Support for Solar Power and Renewable Electricity Generation at the U.S. Environmental Protection Agency

by Brian Krausz

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Kenneth Zweibel
Research Professor of Energy

Abstract of Thesis

Support for Solar Power and Renewable Electricity Generation at the U.S. Environmental Protection Agency

The United States Environmental Protection Agency (EPA) is poised to play an important role in supporting national plans for renewable electricity generation. As distributed and centralized renewable electricity projects forge ahead, EPA must establish criteria for evaluating the environmental effects of electricity-related consumer products and ensure that future infrastructure projects are consistent with the mission of environmental protection. EPA authority and programs for evaluating environmental effects of electricity may need expansion in order to accomplish these goals.

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Glossary of Terms

APPCD	Air Pollution Prevention and Control Division
a-Si	Amorphous Silicon
BACT	Best Available Control Technology
BNL	Brookhaven National Laboratory
BLM	Bureau of Land Management
CAA	Clean Air Act
CEQ	Council of Environmental Quality
CEQA	California Environmental Quality Act
Cd	Cadmium
CdTe	Cadmium telluride
CIS	Copper indium selenide
CSP	Concentrating Solar Power
CWA	Clean Water Act
DOE	Department of Energy
DOI	Department of Interior
EC	Environmental Concerns
EERE	Office of Energy Efficiency and Renewable Energy
EIA	Energy Information Administration
EIS	Environmental Impact Statement
EO	Environmental Objections
EPA	Environmental Protection Agency
EPANMD	EPA National MARKAL Database
EPEAT	Electronic Product Environmental Assessment Tool
ESA	Endangered Species Act
EU	Environmentally Unsatisfactory
FLPMA	Federal Land Use and Management Policy Act
FPTC	Federal Production Tax Credit
FS	Forestry Service
GaAs	Gallium arsenide
GEC	Green Electronics Council
GHG	Greenhouse Gas
GPP	Green Power Partnership
GW	Gigawatt
IEEE	Institute for Electrical and Electronics Engineers Standards Association
kWh	Kilowatt-hour
LO	Lack of Objections
MARKAL	Market-Allocation
MW	Megawatt
MOU	Memorandum of Understanding
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NREL	National Renewable Energy Laboratory
PV	Photovoltaic
RCRA	Resource Conservation and Recovery Act

REC	Renewable Energy Certificate
RPS	Renewable Portfolio Standards
TCLP	Toxicity Characterization Leaching Profile
Te	Tellurium
TW	Terawatt
x-Si	Crystalline Silicon

Solar will inevitably become the most economic solution for most energy applications and the only viable option for many throughout the world. Currently, sunlight is the only renewable-energy source that is ubiquitous enough to serve as the foundation of a global energy economy in all of the locations where energy will be required, from the industrialized world to the developing one.

-Travis Bradford (2006)

Chapter 1: Introduction

The Obama administration has indicated strong support for renewable energy and electricity by signing the American Recovery and Reinvestment Act of 2009. The President proposed a 35 percent increase to the U.S. Environmental Protection Agency (EPA) budget for 2010 compared to fiscal year 2008, signaling the Agency will be given more responsibility to help solve national environmental and energy challenges in the near-term. EPA acts as a regulatory force in the electricity sector by prohibiting certain actions and requiring pollution controls. Partnerships with other agencies and creating voluntary programs are additional ways in which EPA encourages cleaner and smarter energy use. Since EPA's formation in the 1970s, the agency has built up expertise in limiting pollutants derived from traditional energy sources. Air quality has improved in many respects due to the technological and procedural requirements imposed by EPA on electric utilities.

The recent expansion of renewable electricity generation offers the agency new opportunities to develop stricter air regulations. Energy sources such as solar and wind are beginning to become cost-competitive in many applications, and the Agency's scientific and regulatory influence may give renewable technologies a significant boost. A recent example is the EPA's proposed endangerment findings signed on April 17, 2009 indicating a national cap-and-trade system for carbon may be implemented in the near future. (EPA, 2009a)

Chapter II: U.S. Electricity Supplies

a. Overview

Data published by the Energy Information Administration (EIA) in 2006 estimated worldwide electricity generation of 18 trillion kilowatt-hours (kWh) for that year (EIA, 2009). About 16.6 percent was generated from renewable sources, but only 2.3 percent from non-hydroelectric sources. The statistics are similar in the United States, where approximately 9.5 percent of electricity is generated from renewable sources, but only 2.4 percent without hydropower. Since hydropower is already near its maximum output in the United States and building new capacity can have a huge impact on surrounding habitats and water usage, the EIA estimates a negligible amount of new hydropower infrastructure will be built through 2030.

Coal currently is and will remain the primary source of the world's electricity for some time. Without considering life-cycle analysis, no other form of electricity has been able to consistently deliver such a low cost per kilowatt-hour. The dilemma with coal is well documented, mainly that carbon emissions costs are not yet valued monetarily in many countries, notably the United States. Current and future generations are negatively impacted by global warming gases that derive from coal such as carbon dioxide and oxides of sulfur (SO_x) and nitrogen (NO_x), which pose serious health and environmental problems. Approximately 2.5 billion metric tons of carbon dioxide were emitted from conventional power plants in the United States alone in 2006. Emissions of SO_x and NO_x totaled to around 9.5 million and 3.8 million metric tons, respectively in the same year. SO_x and NO_x emissions are decreasing overall due to successful implementation of market-based trading programs and allowances for these emissions. Improvements in emission control technologies such as dry and wet scrubbers and flue gas desulphurization are also helping to reduce SO_x and NO_x emissions at their source. (EIA, 2009)

While there is currently no direct cost to electric utilities for carbon emissions, there are many indirect costs. It is generally well accepted that high CO_2 levels in the atmosphere induce climate change. Medical costs, crop and vegetation damage, biodiversity loss, and higher frequency of extreme weather events are some of the effects associated with high ambient CO_2 levels. The U.S. Climate Change Science Program lists several more effects of climate change upon human health and welfare in a recent report. (USCCSP, 2006)

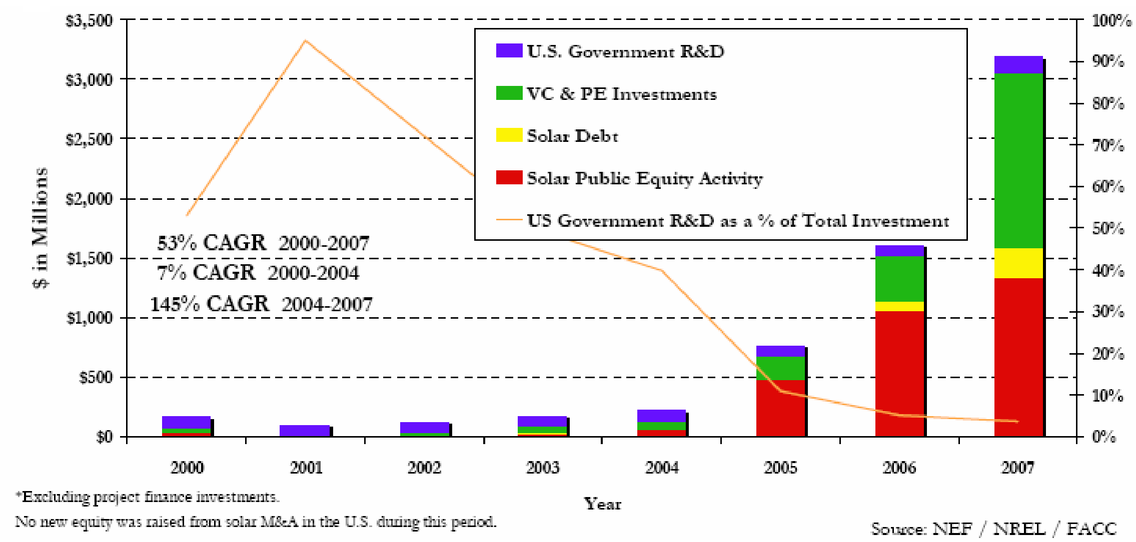
Wind, geothermal and solar energy are expected to have major impacts on the global electricity market for a variety of reasons. These are renewable sources of energy with virtually no emissions of greenhouse gases, and very few harmful social or environmental qualities. Although markets for harnessing these forms of renewable energy are often considered to be in their infancy, technology is improving rapidly.

