C:
Calculation of the Renewables Net Short
(The amount of new renewables needed to reach the 33 percent target by 2020)

Row #	Quantity	Energy (GWh) Full AB 32 Implementation	Energy (GWh) Partial AB 32 Implementation
1	Total Energy Demand for 2020 This is a projection of demand by the California Energy Commission prior to energy efficiency savings from utility programs after 2012.	**341,778**	**341,778**
2	AB 32 Energy-Efficiency Measures[156] This line subtracts energy efficiency savings that are called for in the California Air Resources Board AB 32 Scoping Plan (full or partial).	- 22,304	- 16,267
3	Private Solar PV Electric Generation[157] This line subtracts solar energy generated by customers for their own use, promoted by the California Solar Initiative and other programs through 2020.	- 5,103	- 5,103
4	Private Combined Heat and Power Electric Generation This line subtracts electricity generated by customers for their own use from existing combined heat and power systems.	- 11,677	- 11,677
5	AB 32 Combined Heat and Power[158] This line subtracts additional combined heat and power electric generation not included in Line 4, but called for in the AB 32 Scoping Plan (full or partial).	- 30,000	- 14,031
6	Line Losses and Non-Utility Sales This line subtracts 7.6 percent of electricity that is lost in the wires and 13,556 GWh used for pumping water, none of which are part of utility electricity sales.	-34,826	-36,543
7	Utility Consumer Sales for 2020 This is the consumer energy demand after energy efficiency savings, private generation, power line losses, and non-utility sales are subtracted.	**237,868**	**258,157**
8	Renewable Energy Sales Target This is 33 percent of the Utility Sales for 2020 shown in line 7; actual amount may be smaller due to small utilities that are exempt from state renewables portfolio standard requirement.	78,496	85,192
9	Existing Renewable Energy Sales Electricity sales from existing renewable resources according to the Renewable Energy Transmission Initiative (RETI) as of 2010.	- 38 174	- 38,174
10	Renewables Net Short This is the new additional renewable energy needed to meet California's 33 percent renewables requirement in 2020.	**40,322**	**47,018**

END NOTES

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[5] This chart reflects the projected increase in demand, the energy efficiency savings, and the renewable energy needed to meet California targets by 2020, based on California agency sources, as represented in Appendix C.

[6] John Farrell, "Europe Leads on Decentralized Renewables, but Lags on Effective Building Retrofits," September 13, 2010: http://www.boell.org/web/index-653.html.

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[13] This analysis of California Solar Initiative data by Robert Freehling excludes projects costing less than \$3.00/Watt_{dc} as well as canceled, suspended, and withdrawn projects.

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[32] James Russell, *op.cit.*

[33] *Ibid.*

[34] Schreiber, D., EuPD Research, *op.cit.*, page 17.

Navigant gives the most pessimistic estimates of 10,000 megawatts production capacity with 6000 megawatts of demand, with a surplus of 4000 megawatts capacity.

[35] Schreiber, D., EuPD Research, *op.cit*.

[36] J. Matthew Roney, Earth Policy Institute, S*olar Cell Production Climbs to Another Record in 2009*, September 21, 2010: http://www.earth-policy.org/index.php?/indicators/C47/.

[37] B. Murphy, Fulcrum Technologies, Inc., *The Power and Potential of CdTe (thin-film) PV*, presented at 2nd Thin-Film Summit, San Francisco, December 1-2, 2009.

[38] Schreiber, D., EuPD Research, *op.cit*., page 13.

[39] John Farrell and David Morris, Institute for Local Self-Reliance (ILSR), *Energy Self-Reliant States: Second and Expanded Edition*, October 2009, page 8: http://www.newrules.org/energy/publications/energy-selfreliant-states-second-and-expanded-edition. California electrical consumption in 2007 was 302, 000 GWh: http://www.energyalmanac.ca.gov/electricity/system_power/2007_total_system_power.html.

[40] *RETI Phase 2B Final Report,* May 2010, Table 1-1, page 1-3: http://www.energy.ca.gov/2010publications/RETI-1000-2010-002/RETI-1000-2010-002-F.PDF

Table 1-1 identifies 11,000 megawatts of wind capacity.

[41] Dora Yen-Nakafuji, *California Wind Resources,* Draft Staff Paper, May 2005, CEC 500-2005-071-D: http://www.energy.ca.gov/2005publications/CEC-500-2005-071/CEC-500-2005-071-D.PDF.

[42] BMU, *Development of Renewable Energy Resources in Germany 2009*, BMU –KI III 1, March 2010, page 5: http://www.bmu.de/files/pdfs/allgemein/application/pdf/ee_in_deutschland_graf_tab_2009_en.pdf.

