From:	Hingtgen, Robert J
To:	Patrick Brown; Megan Lawson (mlawson@dudek.com); Joe Monaco
Cc:	Gungle, Ashley; Fogg, Mindy; Witt, William
Subject:	FW: Scoping Comments of The Protect Our Communities Foundation et al. for the Soitec Solar Project PEIR (Email 1 of 3)
Date:	Friday, October 11, 2013 11:16:40 AM
Attachments:	10-10-13 Soitec Solar PEIR Scoping Comments of The Protect Our Communities Foundation et al.pdf Exhibit 1 to Soitec Solar PEIR Scoping Comments of POC et al.pdf Exhibit 2 to Soitec Solar PEIR Scoping Comments of POC et al.pdf Exhibit 3 to Soitec Solar PEIR Scoping Comments of POC et al.pdf Exhibit 4 to Soitec Solar PEIR Scoping Comments of POC et al.pdf

This is the first of three emails received yesterday from the Law Offices of Stephan C. Volker regarding the Soitec Project. Please review and we can discuss next week.

Thanks,

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From: jvolker [mailto:jvolker@volkerlaw.com]
Sent: Thursday, October 10, 2013 3:59 PM
To: Hingtgen, Robert J
Cc: 'svolker'
Subject: Scoping Comments of The Protect Our Communities Foundation et al. for the Soitec Solar Project PEIR (Email 1 of 3)

Dear Mr. Hingtgen,

Attached to this email please find the Scoping Comments (and Exhibits 1-4) of The Protect Our Communities Foundation, Backcountry Against Dumps and Donna Tisdale for the Programmatic Environmental Impact Report being prepared for the Soitec Solar Development Project. Due to their size, Exhibits 5-11 to our Comments are transmitted separately, in two subsequent emails.

Our Comments and Exhibits 1-11 have also been mailed to you via Priority mail today.

Please let us know if you have any difficulty opening the attached documents.

Best regards,

Jamey Volker
Attorney for The Protect Our Communities Foundation,
Backcountry Against Dumps, and Donna Tisdale

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October 10, 2013

VIA EMAIL AND U.S. MAIL

Robert J. Hingtgen
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Services Department
5201 Ruffin Road, Suite B
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Robert.Hingtgen@sdcounty.ca.gov

Re: Scoping Comments of The Protect Our Communities Foundation, Backcountry Against Dumps and Donna Tisdale for the Draft Programmatic Environmental Impact Report on the Soitec Solar Development Project

Dear Mr. Hingtgen:

Pursuant to the California Environmental Quality Act ("CEQA"), Public Resources Code ("PRC") section 21000 *et seq.*, the Protect Our Communities Foundation, Backcountry Against Dumps and Donna Tisdale (collectively "Conservation Groups") submit the following scoping comments for the Programmatic Environmental Impact Report ("PEIR") being prepared for the Soitec Solar Development Project ("Soitec Solar" or "Project").

At the outset, Conservation Groups oppose this Project as an unnecessary industrialization of scenic and environmentally sensitive rural land, including important wildlife habitat and farmland. To avoid many of the Project's significant environmental impacts while still providing renewable energy, Conservation Groups urge San Diego County ("County") to analyze and adopt as an alternative to the proposed Project the development of non-fossil fuel distributed generation projects near demand centers in already-disturbed areas. In further expression of these major concerns and others, Conservation Groups submit the following scoping comments.

I. PROJECT BACKGROUND

As described in the Notice of Preparation Public Review Period ("Notice") circulated by the San Diego County Planning and Development Services Department, the Soitec Solar Project would involve the construction and operation by Soitec Solar Development, LLC, of four separate

concentrated photovoltaic ("CPV") electrical generation facilities spread over 1,473 acres in eastern San Diego County, with a combined estimated electrical generation capacity of 168.5 megawatts ("MW"). The "Tierra Del Sol" project would be located on 420 acres at the California-Mexico border south of Boulevard, and would have a nameplate generation capacity of 60 MW. The "Rugged" project would encompass 765 acres just northeast of Boulevard across I-8, and have an estimated capacity of 80 MW. The 22-MW capacity "LanEast" facility would use 233 acres adjacent to I-8 to the east of Boulevard. And the 6.5-MW capacity "LanWest" facility would cover 55 acres adjacent to the LanEast facility on its western side.[1] The Project would operate year-round for *at least* 25 years – the term of the power purchase agreements ("PPAs") between Soitec Solar Development (and its subsidiaries) and San Diego Gas & Electric Company ("SDG&E").

To generate electricity, the Project would use *7,290* CPV trackers, each approximately "48 feet across by 25 feet tall." Initial Study, p. 9 (quote); Notice, p. 1. Given their massive size and considerable weight, each of the *1,200-square foot* CPV trackers would require mounting on a 28-inch steel mast that is either (1) inserted into a hole up to *20 feet deep*, (2) vibrated into the ground up to 20 feet deep, or (3) attached to a large concrete foundation, causing significant environmental disruption. Initial Study, p. 3. In addition, *each* of the four facilities – Tierra Del Sol, Rugged, LanWest and LanEast – would require underground and overhead collector systems, operations and maintenance buildings and grounds, an on-site collector substation, and an overhead generator tie-line ("gen-tie line") connecting the on-site substation to SDG&E's rebuilt Boulevard Substation. Initial Study, pp. 7-8; Notice, pp. 1-2. Constructing this infrastructure would require at least *44 million gallons of water* – or approximately 135 acre-feet – for the Tierra Del Sol and Rugged facilities *alone*. *Id*.

Given the Project's extensive footprint in environmentally sensitive areas, and the amount of infrastructure and natural resources required to construct and operate it, the Soitec Solar Project will have substantial and likely irreparable environmental impacts, all of which the County must analyze in its PEIR. To avoid many of those impacts while still providing renewable energy, the County should analyze and adopt as an alternative to the proposed Project the development of non-fossil fuel distributed generation projects near demand centers in already-disturbed areas.

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[1] Via letter on September 5, 2013, Soitec Solar Development (and its subsidiary LanWest Solar Farm LLC) requested that the County "withdraw the Major Use Permit Application for the LanWest solar farm project," and "close the case out." However, because Conservation Groups have not received confirmation that the LanWest Major Use Permit application has officially been withdrawn, and because the facility is discussed as part of the Project in the Initial Study and the Notice, Conservation Groups conservatively treat the facility as still part of the Project in these scoping comments.

II. THE COUNTY SHOULD ANALYZE AND ADOPT A DISTRIBUTED GENERATION ALTERNATIVE

To comply with CEQA, agencies must consider a "reasonable range" of alternatives. 14 Cal.Code.Regs. ("CEQA Guidelines") § 15126.6(a). To do so here, the County must analyze a distributed generation alternative. As discussed below, increasing distributed generation capacity in San Diego County by more than 168.5 MW – the expected generating capacity of the Soitec Solar Project – is not only feasible, it is environmentally and economically preferable.