There are other broad forces at work encouraging electricity generation from renewable sources. Fossil fuels will inevitably be depleted, costs of pollution are rising, and policies are beginning to favor clean forms of electricity. As many nations around the world look to the United States for leadership in solving the global energy crisis and problems associated with climate change, industrialized nations with some of the scarcest energy resources actually have the most successful and innovative policies in place. In an address to the Joint Session of Congress on Feb. 24, 2009, President Barack Obama remarked, “We invented solar technology, but we’ve fallen behind countries like Germany and Japan in producing it” (Obama, 2009). In Germany, the president is referring to the highly praised “feed-in tariff” program launched in April 2000 offering solar power producers about 50 Euro cents for every kWh produced and guaranteed this price for 20 years. This feed-in tariff, along with the 100,000 Roofs Program, has resulted in an expansion of solar photovoltaic (PV) installations from less than 20 MW per year to 1.5 GW in 2008. Since the cost is spread over the entire electricity consumer rate, German utilities are not negatively impacted and the government does not have to appropriate money annually. (SEIA, 2004)

Germany is the world leader in terms of aggregate solar power system installations, while Spain was the world leader in new installed PV capacity for 2008, accounting for 2.5 GW of grid-tied solar (EPIA, 2009). Japan has also been very active with solar installations due to substantial funding by the Japanese government. Governmental support in Japan included an initial 50 percent cash subsidy for 3- to 4-kW grid-connected residential systems. This program reduced solar power prices by more than 50 percent and increased total installations from 500 systems to more than 100,000 in 10 years—while gradually phasing out rebates. (SEIA, 2004)

In the United States, the Department of Energy (DOE) is the chief governmental agency in charge of funding and promoting the use of renewable energy. DOE programs directly support research and commercial activity, as well as many activities focusing on smart and efficient energy use. Investments from DOE originally accounted for a significant portion of research and development funding for solar energy in comparison to private investment. However, funding sources have shifted dramatically in recent years, as shown in Figure 1. U.S. capital investments in solar energy logged an impressive 145 percent average growth rate from 2004-2007. In a broad sense, renewable energy expansion and effective national energy management rely on many agencies and stakeholders. Energy policy decisions have direct and indirect impacts on the economy, the environment and society.

Figure 1: U.S. Capital Investments in Solar Energy



The EPA also has an important role in transitioning toward a cleaner, safer electricity infrastructure, although this role is somewhat less defined than the role of DOE. As part of the executive branch, EPA has always faced the challenge of making objective scientific conclusions while satisfying the mandates of the current administration. Two professors (Vig and Kraft, 2006) who analyzed EPA organizational structure in 2006 recognized the political tightrope the Agency must walk, as well as the overburden of responsibilities and occasionally unrealistic deadlines imposed by Congress upon EPA. Since EPA is wholly or largely responsible for the implementation of 13 major environmental statutes and portions of several dozens more (Vig and Kraft, 171), the Agency is notoriously stretched. As resources and funding struggle to catch up with the Agency's ability to meet its requirements, EPA must to look for new mechanisms to support its diverse mission.

This paper seeks to understand EPA's role in the impending transition toward a new energy infrastructure under the assumption solar and wind energy harvesting will become ubiquitous, and discuss the programs, tools and partnerships that EPA has at its disposal to fulfill this role. As market penetration for renewable energy increases, it is important for EPA to devote attention to the tradeoffs involved with building a new electricity infrastructure. Electricity generation has a significant effect on environmental quality that cannot be ignored. Land development, water usage and air quality are all interconnected with electricity production and use. As the primary regulatory agency for the environment, EPA must address the environmental, safety and health issues relating to the electricity sector and work continually to improve them. The following sections will provide a brief introduction to federal policies affecting renewable electricity generation, and EPA programs and tools that could be used to examine environmental effects of electricity. Finally, this paper will include recommendations concerning EPA's environmental review process for renewable energy development. Special attention will be paid to solar energy technology due to the fact that sunlight is the most abundant resource on Earth, has minimal environmental impact, and is adaptable enough to become the preferred solution for energy applications in the residential, commercial and industrial sectors throughout the world.

b. Government Efforts to Promote Renewable Energy

i. Federal Tax Credits

The American Recovery and Reinvestment Act of 2009, enacted on Feb. 17, extended the federal production tax credits (FPTC) for renewable energy generation. Credit amounts to 2.1¢/kWh for wind, geothermal, and closed-loop biomass; and 1.0¢/kWh for other eligible technologies. This applies to the first ten years of operation. (DSIRE, 2009)

Consumers may earn tax credits for purchasing solar panels, solar water heaters, small wind energy thermal systems and geothermal heat pumps, which are eligible for tax credit up to 30 percent of the cost with no maximum benefit, through the year 2016. (Energy Star, 2009)

ii. Renewable Portfolio Standards (RPS)

Renewable Portfolio Standards are voluntary standards requiring utilities to produce or purchase a fixed percentage of their energy from renewable sources. Producers can earn, buy and sell certificates for generating renewable energy. This policy emerged as a part of deregulation of the electricity sector and often works in concert with FPTCs. They are typically implemented by states because there are no federal regulations, and EPA often serves in an advisory role for states who want to develop their own RPS. Even states not currently deregulated are beginning to adopt RPS requirements as a way to deal with emissions concerns and climate change. As of March 2009, 30 states and Washington, D.C., had adopted RPS requirements. Another five states have RPS goals rather than requirements. (mjbeck, 2009)

EPA's *Guide to Action* (2006a) notes RPS requirements typically lead to market development of the most cost-competitive forms of renewable energy, unless the RPS is specifically designed to encourage higher-cost renewable technologies. Table 1 shows a list of current RPS requirements by state, and the percentage of solar energy required, if applicable. In 2008, Michigan's RPS bill provided triple credits for power generated by solar power systems. This type of subsidy is necessary in some regions where large-scale manufacturing of solar power is still uncommon. Establishing thoughtful RPS requirements is an excellent way to facilitate growth of a particular renewable energy industry, and allows states to adjust their policies as they deem appropriate to favor one or all renewable sources. Until a national renewable energy policy is in place, state RPS is a very effective tool to mitigate electricity-sector pollution and remove barriers to entry for renewable energy technologies. Turning over responsibility to the states is not only sensible due to the unique situation of each state, but also involves minimal investment from EPA. Unlike the period immediately following the Agency's inception when environmental protection required a command-and-control style management, states have now improved their regulatory skill and competencies to the point that little oversight is necessary.

Table 1: State RPS and Solar Energy Requirements

State	Target (All renewables)	Target (Solar)
AZ	15% by 2025	0.66% by 2007
CA	20% by 2010	
CO	20% by 2020	0.4% by 2015
CT	10% by 2010, 27% by 2020	
DC	20% by 2020	0.386% by 2022
DE	20% by 2019	
FL	20%, Year to be determined	
HI	20% by 2020	
IA	105 MW (2% by 1999)	
IL	25% by 2025	
MA	4% by 2009 (+1%/year after)	
MD	20% by 2022	
ME	40% by 2017	
MI	10% by 2015	

MN	10% by 2015 (1% biomass), 30% by 2025	
MO	15% by 2021	
MT	10% in 2010, 15% in 2015	
NC	22.5% by 2021	
NH	23.8% by 2025	
NJ	22.5% by 2021	0.16% (95 MW) by 2008
NM	10% by 2011, 20% by 2020	
NV	20% by 2015	5% of portfolio
NY	25% by 2013	0.154% customer-sited by 2013
OH	12.5% by 2025	
OR	25% by 2025	
PA	18% by 2020 (8% is RE)	0.5% by 2015
RI	16% by 2020	
TX	5880 MW by 2015	
VT	Total incremental energy growth between 2005 and 2012 to be met with new renewables (cap 10% of 2005 sales)	
WA	15% by 2020	
WI	2.2% by 2011, 10% by 2015	

(EPA, 2006a) (M.J.Beck, 2009)

iii. Other Federal Policies and Incentives

In the near future, there may be a national policy for renewable energy. This would likely be similar to a national RPS, but might also include special provisions such as net metering, or specific support for transmission and storage. Net metering allows customers who produce renewable energy to sell back to the grid, and provides incentive for distributed sources such as small PV. If such a policy were in place, it would underscore EPA's responsibility of ensuring the safety of widespread renewable energy products.

Chapter 3: Growth of the Solar Energy Industry

a. Projections

The debate over how to encourage renewable energy is continuous. It is unclear whether certain technologies are mature enough to warrant heavy investment, or whether it is prudent to sprinkle funding among all renewables to see which of them might emerge as a clear choice to serve as a foundation for the nation's energy. There are currently some ambitious plans for developing large tracts of land for solar and wind. "A Solar Grand Plan," (Zweibel, et. al) published in Scientific American, outlines a broad agenda that would allow the United States to generate 69 percent of its electricity and 35 percent of its total energy from solar power by the year 2050. This plan would take advantage of the sunlight resources in seven Southwestern states and transmit direct current electricity throughout the country. In an assessment done by DOE (2008), these states have the solar resources in combination with suitable land enough to generate 6,800 GW. For perspective, the total electric generating capacity of the United States is just over 1,000 GW. The DOE assessment assumes only a modest conversion rate and still results in excellent potential. Despite inconsistent funding for solar power over the last 30 years, total installed solar capacity in the United States is starting to boom. In 2008, total capacity grew by 17 percent, or 1,265 MW. PV systems accounted for 342 MW of these installations. These are record numbers in the United States, where new grid-tied PV installations grew by 81 percent in 2008 and overall PV capacity increased by 58 percent (SEIA, 2009). Worldwide, PV production is doubling approximately every two years, making it the fastest-growing renewable energy technology in both the United States and globally. (Kropp, 2009)

Table 2: New Solar Electricity Capacity and Total Capacity in 2008

Country	**New Capacity in 2008**	**Cumulative Capacity**
Spain	2,281 MW	2,973 MW
Germany	1,500 MW	5,308 MW
United States	342 MW	1,547 MW
Japan	235 MW (est.)	2,173 MW
Italy	150-200 MW(est.)	321 MW
France	105 MW	175 MW

(SEIA, 2009)

Electricity generation from solar energy systems is conservatively projected to grow at an average of about 13 percent annually through 2030 (EIA, 2009). While no new concentrating solar power (CSP) projects were completed in 2008, 6 GW of capacity is planned. Breakthroughs and setbacks in production are likely to occur, just as they do with the opening of any developmental market. However, the extension of tax credits for at least another eight years in the United States will allow investors to feel more confident in supporting solar energy companies.