[43] David Tokea, Sylvia Breukers, Maarten Wolsink, “Wind Power Deployment Outcomes: How Can We Account for the Differences?” *Renewable and Sustainable Energy Reviews*, 12 (2008), page 1140.

[44] Paul Gipe, private communication.

[45] This calculation assumes an installed capacity of about 2,000 megawatts per year of solar PV at a capital cost of $5.00 per watt, and producing electricity at a 20 percent capacity factor.

[46] This calculation is based on the following illustrative mix of distributed energy sources:

Distributed Generation Portfolio for Meeting California's 33% Renewables Portfolio Standard.

Category	Annual Install MW	Capacity MW	Capacity Factor	Electricity Generation GWh	Unit Cost per KW	Total Cost
Solar PV	1000	10,000	20%	17,520	$5,000	$50,000,000,000
Wind	400	4,000	24%	8,410	$2,200	$8,800,000,000
Biofuel	170	1,700	80%	11,914	$5,000	$8,500,000,000
Totals	1570	15,700		37,843		$67,300,000,000

[47] Center for Social Inclusion, *Energy Democracy: Community-scale Green Energy Solutions*, page 20: http://www.centerforsocialinclusion.org/publications/wp-content/plugins/publications/uploads/Energy_Democracy_Report_%28WEB%29.pdf.

[48] Jim Bell and Heather Honea, *Electricity Supply and Price Security in San Diego County*, August 2007, page 16: http://www.jimbell.com/mayor/Final%20Draft%20August%202007.pdf.

[49] *Ibid.*

[50] John Farrell and David Morris, *Rural Power: Community-Scaled Renewable Energy and Rural Economic Development,* August 2008, page 22: http://www.newrules.org/sites/newrules.org/files/ruralpower.pdf.

[51] E Lantz and S. Tegan, National Renewable Energy Lab, *Economic Development Impacts of Wind Projects*, May 2009, page iii: http://www.nrel.gov/docs/fy09osti/45555.pdf.

[52] John Farrell, The New Rules Project, *Community Solar Power: Obstacles and Opportunities*, September 2010, page 22: http://www.newrules.org/sites/newrules.org/files/communitysolarpower.pdf.

[53] Strela Cervas, private communication, September 2010.

[54] Alliance for Responsible Energy Policy, "The Better Way," *Desert Report*, December 2008, page 22: http://www.desertreport.org/wp-content/uploads/2008/12/DR_Winter2008.pdf.

[55] Renewable Energy Transmission Initiative, *Mission Statement:* http://www.energy.ca.gov/reti/Mission_Statement.pdf

[56] California/Nevada Desert Energy Committee of the Sierra Club, Desert Protective Council, Mojave Desert Land Trust, The Wildlands Conservancy, Western Watersheds Project, and National Parks Conservation Association, Letter to California Energy Commission Regarding RETI Phase 1B Report, November 19, 2008, page 4: http://www.energy.ca.gov/reti/documents/phase1B/comments/2008-11-19_Several_Enviro_Groups-Taylor.pdf.

[57] One CREZ ranked by RETI as being environmentally benign is the one in which the controversial Ivanpah solar thermal power plant is being sited. This plant will destroy about 4,000 acres of pristine desert considered by the latest Nature Conservancy Ecoregion Assessment to be a "core" ecosystem area.

[58] Basin and Range Watch, *Salazar Plans to Espedite Renewables on California Desert*, October 12, 2009: http://www.basinandrangewatch.org/FastTrackRenewable.html.

[59] The approach appears to be similar to the encouragement of off-shore oil drilling. Salazar and the Interior Department are being sued by the Center for Biological Diversity for ignoring marine-mammal protection laws when approving offshore drilling operations in the Gulf of Mexico. Since Salazar took office, the Department of the Interior has approved three lease sales, more than 100 seismic surveys, and more than 300 drilling operations without permits required by the Marine Mammal Protection Act and the Endangered Species Act that are designed to protect endangered whales and other marine mammals from harmful offshore oil activities. "Under Salazar's watch, the Department of the Interior has treated the Gulf of Mexico as a sacrifice area where laws are ignored and wildlife protection takes a backseat to oil-company profits," said Miyoko Sakashita, oceans director for the Center. http://www.biologicaldiversity.org/news/press_releases/2010/marine-mammals-05-14-2010.html.

[60] *Memorandum of Understanding between the State of California and the Department of the Interior on Renewable Energy,* October 12, 2009: http://www.doi.gov/documents/CAMOUsigned.pdf.

[61] Bureau of Land Management, *Fast-Track Renewable Energy Projects:* http://www.blm.gov/ca/st/en/fo/cdd/alternative_energy/fast-trackfastfacts.html.

[62] Joan Taylor, Sierra Club California/Nevada Desert Committee, provided this analysis in a private communication.