A. Distributed Generation Is Feasible

The evidence is clear: Distributed generation – including such sources as solar photovoltaics ("PV"), small-scale rooftop wind turbines and combined heat and power plants – is both technically and economically feasible. In his testimony on "Alternatives to Large-Scale Wind and Solar Projects in San Diego County" presented at the July 20, 2012, San Diego County Planning Commission meeting, engineer Bill Powers, an expert on San Diego-area electrical systems planning, detailed many of the reasons why a distributed generation alternative is both feasible and desirable.[2]

Indeed, distributed generation is not only feasible, *it is already in use and rapidly expanding*. For example, SDG&E is on pace to add between 80 and 100 MW of distributed solar photovoltaic capacity in its service territory each year from 2013 through 2020. This new PV generation will be developed under the auspices of programs such as the Renewable Auction Mechanism program, which the California Public Utilities Commission ("CPUC") approved in December 2010.[3] Under that program, California will add 1,000 MW of local PV by 2015, 80.7 MW of which were allocated to SDG&E. SDG&E will also be allotted approximately 50 MW of local PV under the 750 MW SB 32 feed-in tariff distributed PV program.[4] Furthermore, by the end of 2016, approximately 180 MW of distributed PV capacity will be added in SDG&E's service territory under the California Solar Initiative "million solar roofs" program.[5] Combined,

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[2] Mr. Powers' testimony is attached hereto as Exhibit 1.

[3] CPUC Decision D.10-12-048, "Decision Adopting the Renewable Auction Mechanism," December 16, 2010, p. 30, Table 1, available at: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/128432.pdf.

[4] CPUC feed-in tariff website, description of SB 32, available at: http://www.cpuc.ca.gov/PUC/energy/Renewables/feedintariffssum.htm.

[5] California Center for Sustainable Energy, "Overview of Solar Incentive Programs," October 9, 2009, p. 7, available at: http://www.slideshare.net/ccsemedia/overview-ofsolar-incentive-programs.

approximately 410 MW of local PV capacity will be developed in SDG&E's service territory by the end of 2015. And SDG&E has the ability to add much more, as its territory has at least 7,000 MW of urban and suburban PV potential.[6]

In addition to distributed PV, SDG&E is also on pace to add a substantial number of distributed combined heat and power plants over the next decade. Biogas- or biomethane-fired CHP plants are renewable portfolio standard-eligible, and there are up to 1,700 MW of currently estimated biogas and/or biomethane potential in California to fuel those plants.[7] California's AB 32 greenhouse gas compliance strategy calls for the development of 4,000 MW of CHP by 2020.[8] Since SDG&E supplies about 7 percent of the state's electricity,[9] about 280 MW of new CHP should be allocated to and added in SDG&E's service territory by 2020 to comply with the AB 32 target.

And, as discussed below, expanding SDG&E's renewable energy portfolio – and California's more broadly – with distributed instead of remote, industrial-scale generation will cause much less harm to the environment and public health, while also providing a more robust and sustainable economic stimulus.

B. Distributed Generation Is Better for the Environment and the Economy than Remote, Industrial-Scale Generation Projects Like Soitec Solar

Distributed energy projects such as rooftop solar PV have substantial environmental, aesthetic, economic and public safety benefits over remote, industrial-scale solar energy facilities

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[6] Powers, *San Diego Smart Energy 2020: The 21st Century Alternative*, October 2007, p. 48, available at: http://www.etechinternational.org/new_pdfs/smartenergy/52008_SmE2020_2nd.pdf.

[7] CEC PIER Program, Consultant Report, "Distributed Renewable Energy Assessment – Final Report," August 11, 2009, Appendix Bio-Power, p. 49, available at: http://www.cleancoalition.org/storage/references/11-aug-09_Navigant_distributed%20renewable%20energy%20assessment_final%20report.pdf.

[8] CPUC Decision D.10-12-035, "Decision Adopting Qualifying Facility and CHP Program Settlement Agreement," December 16, 2010, available at: http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/128624.PDF.

[9] California Energy Commission, "2007 Integrated Energy Policy Report, December 2007," p. 27, Figure 1-11, available at: http://www.energy.ca.gov/2007publications/CEC-100-2007-008/CEC-100-2007-008-CMF.PDF.

such as the Soitec Solar Project.[10] They do not mar the landscape with massive, glare-producing and unsightly CPV panels, or their associated powerlines, substations and industrial operations and maintenance buildings. They are much less likely to ignite catastrophic wildfires (see Section V below). They don't displace agriculture and wildlife habitat (see Sections IV and VIII below). They present a much smaller threat to wildlife (see Section IV below). They do not waste electricity due to conductor resistance and corona discharges along lengthy transmission lines.[11] Their reliability is far greater. And they are easier to upgrade as technology improves.

In addition, as these solar PV technologies improve and the liability costs of utility-scale renewable energy facilities become clearer, the per-watt installed price for distributed solar PV systems should soon drop below that of remote, utility-scale projects like the Soitec Solar Project. In likely recognition of this trend, many utility-scale renewable energy project developers themselves agree that distributed generation is the future of renewable energy power. For example, NRG Energy, Inc., CEO David Crane stated the following in a 2011 call with financial analysts:

> Ultimately, however, we fully recognize that the current generation of utility-sized solar and wind projects in the United States is largely enabled by favorable government policies and financial assistance. It seems likely that much of that special assistance is going to be phased out over the next few years, leaving renewable technologies to fend for themselves in the open market.
>
> We do not believe that this will be the end of the flourishing market for solar generation. We do believe that it will lead to a *stronger and more accelerated transition from an industry that is currently biased towards utility-sized solar plants to one that's focused more on distributed and even residential solar solutions on rooftops and parking lots*.
>
> We are already planning for this transition now within NRG, so that any potential

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[10] As former California Public Utilities Commission ("CPUC") Commissioner John Bohn acknowledged, "[u]nlike other generation sources, [distributed generation] projects can get built quickly and without the need for expensive new transmission lines. And . . . these projects are extremely benign from an environmental standpoint, with neither land use, water, or air emission impacts." CPUC, "CPUC Approves Edison Solar Roof Program," Press Release, June 18, 2009, *available at:* http://docs.cpuc.ca.gov/published/News_release/102580.htm.

[11] The U.S. Energy Information Administration estimates that California lost nearly *18 million* kilowatt-hours of electricity in 2010, due primarily to conductor resistance, corona discharges and other transmission and distribution line losses. Energy Information Administration, January 27, 2012, *State Electricity Profiles 2010*, DOE/EIA-0348(01)/2, at p. 30, *available at:* http://www.eia.gov/electricity/state/pdf/sep2010.pdf.