Wind energy is also making a big impact. Total worldwide installed wind power capacity continued its exponential growth by increasing 29 percent in 2008 to 121,000 MW (WWEA, 2009). The most recent report by the World Wind Energy Association also estimates global capacity may reach 1.5 TW by 2020. The United States is currently the global leader in installed wind capacity, with Germany a close second. There are a number of ambitious plans for new wind infrastructure in the United States, notably the "Pickens Plan" proposed by former oil executive T. Boone Pickens. The Plan seeks to utilize the wind resources in the American Midwest to build enough wind turbines to meet approximately 20 percent of the nation's electricity demand within 10 years. Along with investments in natural gas vehicles, the Plan claims an ability to reduce foreign oil imports by one-third in this timeframe. (Pickens, 2009)

Geothermal and other alternative energies are likely to contribute to the U.S. energy portfolio, but solar and perhaps wind are the only sources that can potentially supply enough renewable energy to support the U.S. and global populations. In the midst of a recession, electricity and fuel demand are waning. This makes the risk of starting a new solar or wind energy company quite high. A prolonged economic recession is potentially damaging to these industries because of the high capital costs involved. Most wind and solar energy systems require very little maintenance and operate for years or often decades, so purchasers typically pay for all their electricity up front. However, this potential drawback is being overcome by companies such as Solar City, who allow their residential customers to lease solar panels for a monthly fee rather than a full purchase. Nevertheless, solar and wind energy will require either subsidies, technological improvements or more favorable policies in order to be cost-competitive with traditional energy sources in most applications. Negative externalities associated with traditional energy sources may be undervalued currently, but absolute cost is still an important factor in consumptive behavior.

b. Comparison of Solar Energy Technologies

i. Overview

There are two main categories of solar energy harvesting: thermal and PV. Low-temperature thermal solar systems transform sunlight into heat, making it useful for heating and cooling applications. These are typically simpler and smaller in scale compared to medium- and high-temperature thermal systems, including concentrating solar power. CSP generation normally takes place on a utility scale, employing parabolic-shaped mirrors to focus light and heat enough to power a steam turbine, which runs an electricity generator. The concentrated sunlight is applied to a heat transfer fluid, usually water or liquid sodium, to either power the generator or store the heat for later use. Contrastingly, PV systems convert sunlight into electricity directly through an energy-absorbing semiconductor such as silicon. This layer absorbs energy from sunlight, giving electrons enough energy to be freed from the material and siphoned off as electricity.

ii. Life-Cycle Analysis Studies

Renewable energy technologies vary widely in purpose, cost and design even if they harvest from the same source. With each one comes a unique set of environmental, safety and health issues concerning their manufacture, use and disposal. Brookhaven National Laboratory (BNL), supported by DOE, has already performed life-cycle analysis for various forms of solar energy technology. According to Vasilis Fthenakis, the principal investigator of the Photovoltaic Environmental Research Assistance Center at BNL, "Photovoltaic electricity generation is a zero-emissions process regardless of which technology is used." In addition, PV systems do not produce any noise or toxic gases (Fthenakis, 2003).

In the PV manufacturing process there may be a variety of hazardous chemicals, from mild irritants to carcinogens. The most common bulk material for solar cells is silicon. There are crystalline (x-Si) and amorphous (a-Si) silicon producers, but some of the environmental effects are very different. Silicon mining poses health risks for each, and fluorine and chlorine emissions are also possible. These emissions are orders of magnitudes lower than corresponding emissions of a coal plant. (EERE, 2009)

Crystalline Si wafers, often less than 1mm thick, are soldered together to make a solar cell. Solid and liquid wastes are produced during manufacture, which may include solvents, cleaners, slurries and lead-based solder. Lead solder is a problem common to nearly all electronics, which is an industry with many parallels to solar. The fact that there are similar risks identified in both industries is an advantage for EPA, which already has a program for assessing environmental effects of electronic products. This will be discussed in more detail in Chapter 4. X-Si production also poses a risk of chemical burns and inhalation of hazardous vapors. These risks are small and take place mainly in the laboratory, but these risks and especially the waste stream are not negligible pieces of the life cycle.

Most other promising PV technologies have fewer environmental costs compared to x-Si. Cadmium telluride (CdTe), a-Si, copper indium selenide (CIS) and gallium arsenide (GaAs) are thin-film technologies that use 1/100 of the PV material used in making x-Si. The main safety hazard of producing a-Si is silane is easily ignitable. This is potentially dangerous to a surrounding community if it is stored in bulk and proper safety features are not enforced. Toxic dopants are also used in manufacture of a-Si, such as germane (GeH_4) and diborane (B_2H_6). These risks can be minimized with proper engineering controls, safety procedures and personal protective equipment. Otherwise, there is virtually no environmental risk.

For CdTe, the concerns are with the use of both cadmium and tellurium compounds at various process stages. Cadmium is extremely hazardous and the biggest exposure risk comes from possible inhalation. In the form of CdTe, however, the toxic effects are far less pronounced. CdTe is an exceptionally promising technology because of the relatively low cost of production and potential to deploy on a massive scale. Critics point out that Cd is extracted from mining operations, which are associated with a host of environmental atrocities. However, this is misleading because Cd is produced by separating it from Zinc mining waste, so it actually prevents Cd from re-entering the environment. The cadmium used in solar cells also uses the metal 2,500 times more efficiently than a typical nickel cadmium battery. (Fthenakis and Zweibel, 2003).

Te is usually found with other elements and may be a limiting factor in CdTe production. Global production of Te amounted to 135 metric tons in 2007, excluding the United States (USGS, 2008). Abundant quantities of Te are known to exist in shallow ocean ridges, but it remains to be seen whether it can be harvested cheaply. The current method of extracting Te is as a byproduct from copper production. CdTe solar cells are already being mass-produced by companies such as First Solar, so an ample Te supply may give this technology a distinct advantage.

CIS materials are thought to be mildly to moderately toxic, but more research is needed. The components of CIS systems are extracted from mining and processing, similar to Cd. Like other PV technologies, CIS systems pose an environmental risk during disposal, but recycling can largely solve this issue. Finally, GaAs cell production involves toxic Arsenic and other dangerous gases, so it should be handled similarly to a-Si.

During the operation stage, almost no human health risks exist due to PV. PV material layers are solid and enclosed by layers of glass or plastic. The materials must be grinded into dust and then inhaled to cause harm. Smoke from a burning PV system is unlikely to contain volatilized hazardous materials, and the fire would itself would likely pose a greater risk. (Fthenakis, 2003)

The major potential environmental impact of the PV system life-cycle is disposal. Disposal of these systems into municipal waste incinerators invariably release airborne toxic metals into the environment. Distributed PV systems often end up in landfills, where metals could leach into the soil and threaten nearby water supplies and ecosystems. The threat of contamination and mobility of the waste in the environment depends on analysis such as the Toxicity Characterization Leaching Profile (TCLP) developed at EPA. CIS and a-Si reportedly have no problem passing the stringent TCLP test, indicating that the leachate does not represent a significant threat. CdTe and x-Si systems have passed or failed depending on the specific module, and no data has been gathered on GaAs. (Fthenakis, 2003)

Utility-scale projects are common for CSP systems, so we must go beyond a single-unit life cycle analysis to understand the environmental effects. Centralized PV farms will also be constructed, but they are currently less common than CSP. CSP becomes economical only on a large scale, which is why there are few examples of small (kW) CSP systems. For CSP technology, the heat transfer fluid running through storage tanks and around panels is often toxic. At one plant in California, a 900,000 gallon storage tank exploded and the transfer fluid, Therminol, caught fire. This particular fluid is mildly toxic, and the accident could have been worse if the fire spread to the sulfuric acid or caustic soda tanks nearby. Employees were evacuated and nobody was injured in this event, but this example shows there are safety and environmental hazards even with solar energy. (LATimes, 1999)

The biggest environmental impact of a centralized solar plant is land use, whether PV or CSP. A study (NREL, 2006) by the National Renewable Energy Laboratory (NREL) in California estimates that a 100MW CSP plant covers approximately 800 acres of land. This does not compare favorably to a typical combined cycle natural gas power plant, which could supply 500MW while occupying only 20 acres. However, life-cycle analysis of electricity generated from natural gas and coal show land requirements are similar to solar energy when strip mining or extraction from oil or natural gas fields are included. These activities are also much more damaging to the environment compared to erecting solar panels. Plant and animal populations surrounding the location of a centralized CSP or PV plant may be adversely impacted, but the construction impacts on land are highly site dependent. Siting must be done carefully so as not to disturb sensitive habitats and wildlife corridors.