[63] NRDC, Sierra Club et al, *Comments on Chevron Energy Solutions Lucerne Valley Solar Project*, May 2010.

[64] California Energy Commission Staff, *Staff's Comments Regarding a Possible Energy Commission Finding of Overriding Considerations – Imperial Valley Solar Project (08-AFC-5),* July 27, 2010: http://faultline.org/images/uploads/TN_57759_07-27-10_Staffs_Comments_to_Override_Considerations.pdf.

[65] *Ibid.*

[66] California Energy Commission Staff Staff, *Staff's Comments Regarding a Possible Energy Commission Finding of Overriding Considerations – Ivanpah solar electric Generating System (07-AFC-5)*, March 10, 2010: http://www.energy.ca.gov/sitingcases/ivanpah/documents/2010-03-16_Staff_Comments_Possible_Energy_Commission_Finding_of_Overriding_Considerations_TN-55921.pdf

[67] Richard Stone, "Have Desert Researchers Discovered a Hidden Loop in the Carbon Cycle?" *Science,* June 16, 2008: http://www.allianceforresponsibleenergypolicy.com/CarbonCyclereport.pdf.

[68] U.S. EPA, *SF_6 Emission Reduction Partnership for Electric Power Systems*: http://www.epa.gov/electricpower-sf6/basic.html

[69] U.S. EPA, *High GWP Gases and Climate Change*: http://www.epa.gov/highgwp/scientific.html#sf6

[70] U.S. EPA, SF_6...*Loc.cit.*

[71] *Where renewable energy production in the desert becomes a necessity, the critical considerations are the following: to avoid biologically and culturally sensitive areas; to develop sources that have a minimal footprint for the amount of energy produced; and for land-intensive development such as solar and wind, to use sites in the desert where energy development would have minimal impact, such as disturbed lands near existing roads and transmission corridors.*

[72] Hans Joseph Fell, *Feed in Tariffs German Experience*, July 2010, page 12: http://www.pacificenvironment.org/downloads/FitConf_San%20Franzisco%20Fell%20World%20future%20Counsil%20July%20%202010.pdf.

[73] Paul Gipe, *Advanced Renewable Tariffs Getting It Right in North America,* Presentation, July 2010, slide 28: http://www.pacificenvironment.org/downloads/FitConf_Gipe%20San%20Francisco%20Pacific%20Envrionment%20FIT%20July%2012%202010.ppt.

[74] California Public Utilities Commission, *Renewables Portfolio Standard Quarterly Report,* Q4 2009, page 7: http://www.cpuc.ca.gov/NR/rdonlyres/52BFA25E-0D2E-48C0-950C-9C82BFEEF54C/0/FourthQuarter2009RPSLegislativeReportFINAL.pdf.

[75] *Ibid.*, page 9.

[76] Bill Powers, "Today's California Renewable Energy Strategy—Maximize Complexity and Expense." *Natural Gas and Electricity*, 27(2), September 2010, page 25.

[77] California Public Utilities Commission, *33% Renewables Portfolio Standard Implementation Analysis Preliminary Results*, June 2009, page 62: http://docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/102354.PDF

[78] *Ibid.*, page 34.

[79] California Public Utilities Commission, Attachment I: Planning Standards for System Resource Plans—Part II, Long-Term Renewable Resource Planning Standards, June 2010, page 20: http://docs.cpuc.ca.gov/efile/RULINGS/119573.pdf.

[80] Douglas K. Porter, Carol A. Schmid-Frazee, Annette Gilliam, *Application of Southern California Edison Company for Authority to Implement and Recover in Rates the Cost of its Proposed Solar Photovoltaic (PV) Program*, March 27, 2008, page 6: http://docs.cpuc.ca.gov/efile/A/80609.pdf.

[81] California Public Utilities Commission, *CPUC Approves Edison Solar Roof Program*, June 18, 2009: http://docs.cpuc.ca.gov/published/News_release/102580.htm.

[82] California Public Utilities Commission, *CPUC Approves Solar PV Program for PG&E,* April 22, 2010: http://docs.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/116816.htm.

[83] Carl Linvill, Aspen Environmental Group, *33% RPS Balanced Portfolio Timeline Overview*, CPUC 33% Implementation Analysis Working Group Meeting, January 15, 2009, slide 45: Not available on Internet, but referenced in Ethan Elkind, opus cit. page 8: http://cdn.law.ucla.edu/SiteCollectionDocuments/Media%20Press/White%20Paper.pdf.

[84] Jim Eyer and Garth Corey, SANDIA Labs, *Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide,* SANDIA Report SAND2010-0815, February 2010.

[85] It is worth pointing out that these problems are being addressed in Germany, where 16 percent of electrical energy consumed is now from decentralized, renewable energy sources.

[86] Antonia Juhasz, *The Tyranny of Oil,* Harper Collins 2009, page 151.