> decline in either the availability of utility-sized solar projects or in the attractiveness of the returns being realized on these projects, *will be exceeded in aggregate by the increase in the business we are doing on smaller distributed and residential solar projects* . . . . (emphasis added).[12]

In sum, distributed generation is not only feasible, it is environmentally and economically preferable to remote, utility-scale renewable energy generation facilities like the Soitec Solar Project.

III. HYDROLOGIC IMPACTS

CEQA requires the County to identify in its PEIR the likely water sources for the Project, and analyze the "environmental impacts of exploiting those sources" and "how those impacts are to be mitigated." *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* ("*Vineyard*") (2007) 40 Cal.4th 412, 421 (quote), 434, 440-441. "An EIR that neglects to explain the likely sources of water and analyze their impacts, but leaves long-term water supply considerations to later stages of the project, does not serve the purpose of sounding an environmental alarm bell." *Id*. at 441 (internal quotations and citation omitted)

Thus far, the County has merely noted that construction of the Tierra Del Sol and Rugged facilities would use at least 20 and 24 million gallons of local groundwater, respectively, for a total of more than *135 acre-feet*. Initial Study, pp. 7-8; Notice, pp. 1-2. CEQA requires more. The County must not only estimate the water needed to construct the other two Soitec Solar Project generation facilities – LanWest and LanEast – it must identify the *operational* water use for the entire Project. And if the evidence shows that Project operation "would demand . . . more than 75 acre-feet of water annually," the County must also prepare a Water Supply Assessment under Water Code section 10910. Water Code § 10912.

Furthermore, the County must do more than state that the Project will use local groundwater. It must identify the specific aquifer – and even well sites – from which the groundwater would be extracted, and the impacts of pumping therefrom. For example, the County must determine whether the Project would extract water from the Campo-Cottonwood Sole Source Aquifer – which seems likely, since the Project sits directly on top of it – and how such extraction would impact that fragile aquifer, the nearby wells, and the local population's ability to

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[12] Seeking Alpha, April 22, 2011, "NRG Energy's CEO Discusses Q4 2010 Results – Earnings Call Transcript," at p. 7, *available at:* http://seekingalpha.com/article/254272-nrg-energy-s-ceo-discusses-q4-2010-results-earnings-call-transcript (attached hereto as Exhibit 2)

obtain adequate water supplies.[13] Without this information, it would be impossible to analyze the impacts of supplying water to the Project as CEQA requires. *Vineyard*, 40 Cal.4th at 434 ("The ultimate question under CEQA . . . is whether [the EIR] adequately addresses the reasonably foreseeable *impacts* of supplying water to the project").

IV. HARM TO WILDLIFE

As the County admits, the "project sites contain sensitive biological habitats with the potential for use by sensitive and/or protected species." Initial Study, p. 19. Among those "sensitive and[] protected species" that the Project would likely harm are the federally endangered Quino checkerspot butterfly, whose critical habitat extends near the Project sites, the federally endangered Peninsular bighorn sheep, the golden eagle, and the burrowing owl, which is a California State Species of Special Concern. The County must thoroughly analyze the Project's impacts to these and other species in its PEIR.

In their 2011 *BioScience* article, Jeffrey Lovich and Joshua Ennen identify many of the "known and potential impacts of utility-scale solar energy development on wildlife in the desert Southwest,"[14] which the County should likewise analyze here. The impacts they identify from "facility construction and decommissioning" include the following:

- "Destruction and modification of wildlife habitat;"
- "Direct mortality of wildlife;"
- "Dust and dust-suppression effects;"
- "Road effects;"
- "Off-site impacts;" and
- "Destruction and modification of wildlife habitat."

Exhibit 4 at 984. They also identify the following impacts "due to facility presence, operation, and maintenance:"

- "Habitat fragmentation and barriers to movement and gene flow;"
- "Noise effects;"
- "Electromagnetic field effects;"
- "Microclimate effects;"
- "Pollution effects from spills;"

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[13] A copy of the official federal Environmental Protection Agency map of the sole source aquifer is attached hereto as Exhibit 3.

[14] Lovich, J.E. & J.R. Ennen, 2011, "Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States," *BioScience*, 61(12): 982-992, at p. 984 (attached hereto as Exhibit 4).

- "Water consumption effects;"
- "Fire effects;" and
- "Light pollution effects, including polarized light."

Id. Because, like the environments studied by Lovich and Ennen, the Soitec Solar Project is located in a predominantly southwestern desert (specifically high desert) environment, the County should analyze all the listed impacts in its PEIR.

V. PUBLIC HEALTH AND SAFETY IMPACTS – FIRE

The California Department of Forestry and Fire Protection ("CalFire") has identified much of the area in and around the Project sites as a Very High Fire Hazard Severity Zone.[15] And within that context, the Project poses a grave risk of igniting, exacerbating and preventing the effective fighting of catastrophic wildfires. Not only do utility-scale solar energy generation plants and their associated transmission, substation and other facilities frequently cause wildfires, they greatly impede fire suppression efforts and pose safety risks to responding firefighters. For example, the Project, like other energy generation and transmission facilities in the San Diego County and Imperial County areas, would create a substantial hazard for low-flying spotter and bomber aircraft that apply aerial retardant. It would be nearly impossible to see the Project's transmission lines in the smoke filled skies, and either pilots would be forced to risk their lives by flying when the lines were not clearly visible, or aerial fire suppression would be stymied. The great risks to firefighters and impediments to firefighting caused by transmission lines are discussed in detail by Mark Ostrander, retired Battalion Chief with CalFire, in his April 14, 2011, expert testimony in a federal lawsuit challenging the Bureau of Land Management's approval of the Sunrise Powerlink project, which is attached as Exhibit 7 hereto. When combined with the extreme limitations industrial-scale solar projects and power lines put on ground firefighting attacks, the huge risks associated with aerial firefighting efforts would make large fires in the Project area virtually uncontrollable.

In addition to the Project's direct fire impacts, the Project also poses significant cumulative fire impacts of the Project alongside the many other energy projects in the region. The cumulative impacts of the industrialization of eastern San Diego County have the potential to permanently alter the fragile desert and mountain ecosystems there through a process called type conversion, described below:

> Plant invasions are widely recognized as significant threats to biodiversity conservation worldwide. One way invasions can affect native ecosystems is by changing fuel properties, which can in turn affect fire behavior and, ultimately,

[15] This is shown in CalFire's 2009 recommended map of very high fire hazard severity zones in the local responsibility area (attached hereto as Exhibit 5), and its 2007 adopted map of very high fire hazard severity zones in the state responsibility area (attached hereto as Exhibit 6).