Water use is also an enormous issue with CSP technology. Cooling towers and piping systems are used often in CSP projects, presenting a challenge to siting in arid regions. The U.S. Southwest and other desert regions considering CSP construction must weigh the benefits of solar power against increased water use and stress, and how to transport additional water resources to the desert. Life-cycle analysis would be useful for this type of decision making.

Despite the potential hazards, the environmental benefits of CSP are great. NREL's analysis in California concluded that 750 lbs. of NO_x and 3,800,000 lbs. of CO_2 are avoided annually for each MW of installed CSP capacity.

Thermal solar units and PV systems will soon be widely distributed. These relatively small systems have a higher chance of ending up in a landfill or incinerator compared to utility-scale systems. The construction of large solar farms, both CSP and PV, are also likely to occur as solar becomes more profitable and policies shift in favor of renewable technologies. Research and development of renewable technologies, and to some degree deployment, fall under the responsibilities of DOE. Nevertheless, EPA is responsible for determining risks to public health and the environment from potentially large amounts of toxic material.

iii. Case for Developing Selection Criteria

EPA's influence over environmental risk has historically been specific to pollutant classification. As the lead agency responsible for implementing the Clean Air Act (CAA), EPA is able to set its own regulations for hazardous air pollutant emissions and often the technologies, too. For example, Best Available Control Technology (BACT) Standards are required for any new or highly modified stationary source of hazardous pollutants in "attainment areas," areas which do not persistently exceed the National Ambient Air Quality Standards (NAAQS). This prevents significant deterioration of air quality and also affects the economic bottom line of utilities using fossil fuels for electricity generation. EPA oversees the permitting process of these new sources of pollution, which may include "what construction is allowed, what emission limits must be met, and often how the source must be operated." (EPA, 2009b)

Renewable electricity is not subject to the same types of control. With virtually no emissions, solar and wind energy have no problem meeting CAA or Clean Water Act (CWA) requirements. Still, these technologies require EPA's attention because they are not without environmental impacts. Distributed PV is often installed on rooftops and other flat surfaces, so it does not affect surrounding land and ecosystems. However, centralized solar projects require large tracts of land.

Conflicts between competing objectives of land conservation and energy use are already manifesting in California. In July 1999, the Wildlands Conservancy arranged for the U.S. Department of Interior (DOI) to purchase over 405,000 acres of land in

California's Mojave Desert. The land was sold under the assumption that it would remain preserved, but the Bureau of Land Management (BLM) of the DOI considers the land open to all kinds of development aside from mining. Fourteen solar and five wind energy proposals were recently submitted to BLM. Senator Dianne Feinstein, D-Calif., is seeking to block development, citing the potentially detrimental effects to the desert tortoise population. The CEO of the Wildlands Conservancy, David Myers, went so far to say that the solar and wind projects "would destroy the entire Mojave Desert ecosystem." (Feinstein, 2009)

On the other side, there are powerful arguments in favor of developing the Mojave Desert for solar power. Areas of the desert rank among the sunniest, driest places in the world. Land use may affect certain plants and animals, but the environmental harm of meeting electricity needs with fossil fuels may be much greater. Strip mining for coal utilizes land comparable to solar farms, but for a much greater environmental cost.

A number of organizations are interested in developing land beyond the Mojave Desert. For example, NREL is currently working with seven Southwestern U.S. states and partnering with the Western Governors' Association to encourage construction of 1,000 MW CSP capacity by 2010 (NREL, 2008), in the same land areas identified for abundant solar resources in *A Solar Grand Plan*. In order to expedite the development of renewable energy and minimize future conflicts, EPA and its partners need to establish a reliable framework for resolution. The next section will discuss the opportunities and resources EPA already has in-house to help advance this cause.

Chapter 4: EPA Resources for Monitoring Solar Energy Technologies

a. EPEAT

The Electronic Product Environmental Assessment Tool, or EPEAT, was developed through an EPA grant at the University of Tennessee in order to help purchasers compare the environmental performance of various computers and monitors. The user inputs information about the system, such as units purchased, product model, product lifetime, packaging, and design for end of life. The calculator then displays savings in energy, materials, greenhouse gas and air emissions, water emissions, toxic materials, municipal solid waste generation, hazardous waste generation and cost.

Launched in 2006, the EPEAT tool was developed by consensus among industry experts, environmentalists and purchasers and has become the new IEEE (Institute for Electrical and Electronics Engineers Standards Association) 1680 standard in environmental assessment of personal computer products. The tool is managed by the Green Electronics Council (GEC) and evaluates products using 51 environmental criteria. EPEAT rates qualified computers and monitors as a bronze, silver or gold-tier product. If the product meets all 23 of the required EPEAT criteria, it achieves the minimum EPEAT rating of bronze. Meeting optional criteria may earn a higher rank. Manufacturers of environmentally sensitive products stand to gain business from federal agencies and private institutions because of more complete information about environmental performance. EPA estimated between 2006 and 2011, EPEAT purchases will reduce hazardous waste by four million pounds, non-hazardous waste by one million pounds and energy use by 200,000 MWh. (Jones, 2006)

EPEAT started as a voluntary project, but major manufacturers such as Apple, Dell and Hewlett-Packard have signed on and achieved EPEAT registration for well over 1,000 products. Effective Feb. 17, 2009, federal agencies must ensure when purchasing electronic products to meet their requirements, the agency meets “at least 95 percent of those requirements with an EPEAT-registered electronic product, unless there is no EPEAT standard for such product” (Fed Register, 2009). The impact of EPEAT is expected to be large from federal procurements alone.

The electronics industry is well established, but recycling electronic waste is still uncommon. In 2007, only 18 percent of the 2.25 million tons of televisions, cell phones and computer products were collected for recycling at the end of their useful life. The remainder was mainly disposed of in landfills despite the materials they contain. Lead, mercury, cadmium, and chromium are just a few of the common hazardous chemicals found in electronic waste (e-waste). Several bills have been introduced in U.S. Congress that sought to govern the recycling of e-waste, but there is still no legislation. Used computers and monitors disposed by households or small business do not currently qualify as hazardous waste. Only large quantity (> 220 lbs./month) generators are required under federal law to send their e-waste to a hazardous waste facility. (EPA, 2008)

E-waste is relevant to the discussion of distributed renewable technologies, especially solar PV, because both contain similar materials that are potentially hazardous. In addition, neither is usually classified as hazardous until the end of the useful life. PV system disposal may prove to be a minute problem compared to consumer electronics, if for no other reason than the useful life of a PV system is an order of magnitude longer than most consumer electronics. Many solar technologies in operation are capable of lasting 30 years or more.

EPA currently works with electronics manufacturers, retailers and the public to provide more opportunities to reduce or reuse e-waste, which is a much larger waste stream than distributed energy system disposal. However, with the prospect of solar panels cropping up on hundreds of thousands of rooftops, EPA can use their E-cycling program as a model to develop new environmental criteria, or simply expand the program to cover end-of-life management of distributed renewable energy systems. A modest grant of $30,000 allowed EPEAT to be developed, and a similar grant could be awarded to develop a renewable energy technology environmental assessment tool for personal consumers.

b. MARKAL

The comparison to e-waste ends when the focus shifts to utility-scale and national-scale deployment scenarios. MARKAL, short for Market Allocation, is a computer optimization model developed in the late 1970s at BNL and is still in use today at EPA, DOE, and a number of federal agencies. DOE's Office of Policy used MARKAL to analyze the impacts of the Kyoto Protocol on U.S. energy systems, and the Energy Information Administration has used MARKAL for its Annual Energy Outlook since 2002. It represents one of the most comprehensive attempts to model the economic, energy and environmental impacts of the electricity sector based on real data. (MARKAL, 2008)

EPA used MARKAL to help characterize the effects of various energy models on greenhouse gas (GHG) emissions. MARKAL is a highly sophisticated model, using over

10,000 different equations and constraints in order to realistically evaluate the costs and benefits of different scenarios. According to the most recent report generated at EPA using MARKAL (EPA, 2006b), pollutant emissions rates and ambient temperature (depending on climate change) are the two main factors determining future air quality.