[87] Yasha Levine, "PG&E's Audacious Plan to Enshrine Its Corporate Energy Monopoly In the California Constitution," *Alternet*, May 18, 2010. http://www.alternet.org/news/146894/pg%26e%27s_audacious_attempt_to_enshrine_its_energy_monopoly_in_the_california_constitution.

[88] Network for New Energy Choices, *Taking the Red Tape out of Green Power,* page 1, September 2008: http://www.newenergychoices.org/uploads/redTape-rep.pdf.

[89] California's IOU companies are Pacific Gas and Electric (PG&E), Southern California Edison (SCE), and San Diego Gas and Electric (SDG&E).

[90] In its first six years, 2003-2008, the RPS program has resulted in 690 megawatts of renewable energy being added in California. This is an average of approximately 115 megawatts per year, which did not keep pace with load growth in California over the same period. 227 megawatts have been added under the RPS program through the first three quarters of 2009, and the CPUC estimates another 107 megawatts will be added in the fourth quarter (Nov 2009 CPUC Q4 RPS Status Report, page 6). This is far short of the amount needed to comply with the state mandate of 20 percent renewables by the end of 2010.

[91] California Public Utilities Commission, *Renewables Portfolio Standard Quarterly Report, Q2* 2010, June 2010, page 3: http://www.cpuc.ca.gov/NR/rdonlyres/66FBACA7-173F-47FF-A5F4-BE8F9D70DD59/0/Q22010RPSReporttotheLegislature.pdf.
The data for 2004 and 2005 in Figure 10 has been verified by the California Energy Commission. Data for 2006 to 2009 is self-reported by the IOUs and has not been verified by the CEC. Data for 2010 is based on utility forecasts and load projections, which are unreliable.

[92] Robert Freehling, Pacific Environment, *Green Opportunity: How California Can Reduce Power Plant Emissions, Protect the Environment, and Save Money,* November 2009, page 8: http://pacificenvironment.org/downloads/PacEnv_GreenOpportunity_final.pdf.

[93] Deborah Behles, et. al., *Pacific Environment's Opening Brief*, CPUC Application 09-09-021, April 14, 2010: http://docs.cpuc.ca.gov/efile/BRIEF/116523.pdf.

[94] Bill Powers, Powers Engineering, *Comments on November 2008 RETI Phase 1B Draft Report,* page 7. http://www.energy.ca.gov/reti/documents/phase1B/comments/2008-11-20_Powers_Engineering.pdf.

[95] Jaleh Firooz, "Transmission in short Supply or Do IOUs Want More Profits?" *Natural Gas & Electricity*, 26(12), July 2010, page 11: http://firoozconsulting.com/files/firooz.pdf.

[96] *Ibid.*

[97] California Energy Commission, "Incremental Impacts of Energy Efficiency Policy Initiatives Relative to the 2009 Integrated Energy Policy Report Adopted Demand Forecast," May 2010, page 43: http://www.energy.ca.gov/2010publications/CEC-200-2010-001/CEC-200-2010-001-CTF.PDF.

[98] Los Angeles Department of Water and Power, *2007 Integrated Resource Plan*, December 2007, pages 20 and A-3: http://www.ladwp.com/ladwp/cms/ladwp010273.pdf.

[99] Renewable Energy Transmission Initiative, *RETI Net Short Update*, DISCUSSION DRAFT – Version 2/22/2010, pages 9; and 10: http://www.energy.ca.gov/reti/steering/2010-02-26_meeting/documents/2010-02-26_Net_Short_Draft.pdf.

[100] Renewable energy credits (RECs) are a mechanism by which utilities can continue to produce fossil fuel power by purchasing credit for someone else's renewable energy. The use of RECs is part of California's RPS law, and because it reduces the need for new renewable generation, it results in a decreased need for new transmission lines.

[101] Ryan Pletka, Black & Veatch, Re-DEC Working Group Meeting, *Summary of PV Potential Assessment in RETI and the 33% Implementation Analysis,* December 9, 2009, see page 39 for the high DG case and page 10 for low DG: http://www.cpuc.ca.gov/NR/rdonlyres/FBB0837D-5FFF-4101-9014-AF92228B9497/0/ReDECWorkshopPresentation1ExistingAnalyses.ppt.

[102] This estimate of the RETI net short is a bit outdated; a more recent figure is the roughly 40,000 to 47,000 GWh/year, calculated by Sierra Club as shown in Appendix C.

[103] Bill Powers, Powers Engineering, *op. cit*., page 7.

This calculation assumed a capital cost of $2.7 to $3.5/We and a 30 percent investment tax credit for capital costs.