> alter fire regime characteristics such as frequency, intensity, extent, type, and seasonality of fire. If the regime changes subsequently promote the dominance of the invaders, then an invasive plant-fire regime cycle can be established. As more ecosystem components and interactions are altered, restoration of preinvasion conditions becomes more difficult.[16]

As a result of the unacceptably high fire risks that the Project poses, Conservation Groups urge the County to reject the Project as currently proposed.

VI. PUBLIC HEALTH AND SAFETY IMPACTS – ELECTRIC AND MAGNETIC FIELDS

The Project would expose Project workers, wildlife and others to electric and magnetic field ("EMF") radiation. People and wildlife near the many inverter modules for the Projects CPV systems would be particularly susceptible to harm. Recent studies, such as those by Dr. Samuel Milham and Dr. Magda Havas, have linked EMF exposure with an increase in ailments such as diabetes, fibromyalgia, chronic fatigue syndrome and attention deficit disorder, among others.[17] Similarly, as reported in Lovich and Ennen's recent *BioScience* article, Doctor Alfonso Balmori (in a 2010 article) found the "possible impacts of chronic exposure to athermal electromagnetic radiation" on mammal species to include "damage to the nervous system,

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[16] M.L. Brooks *et al.*, "Effects of Invasive Alien Plants on Fire Regimes," *Bioscience*, 54:677-688, available at: http://www.californiachaparral.com/images/Brooks_et_al_Effects_of_Invasives_on_Fire_Regimes.pdf.

[17] *See, e.g.,* Samuel Milham, "Attention Deficit Hyperactivity Disorder and Dirty Electricity," *Journal of Developmental and Behavioral Pediatrics*, September 2011 (attached hereto as Exhibit 8); Samuel Milham, "Historical Evidence That Electrification Caused the 20th Century Epidemic of 'Diseases of Civilization,'" *Medical Hypotheses*, 74:337-345, 2010 (attached hereto as Exhibit 9); Samuel Milham and L. Lloyd Morgan, "A New Electromagnetic Exposure Metric: High Frequency Voltage Transients Associated With Increased Cancer Incidence in Teachers in a California School," *American Journal of Industrial Medicine*, 2008 (attached hereto as Exhibit 10); Magda Havas, "Dirty Electricity Elevates Blood Sugar among Electrically Sensitive Diabetics and May Explain Brittle Diabetes," *Electromagnetic Biology and Medicine*, 27:135-146, 2008; Magda Havas, "Electromagnetic Hypersensitivity: Biological Effects of Dirty Electricity with Emphasis on Diabetes and Multiple Sclerosis," *Electromagnetic Biology and Medicine*, 25:259-268, 2006, available at: http://www.next-up.org/pdf/Magda_Havas_EHS_Biological_Effets_Electricity_Emphasis_Diabetes_Multiple_Sclerosis.pdf; The National Foundation for Alternative Medicine, "The health effects of electrical pollution," available at: http://d1fj3024k72gdx.cloudfront.net/health_effects.pdf.

disruption of circadian rhythms, changes in heart function, impairment of immunity and fertility, and genetic and developmental problems." Exhibit 4 at 987. Furthermore, even though there remains some disagreement over the impacts of EMF, many "authors suggest that [this] . . . should not be cause for inaction. Instead, they argue that the precautionary principle should be applied in order to prevent a recurrence of the 'late lessons from early warnings' scenario that has been repeated throughout history." *Id*. The County must analyze the Project's EMF impacts in the PEIR.

VII. PUBLIC HEALTH AND SAFETY IMPACTS – GLARE

The County must analyze the Project's potential to cause significant glare from its 1,200-square foot CPV panel arrays. This glare would not only be an aesthetic nuisance to nearby residents and recreationists, it would pose a significant safety hazard to drivers. This hazard would be particularly acute for those driving along I-8 past the adjacent LanWest and LanEast facilities.

VIII. AGRICULTURAL IMPACTS

Nearly 400 acres of the Project sites are zoned for agriculture, as either A72 (General Agriculture) or A70 (Limited Agriculture). Initial Study, p. 16. And much of the "proposed [Rugged] project site has been used for grazing purposes for at least the past 20 years." *Id*. Indeed, in support of the agricultural use of those lands and for the purpose of preserving them in agricultural use under the Williamson Act (Government Code section 51200 *et seq.*), the County designated an area including part of the Tierra Del Sol site as an Agricultural Preserve (AP 77-46). *Id*. at pp. 8, 9, 15. The Project would undo all of that, and cause significant agricultural impacts. *Id*. at p. 9 (Project would require disestablishment of the portion of Agricultural Preserve 77-46 on the Tierra Del Sol site).

By removing agricultural lands from grazing and agricultural production for *at least 25 years* (with "additional terms anticipated" and a solar facility lifespan of more than 30 years), and stripping those lands of their legal agricultural use protections, the Project makes it unlikely that the lands would be ever again be available – let alone used – for grazing or agriculture. One major reason for that is erosion of topsoil. As the Initial Study acknowledges, the soils on at least the Tierra Del Sol and Rugged sites "have a soil erodibility rating of 'severe.'" Initial Study, p. 24. By converting these areas to an high-intensity industrial use from low-intensity grazing, agricultural and other rural uses, the Project would likely cause substantial erosion of fertile and difficult-to-replace topsoil.

Further impairing the viability of grazing and agriculture in the County would be the Project's impact on ranching- and agriculture-serving businesses. As more ranch land and farmland is converted to non-agricultural uses, and as more ranching- and agriculture-serving businesses close or reduce their stocks, it becomes harder and more expensive for the remaining ranchers and farmers to cost-effectively obtain the supplies and services (e.g. veterinarian care) to

maintain their pastures, crops and animals. This in turn results in more ranch land and farmland conversion, and even greater reductions in agricultural services. It is a vicious cycle of ripple and cascading effects whose cumulative impact on the ranching and agricultural economy is rarely acknowledged, let alone adequately evaluated.

The County must fully analyze these and other impacts to ranching and agriculture, both on the Project sites and in the region generally. The County must also ensure that it complies with the Williamson Act (*e.g.* Government Code sections 51232 and 51233) and the County Board of Supervisors Policy No. I-38 in disestablishing the portion of Agricultural Preserve 77-46 on the Tierra Del Sol site, and analyze compliance with those land use laws and policies in the PEIR.

IX. NOISE IMPACTS

In analyzing the Project's audible noise impacts, the County should normalize its noise emission estimates to account for the fact that the Project area is a rural community with little to no prior exposure to industrial noise, such as would be produced by Project. In addition, the County should analyze not only the Project's audible noise emissions and impacts, but its inaudible infrasound and low-frequency noise emissions too, which have recently been shown to have a much greater potential to impact humans than previously thought.[18]

X. GLOBAL WARMING

The Initial Study states that while the Project will produce some GHGs through construction and operation, it "is expected to offset greenhouse gas ("GHG") emissions by serving as a longterm renewable energy source, thereby decreasing overall emissions attributable to electrical generation in California." Initial Study, p. 27. The County should not be so swift in its conclusions. It must carefully examine these conclusions in the PEIR, analyzing all the Project's potential GHG emission sources and comparing the total emissions per kilowatt-hour (averaged over the expected life of the Project) to the other energy sources the County implies will be displaced.