The strengths of MARKAL include 24 different generating technology options, which the user characterizes by cost, performance and emissions. The modeler also specifies resource supplies, energy conversion technology and end-use service demands. MARKAL accounts for emissions caps on SO_2 and NO_x, which can be determined based on current and future policies. For example, the amendments to the Clean Air Act in 1990 set maximum emissions limits on pollutants causing acid rain, namely SO_2 and NO_x. A successful allowance trading program for SO_2 emissions managed by EPA led to a gradual decrease from 1980 levels to the permanent cap of 8.95 million tons per year by 2010. NO_x emissions do not have a cap-and-trade program in place, but reduction efforts have been successful nonetheless. Varying the maximum allowable net emissions of SO_2 and NO_x adjusts the expected growth of different energy industries. Table 3 shows that despite progress, 65 percent of total SO_2 emissions and 20 percent of NO_x emissions currently come from the electricity sector. Electricity producers are also responsible for a significant share of CO_2 emissions, the gas most closely linked with global warming.

Table 3: Percent of Total U.S. Emissions from the Electric Sector

Impact	**Ambient Air Quality**				**Toxic**	**Climate Change**	
	---------		**Acid Rain**				
Pollutant	PM_{10}	$PM_{2.5}$	SO_2	NO_x	Hg	CO_2	N_2O
Emission %	16	3	65	20	43	38	4

(EPA, 2006b)

Renewable energy investment levels were based on in-house estimations and the EIA's Annual Energy Outlook from 2005. The hurdle rate, a measure of difficulty for market penetration of future energy technologies, was particularly high for renewable sources such as solar. The model projections for investment cost per kW of solar or wind may also be high for today's projections. Since MARKAL determines the least cost energy mix based on technology and market data, coal and natural gas tend to dominate the market even with emissions constraints. MARKAL is a useful tool, but it is only as good as the data input into the model, which must be up-to-date in order to adequately predict national electricity scenarios. An upgrade or extensions to MARKAL could greatly aid analysis. (EPA, 2006b)

Recently, EPA has taken steps toward establishing a carbon cap-and-trade system, which may have a deep and lasting effect on renewable energy development. Such a scenario was not considered in MARKAL analysis. The implementation of a carbon cap-and-trade program could level the playing field between traditional and renewable energy sources because coal, petroleum and natural gas plants would become less profitable.

User input scenarios are compared to a "business as usual" (BAU) model that predicts average 1.3 percent annual growth in electricity demand. The EPA National MARKAL Database (EPANMD) uses technology data from the following five sources to populate the BAU model, in order of precedence.

1. *Annual Energy Outlook 2002* (EIA, 2002)
2. "Supporting Analysis for the Comprehensive Electricity Competition Act" (DOE, 1999)
3. *Technical Assessment Guide* (EPRI, 1993)
4. 1997 DOE MARKAL database
5. National Energy Technology Laboratory (Boilanger, 2002)

(EPA, 2006b)

As evident by the dates of these publications, the data and constraints applied to the report are now obsolete. MARKAL is an excellent tool for energy modeling, but it could be used to characterize more scenarios of consequence to EPA and help the Agency prepare Clean Air Act implementation strategies only if the software is regularly updated with current data.

According to Timothy Johnson, one of the lead authors of EPA's MARKAL analysis paper, there are currently no plans to update the MARKAL findings. Johnson belongs to EPA's Air Pollution, Protection and Control Division (APPCD), which is EPA's primary risk assessment division for the electricity sector. His division is uniquely responsible at EPA for determining the environmental effects of energy use. This monumental task takes APPCD researchers in many different directions. As of April 2, 2009, the APPCD is working simultaneously on issues such as energy efficiency, plug-in hybrids, and biofuels. (Interview, 4/2/09)

c. EPA Guidance and Conflict Resolution

Recognition of competing environmental objectives for new energy system construction is critical for EPA. It is appropriate for EPA to perform and evaluate tradeoff analyses that take into account multiple perspectives. Consumers, utilities, environment, economy and culture are impacted uniquely with every energy decision. While it has never been EPA's role to decide which of these are most important or to demand the solution with the least environmental impact, a consistent framework for conflict resolution could aid renewable energy development. As a primarily scientific research agency, EPA has an extensive library of guidance documents for activities affecting the environment, ranging from stormwater control during construction to sulfur removal technology in a coal-fired power plant.

i. Renewable Energy Projects on Federal Lands

The National Environmental Policy Act (NEPA) provides a useful framework for analyzing energy projects. NEPA "requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions." (EPA, 2009c) The federal agency taking action must prepare an environmental assessment unless the project is categorically excluded from evaluation. Normally this exclusion applies to actions predetermined by the agency to have no significant environmental effect. If there is no automatic exclusion, NEPA applies to all construction and post-construction activities. federal agencies must justify any effects on air quality, water quality, endangered species and resources.

If the environmental assessment determines significant environmental effects may ensue from the project, or if the project is controversial from the beginning, the agency must prepare a more detailed environmental impact statement (EIS). An agency must always prepare an EIS "on proposals, for legislation or other major federal actions significantly affecting the quality of the human environment" (Regulations, 1986). NEPA includes specific statutory language detailing the requirements of an EIS.

> The discussion will include environmental impacts of the alternatives including the proposed action, any adverse environmental effects which cannot be avoided should the proposal be implemented, the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would be involved in the proposal should it be implemented. (Regulations, 1986)

Once a draft EIS is completed, it is opened up to the public and other federal agencies for comment, then the agency must make a decision whether to proceed. The decision becomes a public record and includes analysis of alternatives and an explanation of how the EIS findings were incorporated into the decision. NEPA regulations are intentionally broad, but they contain key elements for conflict resolution among electricity sector projects and alternatives. These include documentation of direct and indirect effects of a proposal and the significance; possible conflicts between the proposed action and the objectives of federal, regional, state, and local land use plans; policies and controls for the area concerned; the environmental effects of alternatives including the proposed action; energy and natural resource requirements and conservation potential of the alternatives including mitigation measures; urban quality, historic and cultural resources conservation, and means to mitigate adverse environmental impacts. (Regulations, 1986)

EPA has authority to comment on the merits of environmental data supplied in an EIS. After an agency publishes a draft EIS, EPA makes a determination using an internal ranking system that the EIS is Environmentally Unsatisfactory (EU), there are Environmental Objections (EO), Environmental Concerns (EC), or a Lack of Objections (LO). Only in the EU rating does EPA explicitly recommend not to proceed with a proposal. This is a layer of review aside from internal and public comments for the agency taking action, and is the primary method of EPA input into the federal land use debate for renewable electricity. (EPA, 2009c)

EPA's role in the EIS process is unique. Permanent staff reviewers have the ability to comment on all the environmental effects of federal projects and legislation, although generally EPA's expertise is in air and water quality. Congress passed Section 309 of the CAA (Policy Review, 2008), which explicitly gives the EPA administrator a requirement to comment on NEPA-related projects. It also provides that if the administrator determines the legislation, action or regulation to be unsatisfactory, the case can be referred to the Council on Environmental Quality (CEQ) for further review. The administrator's responsibility is delegated to the NEPA Compliance Division in the Office of Federal Activities, but it is more common that the EPA Region affected by the proposal compiles and sends comments concerning the EIS.

Ken Mittelholtz of the NEPA Compliance Division is a reviewer with over 30 years experience, and said referrals to CEQ are rare, having only happened about 30 times over 40 years. The original intent of CAA Section 309 was for EPA to take the lead in reviewing and maintaining EIS records, not to determine the fate of major federal proposals. EPA's findings on a specific EIS may spur major modifications to agency's proposal, but ultimately the choice to terminate or proceed with a project lies with the agency performing the action.

If an agency decides to move forward with a controversial or environmentally unsatisfactory project, there are other stakeholders keeping the agency in check. Beside CEQ referrals, environmental groups and individuals may contest the validity of an environmental assessment through a "citizen suit." In addition, there may be state permits and regulations interfering with a federal project, even on federal lands. For many years, it appeared DOE was going to install a nuclear waste repository in Yucca Mountain, Nevada, despite heavy protest from the state. The EIS report found very few environmental effects, and determined that storage would be safe and well protected underground. The nearest population center, Las Vegas, was approximately 100 miles away in case of a leak or other disaster.