[104] An example of this influence is the failure of the California Public Utilities Commission to effectively rein in Pacific Gas & Electricity's efforts to take control over the pace and character of renewable energy development. PG&E's Proposition 16, a state ballot initiative paid for by about $70 million in ratepayer money, had the goal of preventing renewable energy competition from public power agencies by changing the California Constitution. In its Proposition 16 efforts PG&E benefited from the Commission's inadequate response to this misuse of ratepayer funds for political purposes and to PG&E's anti-competitive, deceptive, and (arguably) illegal practices. (Note: Proposition 16 was defeated by a grassroots campaign despite PG&E outspending its opposition by a factor of 700 to 1.)

[105] *Green Energy Reporter,* "BrightSource Gets $1.37 bln DOE Loan Guarantee For Ivanpah Project, Whoa!" February 2010: http://greenenergyreporter.com/2010/02/brightsource-gets-1-37-bln-doe-loan-guarantee-for-ivanpah-project-whow.

[106] David R. Baker, "Fed guarantee helps BrightSource Energy plan," *S.F. Chronicle*, February 23, 2010: http://articles.sfgate.com/2010-02-23/business/17951804_1_renewable-energy-loan-guarantees-california-energy-commission.

[107] Bill Powers, "Today's California Renewable Energy Strategy—Maximize Complexity and Expense." *Natural Gas and Electricity,* 27(2), September 2010, page 23.

See the discussion of fast-tracking remote power plants on page 23.

[108] Jessica Cejnar, "County could establish position on green energy projects," *Desert Dispatch,* April 2010: http://www.desertdispatch.com/news/board-8265-position-energy.html.

[109] John Farrell, "Europe Leads on Decentralized Renewables, but Lags on Effective Building Retrofits," September 13, 2010: http://www.boell.org/web/index-653.html.

[110] Center for Social Inclusion, *Energy Democracy: Community-scale Green Energy Solutions,* page 8: http://www.centerforsocialinclusion.org/publications/wp-content/plugins/publications/uploads/Energy_Democracy_Report_%28WEB%29.pdf.

[111] California Public Utilities Commission, *Q4 RPS Status Report*, November 2009, page 3: http://www.cpuc.ca.gov/NR/rdonlyres/52BFA25E-0D2E-48C0-950C-9C82BFEEF54C/0/FourthQuarter2009RPSLegislativeReportFINAL.pdf.

[112] Ethan N. Elkind, U.C. Berkeley Center for Law, Energy & the Environment and UCLA Environmental Law Center, *In Our Backyard: How to Increase Renewable Energy Production on Big buildings and Other Local Spaces,* December 2009, page 1: http://cdn.law.ucla.edu/SiteCollectionDocuments/Media%20Press/White%20Paper.pdf.

[113] John Farrell, *op. cit.*

[114] REN21. 2010. *Renewables 2010 Global Status Report* (Paris: REN21 Secretariat). Copyright © 2010 Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH. p. 11.

[115] Commission of the European Communities, *The Support of Electricity from Renewable Energy Sources,* January 2008, pages 3 and 6: http://ec.europa.eu/energy/climate_actions/doc/2008_res_working_document_en.pdf.

"*Well adapted* feed-in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity."

[116] Some argue against feed-in tariffs by comparing the proposed cost of new renewable generation to the $0.10 – $0.12//kWh of cheap gas-fired generation from plants built 30 years ago. According to the CPUC, however, a natural gas-fired peaker plant built today would provide electricity for $0.30 – $0.60//kWh . At these prices, solar and other renewables can be very competitive. As natural gas prices continue to rise, renewables offer an increasingly cost-effective alternative in which the cost of fuel is essentially free, with no pollution or carbon emissions produced.

[117] John Farrell, *Feed-in Tariffs in America: Driving the Economy with Renewable Energy Policy that Works*, April 2009, page 14: http://www.newrules.org/sites/newrules.org/files/feed-in%20tariffs%20in%20america.pdf.

[118] Ontario Power Authority, *Renewable Energy Feed-in Tariff Program*: http://fit.powerauthority.on.ca/Page.asp?PageID=122&ContentID=10380&SiteNodeID=1103&BL_ExpandID=260.

[119] Another tariff program called net metering applies to smaller scale residential and commercial customer decentralized generation. Net metering means that the electrical meter runs backwards when a solar installation is producing more energy than is being used on premises, meaning the customer is being credited for excess energy fed into the distribution grid.

Under net metering, residential or commercial property owners get paid at a price less than the retail rate (to be determined by the CPUC) for excess power fed into the grid. Under a feed-in tariff, property owners sell all their power to the grid for a premium price, and buy all their power from the grid at retail rates. For this reason, under net metering (where excess power is purchased at less than retail rates), property owners will normally size solar generating systems to their building's internal use, while under a feed-in tariff (where power is purchased at premium rates), solar systems will be sized to maximize the rate of return. In this case a solar system is an investment, and therefore has a very different impact on the property owners' decisions about the size of the renewable energy facilities that will be installed.