In assessing the Project's GHG emission impacts in the PEIR, the County must do more than just calculate the GHG emissions from construction activities, construction-related vehicle traffic and employee vehicle use during Project operation, which is all the Initial Study indicates will be done. Initial Study, p. 27. The County must also (1) assess the Project's substantial *embedded* greenhouse gas emissions: the GHG emissions associated with production of the materials used to construct the Project, such as the photovoltaic panels; and (2) compute the change in GHG emissions from the soil on the Project site resulting from the Project's conversion

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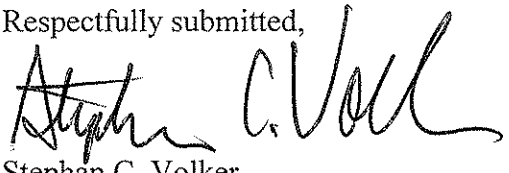
[18] Salt, Alec & Jeffery Lichtenhan, 2012, "Perception-based protection from low-frequency sounds may not be enough," presented at InterNoise 2012 in New York City, New York, August 19-22, 2012, at p. 5 (attached hereto as Exhibit 11).

of the land from grazing, agricultural production and other lower-intensity rural uses to the proposed industrial-scale CPV facilities. Additionally, the County must ascertain whether the electricity produced by the Project would actually either (1) supplant electricity currently generated by fossil fuel-based systems, or (2) meet a future energy demand that would otherwise be met with fossil fuel-based generation.

XI. CONCLUSION

Conservation Groups oppose this Project as an unnecessary industrialization of scenic and environmentally sensitive rural land, including important wildlife habitat and farmland. To avoid many of the Project's aforementioned significant environmental impacts while still providing renewable energy, Conservation Groups urge the County to analyze and adopt as an alternative to the proposed Project the development of non-fossil fuel distributed generation projects near demand centers in already-disturbed areas. The County must also fully analyze each of the foregoing environmental impacts in its PEIR.

Respectfully submitted,



Stephan C. Volker
Attorney for The Protect Our Communities Foundation.,
Backcountry Against Dumps and Donna Tisdale

SCV:taf

LIST OF EXHIBITS

1. Powers, Bill, July 20, 2012, "Alternatives to Large-Scale Wind and Solar Projects in San Diego County," presentation at the July 20, 2012, San Diego County Planning Commission Regular Meeting;

2. Seeking Alpha, April 22, 2011, "NRG Energy's CEO Discusses Q4 2010 Results – Earnings Call Transcript;"

3. U.S. Environmental Protection Agency, Region 9 GIS Center, 2008, "Campo-Cottonwood Sole Source Aquifer: Designated Area" (map);

4. Lovich, Jeffrey E., and Joshua R. Ennen, 2011, "Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States," *BioScience* 61(12):982-992;

5. California Department of Forestry and Fire Protection, June 12, 2009, "Very High Fire

Hazard Severity Zones in LRA: As Recommended by CalFire" (map), CalFire Map ID: FHSZL_MAP;

6. California Department of Forestry and Fire Protection, November 7, 2007, "Fire Hazard Severity Zones in SRA" (map), CalFire Map ID: FHSZS_MAP;

7. Declaration of Mark Ostrander in Support of Plaintiffs' Motion for Preliminary Injunction and Application for Temporary Restraining Order, April 14, 2011, Docket # 122-5 in Case # 3:10-CV-01222 (S.D.Cal.);

8. Milham, Samuel, September 2011, "Attention Deficit Hyperactivity Disorder and Dirty Electricity," Letter to Editor, *Journal of Developmental and Behavioral Pediatrics*;

9. Milham, Samuel, 2010, "Historical Evidence That Electrification Caused the 20th Century Epidemic of 'Diseases of Civilization.'" *Medical Hypotheses*, 74:337-345;

10. Milham, Samuel & L. Lloyd Morgan, 2008, "A New Electromagnetic Exposure Metric: High Frequency Voltage Transients Associated with Increased Cancer Incidence in Teachers in a California School," *American Journal of Industrial Medicine*;

11. Salt, Alec & Jeffery Lichtenhan, 2012, "Perception-based protection from low-frequency sounds may not be enough," presented at InterNoise 2012 in New York City, New York, August 19-22, 2012;

EXHIBIT 1

Alternatives to Large-Scale Wind and Solar Projects in San Diego County

Presented at San Diego County Planning Commission Regular Meeting

July 20, 2012

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I. Introduction

Q: Please state your name, job title, and business address.

A: William A. Powers, P.E., principal of Powers Engineering, 4452 Park Blvd., Suite 209, San Diego, California, 92116.

Q: Please describe your qualifications.

A: I have a B.S. in mechanical engineering from Duke University and a Master of Public Health degree in environmental sciences from the University of North Carolina – Chapel Hill. I am a registered professional mechanical engineer in California with 30 years of experience in the energy and environmental fields. I began my career converting Navy and Marine Corps shore installation power plants from oil-firing to domestic waste, including woodwaste, municipal solid waste, and coal, in response to concerns over the availability of imported oil following the Arab oil embargo. I have permitted five 50 MW peaking turbine installations in California, as well as numerous gas turbine, microturbine, and engine cogeneration plants around the state. I organized conferences on permitting gas turbine power plants (2001) and dry cooling systems for power plants (2002) as chair of the San Diego Chapter of the Air & Waste Management Association.

I am also the author of the March 2012 Bay Area Smart Energy 2020 strategic energy plan. This plan uses the zero net energy building targets in the California *Energy Efficiency Strategic Plan* as a framework to achieve a 60 percent reduction in GHG emissions from Bay Area electricity usage by 2020. I authored the October 2007 strategic energy plan for the San Diego region titled "San Diego Smart Energy 2020." The plan uses the state's Energy Action Plan as the framework for accelerated introduction of local renewable and cogeneration distributed resources to reduce greenhouse gas emissions from power generation in the San Diego region by 50 percent by 2020. I am the author of several articles in Natural Gas & Electricity Journal on use of large-scale distributed solar photovoltaics (PV) in urban areas as a cost-effective substitute for new gas turbine peaking capacity. I have a B.S. in mechanical engineering from Duke University and an M.P.H. in environmental sciences from the University of North Carolina – Chapel Hill. My resume is attached as Exhibit A to this testimony.

II. Renewable Distributed Generation and State Energy Goals

Q: Does priority emphasis on renewable distributed generation (DG) resources advance the state's energy goals?