Nevada found a way to block the project just before it was set to proceed. Construction of the repository required a railroad to transport spent nuclear waste, which included bridges and pilings that could impact surrounding wetlands. Sections 401 and 404 of the CWA are concerned with discharges into the Nation's public waters and construction within those waters, respectively. CWA permitting authority resides with EPA, but EPA delegated this power to nearly all states, including Nevada. This delegation of authority allowed Nevada to be able to threaten a denial of these permits, which effectively killed the project. Nevada may not have had adequate data to support this denial, but it is legal nonetheless. EPA could potentially take back primary authority for issuing CWA permits from Nevada, but this would complicate matters even worse and Mittelholtz believes firmly that EPA will not choose to do so. He believes this case is symptomatic of many large projects including the construction of renewable energy capacity, namely that residents near a proposed construction site are given to protest, even if the project is effectively harmless and could do the country a service. This NIMBY (not in my backyard) response and the legal battles that follow add complexity to well-meaning projects such as "A Solar Grand Plan," and wind turbines in Nantucket Bay. (Interview, Mittelholtz)

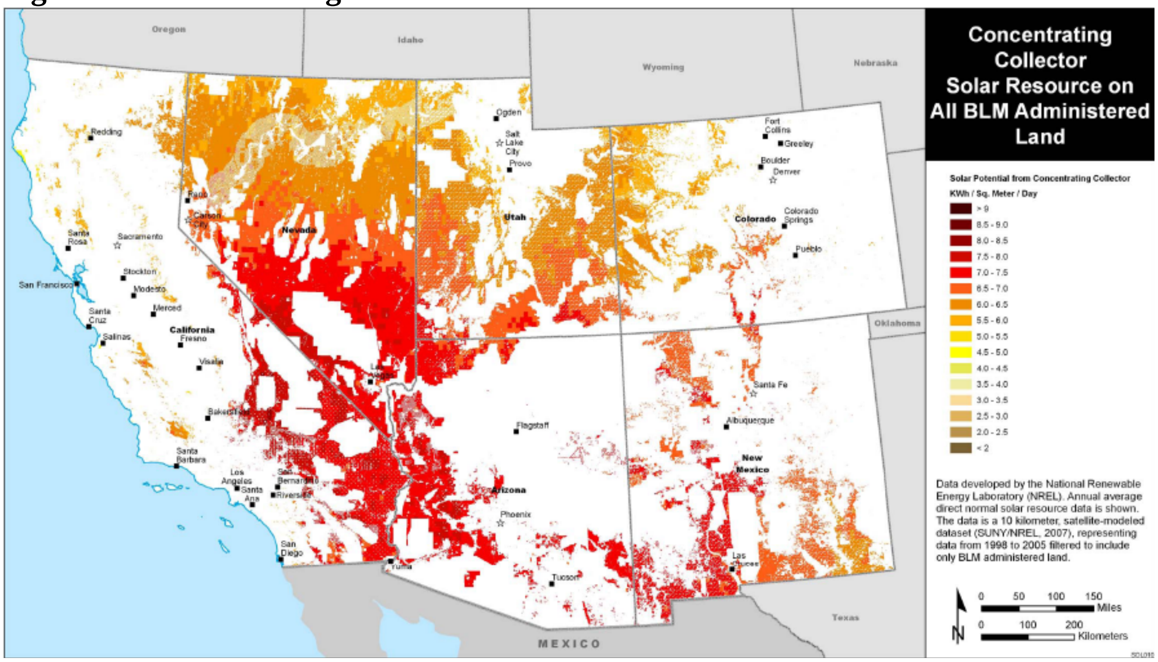
Another relevant example is the EIS being prepared by the DOE Office of Energy Efficiency and Renewable Energy (EERE) in collaboration with the Department of Interior's Bureau of Land Management (BLM). The EIS will provide programmatic data for utility-scale solar development in the Southwest, and is the same federal action Senator Feinstein is attempting to block. It appears likely that attempts to block development will be unsuccessful for multiple reasons. Unlike in the Yucca Mountain case, there is no applicable permitting authority for solar panels or wind turbines. In addition, DOE and BLM are under pressure to develop new electric generating capacity by 2015. Title II, Section 211, of the Energy Policy Act of 2005 (P.L. 109-58) provides that the Secretary of the Interior should, within 10 years of enactment of the Act, "…seek to have approved non-hydropower renewable energy projects located on the public lands with a generation capacity of at least 10,000 megawatts of electricity." (Energy Policy Act, 2009)

To fulfill this requirement, DOE and BLM are looking at six Southwestern states as critical locations for compliance. The evaluation of this EIS will have a large impact as DOE and BLM try to implement program-wide guidelines that facilitate environmentally responsible utility-scale solar energy development. (Energy Policy Act, 2009)

The Programmatic EIS draft soon to be released by DOE and BLM will analyze three alternatives: a facilitated development, limited development and no action alternative. Facilitated development would establish agency-wide environmental policies and mitigation strategies that would be applicable to solar energy deployment, and include detailed analysis of potential activities over the next twenty years. A limited development plan would only evaluate the impact of a finite number of solar projects. The Federal Land Use and Management Policy Act (FLPMA) also guides the actions of BLM in these alternatives. (ANL, 2009)

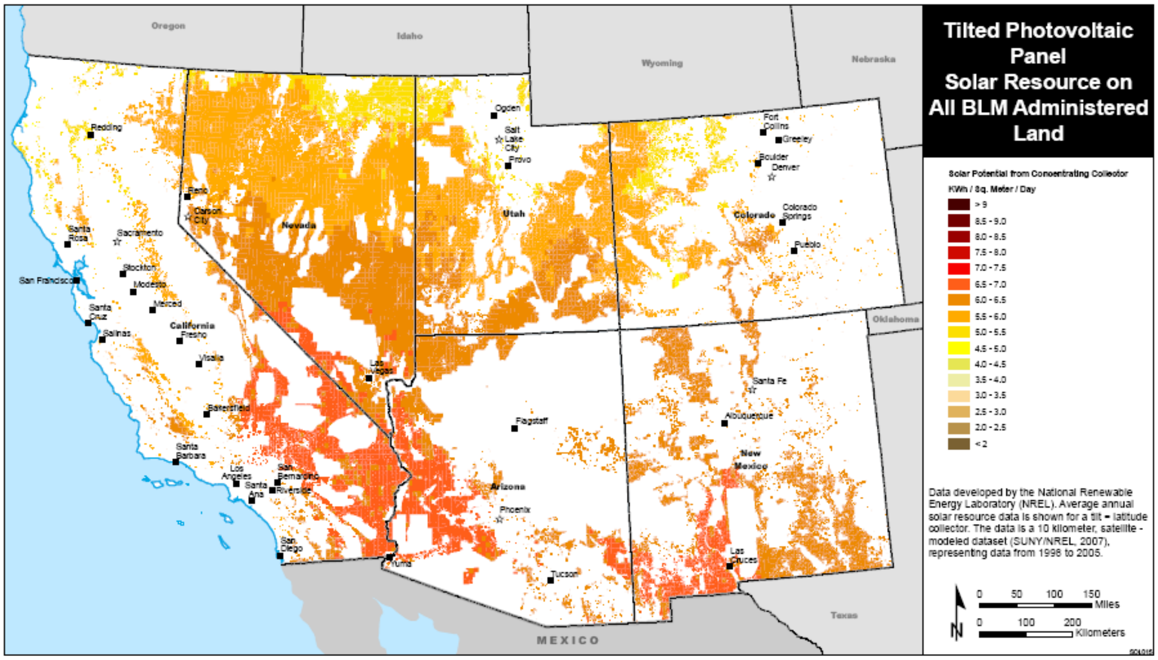
In order to help BLM identify land suitable for development, NREL produced maps of solar resources in the Southwest. Concentrating collector solar resources are shown in Figure 2 and tilted PV panel potential is shown in Figure 3. The darker the color, the more solar resource potential, measured in kWh per square meter per day.

Figure 2: Concentrating Collector Solar Resource on All BLM Administered Land



These maps are intended to help guide decisions for siting solar energy projects based strictly on solar resources. A recent project launched by Google Earth is seeking to expand the details of these maps, including the potential of 13 Western states suitable for large solar and wind energy projects. The project, called "Map Green Energy," will also identify critical habitats for protected wildlife and superimpose these locations with solar and wind resource data. This will be the most comprehensive effort of its kind. (Woody, 2009)

Figure 3: Tilted Photovoltaic Panel Solar Resource on All BLM Administered Land



(ANL, 2009)

When the draft EIS for the Southwest project is prepared, EPA Region 9, headquartered in San Francisco, will likely take the lead with input from Region 6 and possibly Region 8. The CAA Section 309 reviewer in each Region will send the EIS to appropriate air and water staff for their review. Only one EPA comment letter is sent, so the lead region will collect all comments and put together the final comment letter. If time allows, the lead reviewer will send the draft letter back to the other regions for a brief internal review. (Interview, Mittelholtz)

Federal agencies are not always cordial when it comes to settling a difference of opinion about the impacts of a project or how to characterize these impacts. According to an internal EPA release (InsideEPA, 2009a), EPA recently clashed with BLM on "how to address the cumulative impacts of oil and gas development, which include the total present and likely future air quality impacts of current and potential development."