Currently there are many types of limitations on the amount of net metering credit a customer can receive, limiting the incentive to produce more power than can be used directly on the premises.

[120] Los Angeles Business Council, *FIT Fundamentals*: http://www.labusinesscouncil.org/sustainability.php

[121] Max Wei and Daniel M. Kammen, Energy and Resources Group, UC Berkeley, Economic Benefits of a Comprehensive Feed-In Tariff, July 2010: http://www.fitcoalition.com/storage/resources/studies/economic-benefits-of-a-fit/economic_benefits_of_a_comprehensive_feed-in_tariff-july072010.pdf.

[122] One example of this orientation is the California Public Utilities Commission's placing administration of residential and commercial electrical energy efficiency programs in the hands of the IOUs whose primary profits and stock value depend on an expanding base of energy sales. Testimony at CPUC hearings has alleged that there is inadequate public accountability for these programs. Some argue that the CPUC has put the fox in charge of guarding the chicken coop.

[123] PV technology includes thin-film, polycrystalline, and monocrystalline solar panels. Polycrystalline and monocrystalline are more efficient but cost more than thin-film. This cost differential has narrowed in the last year and a half. In addition, panel mounts can be at a fixed angle or tracked to follow the sun.

[124] Southern California Edison, *Solar Photovoltaic (PV) Program Testimony,* March 27, 2008, Table IV-6, page 43: http://www3.sce.com/sscc/law/dis/dbattach6.nsf/0/57E94A444B55904F88257419006065B4/$FILE/A0803015+-+SCE+Solar+Photovoltaic+Program+Testimony.pdf.

[125] U.S. Department of Energy, *DOE Solar Vision Study* – Draft, May 28, 2010, Chapter 4, Figure 4-4, page 7: http://www1.eere.energy.gov/solar/pdfs/svs_chapter_4_photovoltaic.pdf.

[126] *Ibid*.

[127] California Public Utilities Commission, *Decision Adopting a Solar Photovoltaic Program for San Diego Gas and Electric Company,* September 2010: http://docs.cpuc.ca.gov/PUBLISHED/AGENDA_DECISION/122918.htm.

[128] Ryan Pletka, Black & Veatch, *LTPP Solar PV Performance and Cost Estimates*, prepared for CPUC as input to Long-Term Procurement Proceeding, June 18, 2010, slide 14: http://www.cpuc.ca.gov/NR/rdonlyres/A0CBE958-E2C4-4AC7-9D56-3AB4D14D723D/0/BVE3PVAssessment.ppt.

This analysis eliminated projects from the dataset that were felt to have erroneously low cost estimates, but did not apply a similar screen to projects that could have erroneously high cost estimates (they lag behind market prices) or that could have high cost estimates for reasons unrelated to current PV market pricing.

[129] Renewable Energy Transmission Initiative, *RETI Phase 2B Final Report*, May 2010, Figure 4-1, page 4-8: http://www.energy.ca.gov/2010publications/RETI-1000-2010-002/RETI-1000-2010-002-F.PDF.

This report shows a range of \$3.60–\$4.00/W_{ac}; however, a RETI spreadsheet of project data uses the average value of \$3.80/W_{ac} for all thin-film PV projects 20 megawatts and higher: http://www.energy.ca.gov/reti/documents/phase2B/CREZ_name_and_number.xls.

[130] U.S. Department of Energy, *DOE Solar Vision Study* – Draft, May 28, 2010, Chapter 4, Figure 4-4, page 7: http://www1.eere.energy.gov/solar/pdfs/svs_chapter_4_photovoltaic.pdf.

[131] Ryan Pletka, Black &Veatch, *op. cit.*, slides 14 and 16.

The capital cost for 20-megawatt systems was based on a module price of \$1.65/W_{dc} at a time that First Solar was publicly stating a production cost of \$0.76/W_{dc}: http://www.firstsolar.com/Downloads/pdf/FastFacts_PHX_NA.pdf.

[132] Renewable Energy Transmission Initiative, *RETI Phase 1A Final Report,* April 2008, Appendix B (Response to Phase 1A Draft Report Comments), Footnote #4, page 5-5: http://www.energy.ca.gov/2008publications/RETI-1000-2008-002/RETI-1000-2008-002-F.PDF

The dc to ac conversion factor ranges from 77 to 85 percent, depending on the photovoltaic technology and location. We assume an average of 80 percent.

[133] Ryan Matulka, UCLA Luskin Center, *Bringing Solar Energy to Los Angeles: An Assessment of the Feasibility and Impacts of an In-basin Solar Feed-in Tariff Program,* July 2010, Table 3, page 32: http://www.labusinesscouncil.org/online_documents/2010/Consolidated-Document-070810.pdf.