A: Yes. Customer decisions to utilize DG to offset consumption of electricity from the grid is consistent with state energy goals, including the loading order, the Governor's 12,000 MW goal for DG, and the state's ambitious net zero energy building goals.

Q: How does DG contribute to the state's loading order?

A: The California Energy Commission ("CEC") and the California Public Utilities Commission ("CPUC") developed the *Energy Action Plan* in 2003 to guide strategic energy planning in California.[1] It establishes a resource priority list, or loading order, to guide strategic energy planning. The loading order prioritizes energy efficiency and demand response, renewable energy, combined heat and power, followed by utility natural gas-fired resources. The *Energy Action Plan* is explicit that rooftop PV is an element of building energy efficiency standards. *Energy Action Plan I* states that California should "[i]ncorporate distributed generation or renewable technologies into energy efficiency standards for new building construction." The CPUC confirmed in January 2012 that the "loading order applies to all utility procurement, even if pre-set targets for certain preferred resources have been achieved."[2] Customers utilizing renewable DG advance the loading order by reducing demand on the grid at the point-of-use with clean energy.

Q: Describe the Governor's 12,000 MW goal for new renewable DG resources.

A: Governor Jerry Brown proposes through his *Climate Strategy* and *Clean Energy Jobs Plan* that a majority of the new renewable energy resources to be built in the state by 2020, 12,000 MW of total of 20,000 MW, be local renewable power.[3]

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[1] Energy Action Plan I: http://www.energy.ca.gov/energy_action_plan/2003-05-08_ACTION_PLAN.PDF
[2] *See* Commission Decision 12-01-033 at 20-21.
[3] Governor Jerry Brown, April 25, 2012 Support Letter for DRECP Process, at 2 (http://www.drecp.org/meetings/2012-04-25-26_meeting/presentations/04_Office_of_the_Governor_Paper.pdf.; Governor Jerry Brown, *Clean Energy Jobs Plan*, June 2010.

Q: Do you have an estimate for how much SDG&E might contribute to the Governor's 12,000 MW goal?

A: SDG&E demand represents about 8 percent of statewide electricity demand.[4,5] The proportionate SDG&E share of 12,000 MW of new local renewable energy in California by 2020 would be about 960 MW.

Q: Is SDG&E close to reaching this estimated goal of 960 MW new local renewable generation?

A: No. At the end of 2011, SDG&E territory had about 120 MW of net-metered (NEM) PV systems online.[6] SDG&E is required to maintain a certain minimum amount of local generation supplies to assure local grid reliability. Instead of promoting local solar, SDG&E is promoting the construction of a number of new peaking gas turbine power plants to address an issue that could be more cost-effectively addressed with local solar.

Q: How does DG contribute to the state's net zero building goals?

A: The CPUC and SDG&E, SCE, and PG&E jointly developed the *California Long Term Energy Efficiency Strategic Plan* in 2008.[7] The *Plan* was updated in 2011.[8] It calls for 25 percent of existing homes to reach 70 percent reduction in energy usage by 2020, and 50 percent of existing commercial buildings to reach zero net energy by 2030. The concept of net zero energy is shown graphically in Figure 1.

The *Energy Efficiency Strategic Plan* assumes that 50 percent of existing commercial buildings achieve net zero energy by 2030 with no interim 2020 target. The CPUC projects that 15 to 20 percent of existing commercial buildings will reach net zero energy by 2020, as shown in Figure 2.

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[4] CEC Final Staff Report, *California Energy Demand 2012-2022 Final Forecast - Volume 1: Statewide Electricity Demand and Methods, End-User Natural Gas Demand, and Energy Efficiency*, May 2012, p. 2. Statewide 2011 electricity demand was 273,103 GWh.

[5] SDG&E Application A.08-11-014 , *Prepared Direct Testimony of Greg Katsapis - Authority to Update Cost Allocation And Electric Rate Design*, November 14, 2008. Forecast 2009 SDG&E demand was 20,890 GWh.

[6] J.C Thomas – SDG&E, *San Diego/Solar Stakeholder Collaboration Rates & Educational Overview*, January 25 & 27. 2012, p. 48 (for current NEM level).

[7] See: http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/ .

[8] CPUC, *California Energy Efficiency Strategic Plan*, January 2011 Update.

Figure 1. Graphical Representation of Net Zero Energy Concept[9]

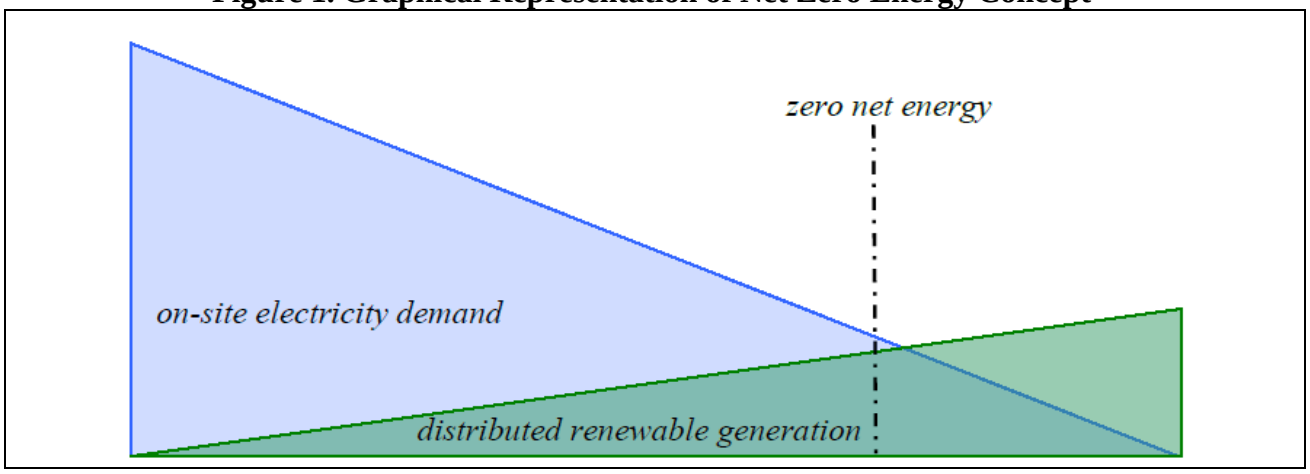
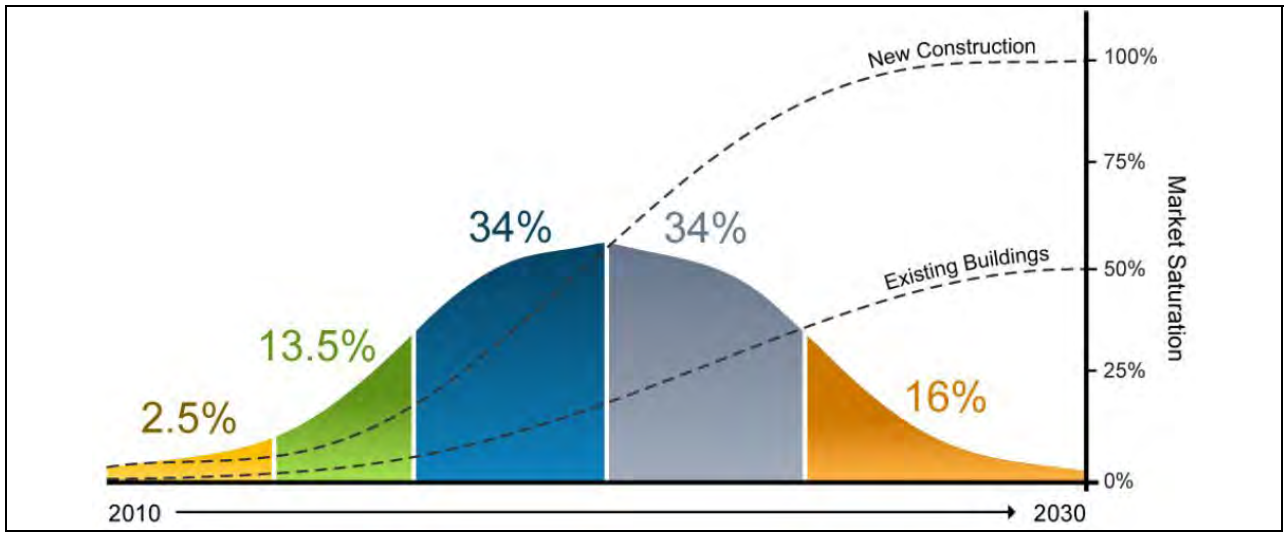