Disagreements between EPA and BLM concerning NEPA implementation began in 2008 when EPA Region 8 raised concerns about BLM's programmatic EIS for oil shale development. The region was dissatisfied with the analysis provided and argued that future analyses from BLM must include cumulative and indirect environmental effects. The NEPA conflict amplified when BLM and the Forest Service (FS) of the Department of Agriculture published a Memorandum of Understanding (MOU) defining what constituted appropriate air quality analysis for projects that take place on land owned by the two agencies. Major renewable energy projects are likely to be constructed on these lands, which add up to approximately 450 million surface acres between the agencies. Table 4 shows the decision table that the FS and BLM attempted to establish with the MOU. (InsideEPA, 2009b)

Table 4: Federal Land Management Agency's Decision Table

Decision Level	Appropriate Air Quality Analysis	Remarks
PLANNING	• Quantitative Modeling: None required • Qualitative Analysis: As needed, based on appropriate development scenarios	Available information is too speculative (neither specific or detailed) to support quantitative air quality modeling as only broad decisions are being made concerning whether lands are available for energy development activities.
LOW-LEVEL ENERGY DEVELOPMENT ACTIVITY	• Quantitative Modeling: None required except in the rare situation when the land management agency determines emissions analysis indicates need • Qualitative Analysis: As needed	Available information is generally highly speculative. The action involves low levels of surface disturbance and projected emissions are usually too small to warrant use of a quantitative model.
PROJECT / HIGH-LEVEL ENERGY DEVELOPMENT ACTIVITY	• Quantitative Modeling: Appropriate level as determined by the land management agency in consultation with EPA (or delegated state agency) • Qualitative Analysis: As needed	Availability of information for a project with a high-level of development is more certain. A quantitative estimate of emissions can be produced and can result in useful modeling.

(MOU, 2009)

The MOU, signed in the final days of President George W. Bush's administration, complicates air enforcement and renewable energy development on federal land. Catherine McCabe, Acting Assistant Administrator for EPA's Office of Enforcement and Compliance Assurance, responded in a memorandum to FS and BLM with concerns that "the MOU would establish a 'one size fits all' paradigm on air quality analyses that is unacceptable to EPA" and the approach is "inconsistent with NEPA" (EPA, 2009d). The letter directly suggests the agencies put aside this MOU in favor of a collaborative effort for establishing air quality analysis guidelines with EPA. One of the main points of conflict was the implication of Table 4 that air quality analyses performed in the planning stage are too speculative. McCabe also disagreed with the conclusion that quantitative modeling and cumulative impact analyses are unnecessary except in the case of projects with a high-level of development or in the later stages of a project. McCabe alternatively supports these analyses to be performed in the early stages of a project in order to help identify mitigation strategies.

Although the MOU is non-binding, the conflict between EPA and FS/BLM is problematic for certain states, who are complaining the disagreement is "adversely impacting their ability to protect air quality from oil and gas development" (InsideEPA, 2009a). The problem is most evident in Western states such as Colorado, where over 50 percent of oil and gas development occurs on private land. Emissions from private rural areas do not figure into EIS calculations currently, because these are the areas that typically lack air quality monitoring devices. This leads federal agencies filing an EIS to understate the emissions impacts of their actions, and may cause a state to slip into non-attainment status for NAAQS.

One possible tool for preventing this situation is what is known as "general conformity law," which mandates that federal actions not contribute to a violation of air standards. Colorado is considering a lawsuit against BLM for a possible violation of the state's air quality plans. (InsideEPA, 2009a)

Interstate transport of air pollution is also an issue remaining unaddressed by EPA. California, New Mexico and Colorado are among the states that recently failed to submit State Implementation Plans for interstate transport of particulate matter and ozone pollution, which means that EPA must instead define a Federal Implementation Plan (FIP) for these states within two years. It has been four years now without an FIP, and EPA is being sued by a non-profit organization working on behalf of the states for their delay. States are arguing that there is little that they can do to curtail oil and gas development on private lands without an FIP. (InsideEPA, 2009c)

ii. Renewable Energy Projects on Non-Federal Lands

Non-federal projects are not covered under NEPA, but many states have similar legislation. California has one of the largest parallel programs to NEPA called the California Environmental Quality Act (CEQA), passed in 1970, the same year as NEPA. State-owned lands may be subject to this type of legislation where NEPA does not apply. Other Federal Acts such as the Resource Conservation and Recovery Act (RCRA) and the Endangered Species Act (ESA) always apply whether or not the land in question is publicly or privately owned. In the case of developing private lands, EPA and other federal agencies cannot enforce NEPA requirements.

Chapter 5: Leveraging Partnerships

EPA regulations and actions are subject to review and rely on input from its partners in both the private and public sectors. Dialogue between EPA and all its stakeholders is essential for safe and effective renewable energy deployment. The optimal solution for reducing pollution, dependence on foreign oil, and the effects of global warming through electricity use is reliant on many factors. The residential, commercial and industrial sectors all require different approaches. The appropriate management for a specific project may depend on size, location, intention and a host of other characteristics.

a. Energy Star Program

Commercial electric utilities and organizations seeking to make energy improvements can do so by signing a partnership agreement with EPA and DOE for the Energy Star Program. This long-standing program is known to over 70 percent of Americans (Energy Star, 2008), and includes a familiar label for consumer products and advice for home construction and renovation, commercial and industrial building design, and utilities. The focus of Energy Star is mostly on energy efficiency, but there may be opportunity to connect Energy Star with consumer-based renewable energy products such as PV. There may be a great advantage for the renewable industry in expanding the Energy Star label to include these products because of name recognition and sheer size of the program.

b. Green Power Partnership

The Green Power Partnership (GPP), launched in 2001, is aimed at public and private corporations, government agencies, non-profit and educational institutions. The program is administered jointly by EPA, DOE, the World Resources Institute, and the Center for Resource Solutions. After signing a partnership agreement, an organization must fulfill its purchasing requirements for renewable energy set by EPA within six months (Interview, Collison). Table 5 shows the requirements for various size electricity consumers.

Table 5: Green Power Purchase Requirements

Organization's annual electricity use (kilowatt-hours)	GPP Requirements (organization must purchase this much green power within 6 months)	Green Power Leadership Club Requirements (organization must purchase this much green power within 6 months)
≥100,000,001 kWh	2% of use	20% of use
10,000,001 – 100,000,000 kWh	3% of use	30% of use
1,000,001 – 10,000,000 kWh	6% of use	60% of use
≤ 1,000,000 kWh	10% of use	Not applicable

(EPA, 2009d)

GPP is a strictly voluntary program helping companies connect with green energy suppliers, purchase electricity, and gain a positive reputation for their company. There are no financial or tax credit incentives. However, according to Blaine Collison, director of the GPP Program, the GPP provides a "recognition and communication platform for its partners. EPA is not in a position to roll out a broad, multifaceted consumer ad campaign, but they try to help partners improve relations with stakeholders." (Interview, Collison)

Eligibility for the GPP requires marginal improvements of green power purchasing by organizations that go beyond mandated requirements such as state RPS. Annual reporting to EPA summarizing green electricity purchases and partnership status is also required. Collison notes EPA does not have the capability to verify data supplied by the nearly 1,100 GPP partners. However, he is confident companies provide accurate information because misreporting numbers for a voluntary program such as GPP is not worth risking a company's reputation. In addition, the renewable energy supply and purchasing industries are competitive enough that there is actually some self-policing. If there is ever any doubt about the accuracy of a report, EPA can go to the electricity providers to verify that client information exists with the provider.

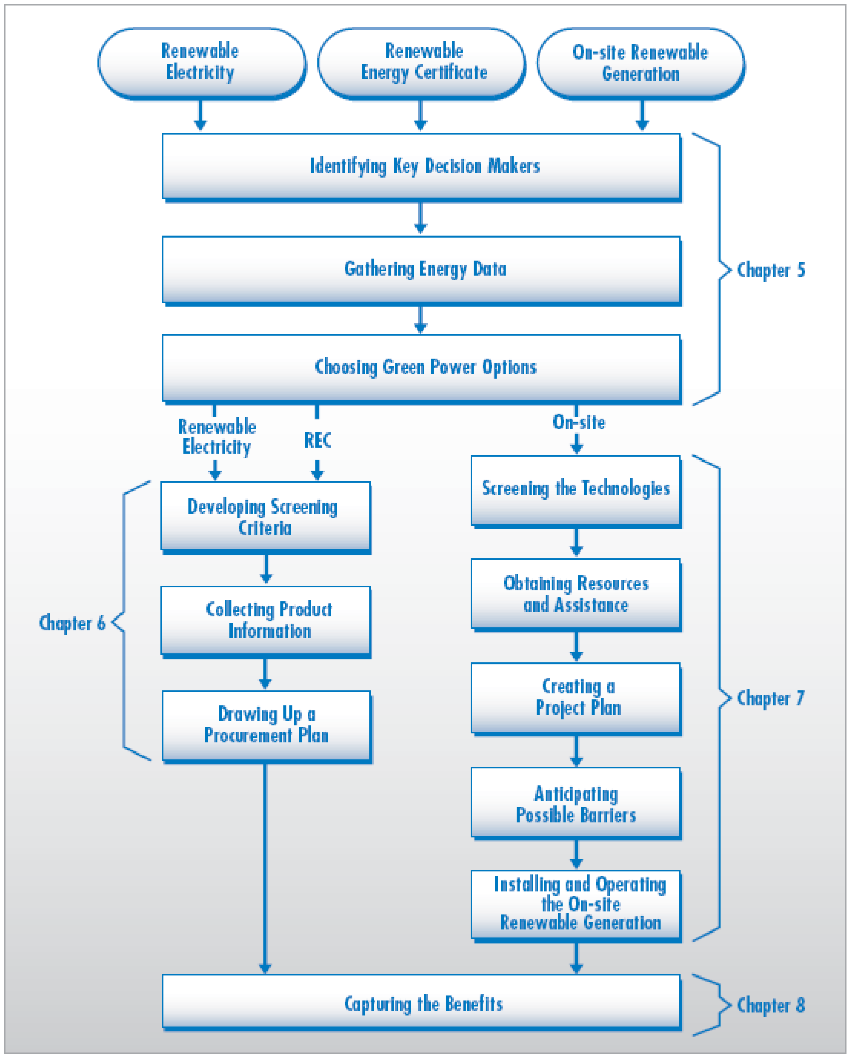
Minimum purchasing percentages are relatively small, with the largest electricity consumers (≥ 100,000,001 kWh/year) only required to purchase 2 percent of their electricity from renewable sources to qualify for GPP. The reason the percentages are low, according to Collison, is that it attracts more companies. Setting standards too high will decrease the likelihood of investment in renewable energy. The goal is to establish partnership because once an agreement is finalized, companies tend to increase their green purchases each year. The GPP helped increase growth in commercial customer purchases from less than 400,000 MWh in annual purchase commitments in 2001 to nearly 7 million MWh in 2006, an 18-fold increase in just five years. (EPA, 2007)