[134] Energy and Environmental Economics, Inc., *Potential and Levelized Cost of Energy (LCOE)*, June 18, 2010: http://www.cpuc.ca.gov/NR/rdonlyres/A0CBE958-E2C4-4AC7-9D56-3AB4D14D723D/0/BVE3PVAssessment.ppt.

[135] Different configurations include crystalline technology with single-axis tracking of the sun's position and fixed-tilt, thin-film technology. Tracking PV arrays generally cost 10 to 25 percent more than fixed thin-film PV arrays but produce 15 to 20 percent more electricity over the course of a year. PV arrays can be mounted on the ground or on rooftops.

[136] Note, for example, that the $268/MWh E3 cost of energy for commercial rooftop solar PV in southern California (the red South Coast bar in the first group in Figure 14) is significantly higher than the $220/MWh FIT price point for commercial rooftop PV systems in the Los Angeles study (the second row of Table 5).

[137] Energy and Environmental Economics, Inc., *op. cit.*, slide 45.

[138] Renewable Energy Transmission Initiative, *RETI Phase 2B Final Report,* May 2010: http://www.energy.ca.gov/2010publications/RETI-1000-2010-002/RETI-1000-2010-002-F.PDF.

[139] California Public Utilities Commission Proceeding R0604009, *Documentation for Emission Default Factors in Joint Staff Proposal for an Electricity Retail Provider GHG Reporting Protocol*, June 2007, page 3: http://www.arb.ca.gov/cc/ccei/presentations/OOS_Emission-Factors.pdf.

[140] California Public Utilities Commission, *33% Renewables Portfolio Standard Implementation Analysis Preliminary Results,* June 2009, Table 4 on page 21 and Table 5 on page 22: http://docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/102354.PDF.

In both these tables we take the increment of the 33 percent reference case over the 20 percent case. Also subtract out renewables in Table 4 that do not need transmission lines.

[141] According to a private communication from E3, a 20-year amortization increases the annual cost factor from 0.1246 to 0.1676, a 34.5 percent increase in the annualized cost of transmission. As a result, the transmission penalty must be adjusted upward by an equivalent amount. The adjusted transmission penalty is $34.45/MWh x (1.345) = $46.34/MWh.

[142] Renewable Energy Transmission Initiative, *RETI Phase 2B Project Spreadsheet*, April 2010: http://www.energy.ca.gov/reti/documents/phase2B/CREZ_name_and_number.xls.

[143] *Ibid.*

A 5 percent line loss is assumed by RETI in its spreadsheet of project data.

[144] Note that the cost figures in this table only include generation and transmission costs. They do not include environmental costs or costs of time delays for new transmission, nor do they include economic benefits to local communities of distributed solar PV compared to remote solar generation.

[145] Ryan Matulka, UCLA Luskin Center, *Bringing Solar Energy to Los Angeles: An Assessment of the Feasibility and Impacts of an In-basin Solar Feed-in Tariff,* July 2010, Table 3, page 32: http://www.labusinesscouncil.org/online_documents/2010/Consolidated-Document-070810.pdf.

The cost of energy for decentralized solar PV is a weighted average of the costs of energy across all categories shown in Table 5.

[146] California Public Utilities Commission, *Decision Adopting a Solar Photovoltaic Program for San Diego Gas and Electric Company,* September 2010: http://docs.cpuc.ca.gov/PUBLISHED/AGENDA_DECISION/122918.htm.

[147] Energy and Environmental Economics, Inc., *Potential and Levelized Cost of Energy (LCOE),* June 18, 2010, slides 38 and 46: http://www.cpuc.ca.gov/NR/rdonlyres/A0CBE958-E2C4-4AC7-9D56-3AB4D14D723D/0/BVE3PVAssessment.ppt.

The cost of energy is a weighted average of rooftop PV and ground-mounted PV across all three capacities and across all regions of the state, as shown in Figure 14.

[148] California Public Utilities Commission, *33% Renewables Portfolio Standard Implementation Analysis Preliminary Results,* June 2009, Appendix C, page 87: http://docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/102354.PDF.

Solar thermal = 14,300 GWh, solar PV = 3,420 GWh, resulting in an approximate 70 percent to 30% contribution.

[149] California Air Resources Board, *Proposed Regulations for a California Renewable Electricity Standard—Staff Report: Initial Statement of Reasons,* June 3, 2010, Table X1-3, page XI-5: http://www.arb.ca.gov/regact/2010/res2010/res10isor.pdf.

Solar thermal = 17,956 GWh, solar PV = 6,913 GWh, resulting in an approximate 80 percent to 20% contribution.

[150] Renewable Energy Transmission Initiative, *RETI Phase 2B Final Report,* May 2010, Figure 4-1, page 4-8: http://www.energy.ca.gov/2010publications/RETI-1000-2010-002/RETI-1000-2010-002-F.PDF.