Figure 2. CPUC Estimate of Rate of Retrofit of Existing Commercial Buildings to ZNE from 2010 to 2030[10]



Q: How much DG is required to fully realize the net zero building goals?

A: Statewide, full implementation of the existing residential and commercial load reduction goals in the *Energy Efficiency Strategic Plan* would result in about 14,000 to 15,000 of rooftop PV by 2020.[11] This is consistent with the Governor's target of 12,000 MW of

[9] *California Energy Efficiency Strategic Plan*, January 2011 Update: http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/.

[10] CPUC, *California Energy Efficiency Strategic Plan - Zero Net Energy Action Plan: Commercial Building Sector*2010-2012, August 31, 2010, Appendix C, p. 34. See: http://www.cpuc.ca.gov/NR/rdonlyres/6C2310FE-AFE0-48E4-AF03-530A99D28FCE/0/ZNEActionPlanFINAL83110.pdf.

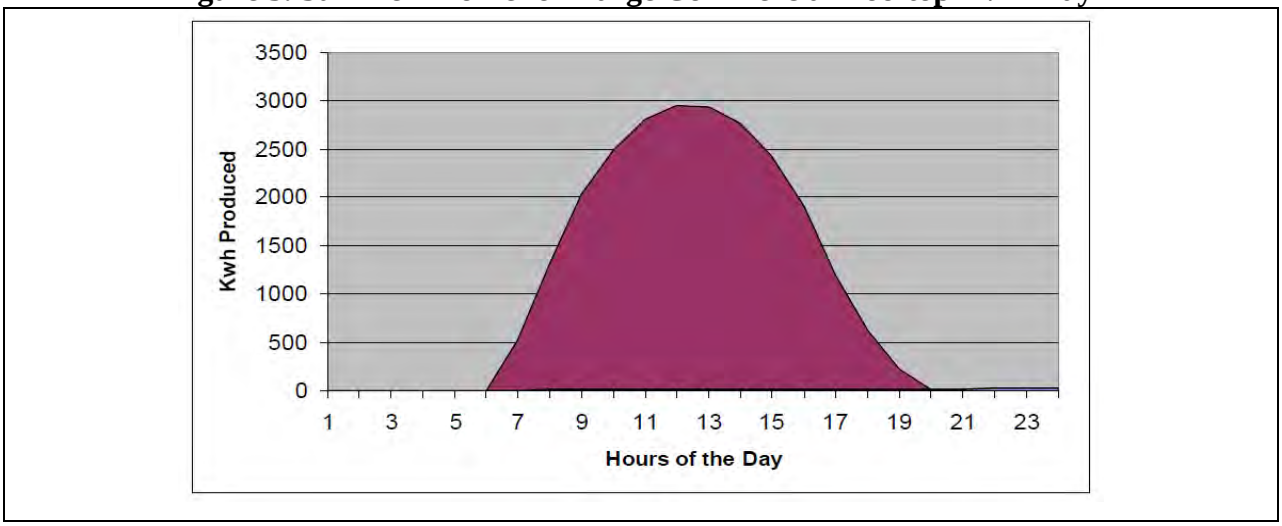
[11] B.Powers, *Bay Area Smart Energy 2020*, March 2012, Table 10-1, pp. 88-89. Assume 15 percent existing commercial buildings are ZNE by 2020, and for the 25 percent of existing homes that reduce demand by 70 percent,

new local renewable energy, and would add about 960 MW of rooftop solar to San Diego by 2020.

Q: Does rooftop solar PV, in particular, advance these state energy goals?

A: Yes. The only currently operational CPUC program available to achieve these *Energy Efficiency Strategic Plan* rooftop PV targets is net-metering (NEM).[12] The clear day electricity production profile of a south-facing rooftop PV system is shown in Figure 3. Output is at its maximum around 1 pm, and is about 50 percent of maximum at 5 pm.

Figure 3. Summer Profile for Large Commercial Rooftop PV Array[13]