EPA's *Guide to Purchasing Green Power* is an informational guide for organizations considering their options for purchasing renewable electricity. The guide states that "EPA will periodically review and update the minimum purchase requirements to keep pace with the market and buyer patterns" (EPA, 2005). Over the four years Collison has been with GPP, he has seen the standards modified twice. His division reviews the requirements approximately every year and found that since 2001, organizations in the lower tiers (small consumers) had a much easier time meeting requirements compared to large or Fortune 500 companies. A deeper look into this fact revealed smaller companies can more easily purchase a higher percentage of renewable energy because of volume. Hence, the percentage requirements were recently increased for the bottom two tiers in Table 2.

The GPP exemplifies the methods EPA uses to encourage renewable energy development when there is no regulatory backing. Without statutory directives to administer a program, EPA cannot directly intervene and must set up voluntary programs to satisfy an objective. "Clean Air and Global Climate Change" is the first goal listed under EPA's Strategic Plan (EPA, 2008b), but EPA must not be relegated to an advisory role if major progress is to be made in the electricity sector.

Work from the GPP produced some very useful guidance for renewable energy project managers. For example, Figure 4 shows a generic workflow diagram for implementing a renewable electricity plan from a manager's perspective. Whether the decision is to produce electricity on-site, purchase electricity from outside, or purchase renewable energy certificates (REC's), these steps can guide decision-makers in the public and private sectors who must determine how to best utilize renewable energy.

Figure 4: Steps to a Successful Green Power Project



(EPA, 2004)

Interagency collaboration is beginning to cultivate new demand for renewable energy. Communication between organizational partners and agencies administering the GPP is critical to the program's success. Currently NREL maintains a list of green energy suppliers and EPA maintains and reviews partnership status. One way the GPP might improve is by developing a tool comparing the different regional suppliers of renewable electricity opposed to merely listing them. Agencies may also increase participation by boosting incentives holding events to foster more competition.

Chapter 6: Needs and Recommendations

As the lead agency responsible for implementing the Clean Air Act, EPA can set regulations affecting the entire electricity sector. A national cap-and-trade program for carbon emissions would do a great deal to encourage the prospects of renewable energy producers and investors. Although this legislation must be enacted by Congress, it is reasonable to expect EPA will act as the lead agency for implementing such a program. EPA is currently taking steps to prepare for this possibility with a recent proposal that seeks to create the first national reporting system for GHGs. Approximately 13,000 facilities accounting for 85-90 percent of GHG emissions in the United States would be required to report. This new system will pull together and add to the efforts of state and voluntary CO_2 reporting. (EPA, 2009e)

To properly assess the ongoing impacts of regulations affecting the electricity sector, EPA must perform objective scientific analysis and stick to clear and accepted methods for making its conclusions. In a general sense, this may include independent monitoring of scientific activities by advocacy groups and regulatory stakeholders, oversight by respected scientific societies and research institutions, and transparency of scientific procedures to the public and appropriate media. (Vig and Kraft, 2006)

Assuming EPA’s data is sound and opinions are maximally objective, one of the chief recommendations of this paper is for EPA to establish standards for comparing renewable energy technologies. The second is to leverage partnerships and expand certain programs to promote deployment of safe renewable energy. While EPA does not have control over developments on private land, distributed energy sources and PV in particular may soon be on rooftops throughout the world. To ensure the safe deployment of distributed electricity, steps EPA may take include:

- Designating a program such as the RCRA Program to create a national environmental review system for distributed renewable energy technologies
- Allocating approximately $30,000 for a grant or contract to develop environmental criteria for consumer-based renewable energy technologies similar to EPEAT
- Certifying qualified electricity generators with a "low environmental impact" or similar rating, analogous to the Energy Star program for efficient energy use
- Establishing regular reporting requirements for companies and organizations that achieve certification
- Performing outreach to the renewable energy sector through educational seminars
- Hosting promotional events to help raise awareness, including industry competitions and take-back programs for distributed systems at the end of their useful lives

Many of these steps come with little investment aside from staff time, and could go a long way to ensure the safety of emerging distributed renewable energy units. For utility scale production, a different set of rules apply. NEPA is the guiding force for projects on federal lands along with the FLPMA. DOE, BLM and private companies have plans to significantly develop these lands for new electricity generation over the next few decades, making it imperative for EPA to lay out a thorough process for environmental assessment. In addition to the EIS process already in place, EPA should consider the following actions for renewable energy deployment on federal lands:

- Initiate a workgroup to discuss ways of improving NEPA implementation across EPA and the federal government as a whole
- Publish a white paper outlining needs, goals and strategies
- Increase the resources available for research in the APPCD so EPA can regularly update national energy models
- Encourage federal agencies taking action to use EPA data for calculating emissions or emissions avoided
- Seek authority from Congress to develop and enforce standards for EIS reporting beyond current NEPA requirements
- Monitor projects by requesting regular updates from the federal agency taking action and how they have met or not met goals in EIS proposal

- For programmatic EIS, ensure uniform standards are set for each project implemented
- Directly involve and collaborate with the agency performing an EIS for large or controversial projects
- Improve EIS data verification capabilities
- Appoint a committee with oversight over these actions, or create a new branch or division within the Office of Federal Activities

EPA recently took steps to standardize air quality analysis procedures in an EIS. The new checklist procedures were circulated after the agency received what they called "a string of poor air quality analyses" (InsideEPA, 2009b). Standardizing EIS procedures should be a requirement for EPA, rather than an optional project resulting from poor EIS submissions. Although EPA is the lead agency making comments and keeping records for NEPA projects, it is problematic that the agency has no real power over federal land use projects. Until such authority is established, developing non-enforceable criteria after receiving input from other agencies could help reduce protracted court battles. If and when this authority is granted, EPA may require a new branch or division to handle the workload.

Life cycle analysis should also be a guiding principle for major decisions involving EPA. NEPA activities as well as other programs could benefit from applying this method consistently throughout the agency. From evaluating distributed energy products to utility-scale power decisions, the life cycle perspective should be a lynchpin at EPA.

Chapter 7: Conclusion

Electricity production and use have major effects on air, water, and land quality. As the foremost regulatory authority on these issues, it is important EPA continuously examine the possible methods of reducing the environmental impacts of increasing electricity demand. EPA already has the tools, expertise and personnel available to perform this function but could benefit from a comprehensive strategy. Of course, controlling pollution from the electricity sector is a complex task involving supply- and demand-side management, but taking initial steps such as forming workgroups to examine NEPA implementation or to outline strategies for national electricity use could prove very beneficial.

EPA's history is rich with examples of identifying a pollution source and then controlling it through regulation. This tactic has proven effective for many waste streams, but improving the environmental performance of the electricity sector may require additional strategies. With the threat of climate change growing, so are the possible technologies in the electricity sector that may help to abate the worst of its effects. In addition to the tools and strategies discussed here, there may be other assets EPA has in-house to help compare electricity alternatives and promote cleaner, efficient use of energy. Given that a significant share of GHGs are emitted from the electricity sector, introducing life cycle analysis, comparison of alternatives, and incentives for top environmental performers may be a preferable strategy to "identify and reduce." Partnerships between EPA, DOE and other agencies will be paramount to any successful strategy. Solar and wind energy sources are likely to emerge victorious as a result of such programs because they are virtually emission-free, use minimal resources, and enhance national security through their distributed locations and environmentally benign nature. A thorough examination of the environmental effects of electricity at EPA will have long-lasting benefits.

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