[151] *Ibid.*

[152] Estimate by Bill Powers, Powers Engineering, based on $259 million/year in levelized costs (current SDG&E capital cost estimate is $1.883 billion) for a 1,000 MW capacity powerline (estimated energy transferred at 30 percent capacity factor = 2.628 million MWh/year). $259 million/year to $2.628 million MWh/year = $98.55/MWh.

[153] An astute reader might wonder why, given the intermittency of renewable generation, our analysis has not included the costs of energy storage. The reason is that solar PV is used mainly to provide electricity during peak demand periods. When solar PV has achieved deeper market penetration and is a significant share of electricity generation, then storage will become a more important question, and the costs of decentralized storage compared to remote central-station storage will need to be analyzed.

[154] RETI, *Mission Statement:* http://www.energy.ca.gov/reti/Mission_Statement.pdf.

[155] CPUC, *33% RPS Implementation Analysis Preliminary Results,* June 2009, page 9: http://www.cpuc.ca.gov/NR/rdonlyres/1865C207-FEB5-43CF-99EB-A212B78467F6/0/33PercentRPSImplementationAnalysisInterimReport.pdf.

[156] This value represents the 32,000 GWh called for in the AB 32 Scoping Plan diminished by 10,000 GWh already included in the projected energy demand for 2020 shown in Line 1.

[157] Private PV electric generation is not part of decentralized generation shown on Line 11 because the RPS refers only to sales of electricity from the utility to customers, while private PV is electricity that customers generate for themselves.

[158] CPUC, *Planning Standards for System Resource Plans—Part II: Long-Term Renewable Resource Planning Standards,* June 2010, page 7: http://docs.cpuc.ca.gov/efile/RULINGS/119573.pdf.

This value is developed from CEC projections of 4,000 megawatts of CHP at a 92.2 percent capacity factor.

CRITICAL ACCLAIM FOR (continued from back cover)

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COMMUNITY POWER: Decentralized Renewable Energy in California

One of the great side effects of moving to renewable power is that we will replace vulnerable, brittle centralized systems that are too big to fail with spread out democratic energy sources small enough to be resilient. COMMUNITY POWER makes a compelling case for moving in this direction.

Bill McKibben, Co-founder of 350.org; author of a dozen books on the environment, including The End of Nature

COMMUNITY POWER is a must read for anyone interested in the myriad of benefits (jobs, lower prices, energy security, sustainability, economic development) that can be derived from local decentralized electricity generation. Decentralized power is truly Power To The People." This publication provides a clear explanation of how and why our communities have so much to gain from local decentralized power and so much to lose if big energy corporations continue to control our energy resources.

Angelina Galiteva, founder of Renewables 100 Policy Institute; chairperson of the World Council for Renewable Energy (WCRE)

Distributed generation offers a unique set of economic, social, and environmental benefits, including the ability to diversify energy markets, turn buildings into profitable power plants for even low-income households, and to spur a wave of small-business job creation. COMMUNITY POWER provides an essential guide to the technologies, policies, and management skills needed to make this energy transformation a reality.

Dan Kammen, Founding Director of the Renewable and Appropriate Energy Laboratory, UC Berkeley; Chief Technical Specialist for Renewable Energy and Energy Efficiency, World Bank

Al Weinrub's COMMUNITY POWER puts forth practical and achievable renewable energy solutions for communities most impacted by our dependence on fossil fuel. The paper exemplifies how distributed/decentralized generation creates genuine local green jobs and environmental health benefits for communities across California choking from dirty air and toxic dumping. Anyone who prefers community control over profit-focused utilities, and anyone who wants clean air for our children should read COMMUNITY POWER.

Strela Cervas, Co-Coordinator, California Environmental Justice Alliance

The renewable revolution has begun and Californians are finally waking up to the role community power can play in our energy future. Al Weinrub's COMMUNITY POWER is leading the charge of electricity rebels calling for distributed, decentralized renewable generation in the Golden State.

Paul Gipe, author, advocate, and industry analyst

COMMUNITY POWER shows that local renewable power generation can open doors to clean energy careers for working class communities of color. It can bring jobs, health, and wealth to cities like Oakland.

Emily Kirsch, Green Collar Jobs Campaign, Ella Baker Center for Human Rights; Convener, Oakland Climate Action Coalition

California must take a multi-faceted approach to meeting its future energy needs and this includes decentralized renewable energy generation. COMMUNITY POWER provides vital information so that we can move the state forward to grow this emerging sector so that California can meet its goals of reducing pollution to protect the environment and public health.

Assemblymember Pedro Nava, Chair, California Assembly Select Committee on California's Green Economy

--Continued on inside back cover--

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