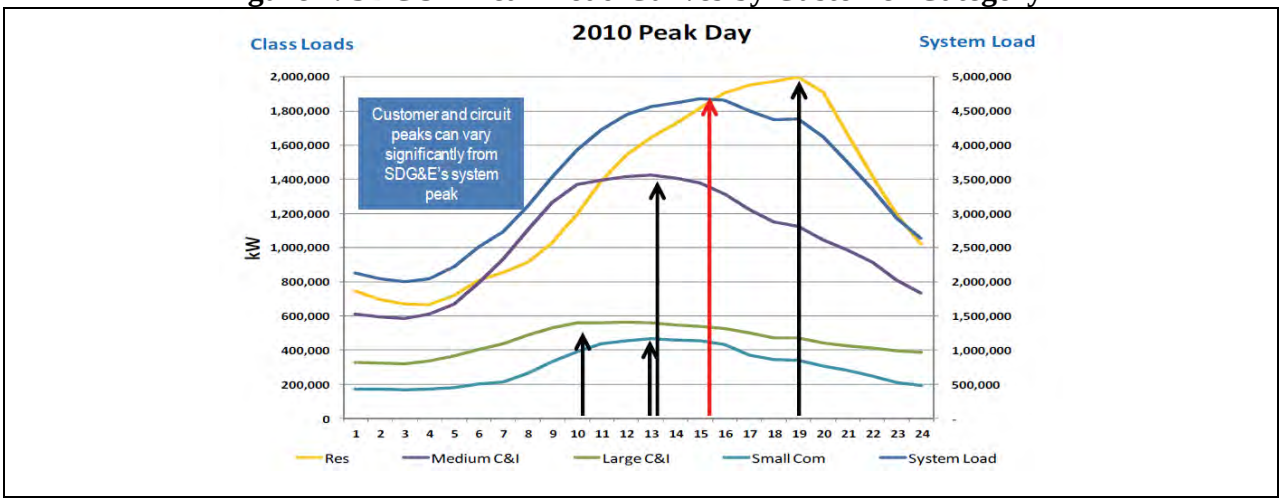
The peak day demand of major SDG&E customer categories is shown in Figure 4. The three commercial SDG&E customer categories, Small Commercial, Medium Commercial & Industrial, and Large Commercial & Industrial, reach maximum demand at mid-day. Demand gradually decline over the course of the afternoon.

30 percent is achieved through energy efficiency and 40% is achieved with rooftop PV. Multi-family reduces demand by 40 percent, of which 30 percent is achieved through energy efficiency and 10 percent though rooftop PV. The amount of rooftop PV necessary to achieve these targets is 14,000 to 15,000 MW_{ac}, assuming an average PV output of 1,800 to1,900 kWh-yr per kW_{ac} installed. See: http://pacificenvironment.org/downloads/BASE2020_Full_Report.pdf

[12] The Commission approved a tariff structure for 750 MW (statewide) SB 32 feed-in tariff legislation in D.12-05-035, issued on May 31, 2012. The tariff structure is called the Renewable Market Adjusting Tariff (ReMAT). The capacity limit is 3 MW. Projects must be located at sites with minimal transmission and distribution interconnection costs. There is no pure requirement that the ReMAT projects be located in or near load centers.

[13] P. Shoemaker - PG&E, *Basics of Photovoltaic (PV) Systems for Grid-Tied Applications*, PowerPoint, 2008.

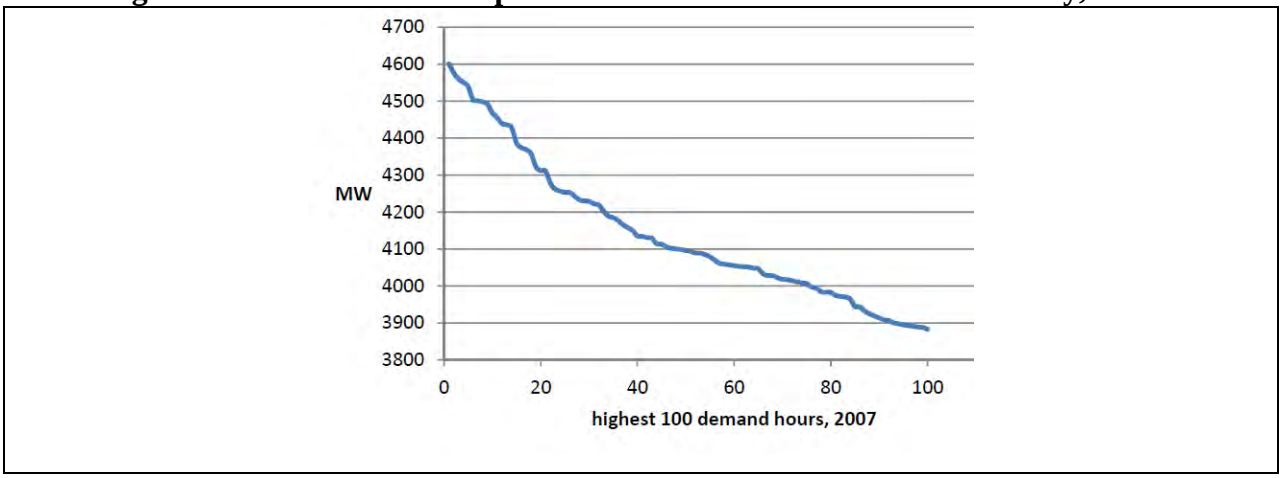
Figure 4. SDG&E Peak Load Curves by Customer Category[14]



Q: Is it appropriate to focus on the availability of the solar resource in the top 100 hours of peak demand when assessing the availability of rooftop solar?

A: Yes. SDG&E allocates generation capacity charges based on use in the top 100 demand hours of the year. As SDG&E states, "The "Top 100 hours" methodology allocates revenues based on the customer classes' contribution to the top 100 hours of system load during a given annual period."[15] This makes sense, as expensive peaking capacity resources are financed and maintained primarily to address demand during the highest demand hours of the year. SDG&E load drops rapid in the top 100 demand hours, as shown in Figure 5.

Figure 5. Load Decline in Top 100 Demand Hours in SDG&E Territory, 2007[16]



[14] SDG&E Application A.11-10-002, *Revised Prepared Direct Testimony of Chris Yunker*, February 2012, p. 7.
[15] SDG&E Application A.11-10-002, *Application for Authority to Update Marginal Costs, Cost Allocation, and Electric Rate Design. Revised Prepared Direct Testimony of William G. Saxe - Chapter 3*, February 2012, p. 4.
[16] CAISO OASIS database, "System Load": http://oasishis.caiso.com/

Q: Is rooftop PV at least as reliable as peaking gas turbine capacity during top 100 hours of demand?

A: Yes. NEM PV is at least as reliable as peaker capacity during top 100 demand hours in SDG&E territory. Powers Engineering correlated hourly 2007 SDG&E load data from the California Independent System Operator "OASIS" online database to hourly cloud cover and global irradiance data to assess the availability of the solar resource in San Diego County during peak demand hours. 2007 datasets were used because all datasets for 2007 were readily available at reasonable cost at the time the evaluation was initiated.

"Availability of the solar resource" is defined here as the percentage of potential solar energy, also known as global irradiance, that was actually available to produce PV electricity in a given hour. The reason that the solar resource would not be fully available is cloud cover. To put the 2007 peak load data set in perspective, the 2007 SDG&E load, at 4,601 MW, was about 250 MW higher than the 2011 peak load of 4,355 MW. The lower cut-off load level in the analysis was 3,500 MW. In 2007, there were 239 hours where the SDG&E demand was at or above 3,500 MW. The results of the analysis are presented in Table 1.

Table 1. Availability of Solar Resource During Peak Demand Hours in SDG&E Territory

Demand hour range	Load Range (MW)	Average Solar Resource Availability (%)
Top 10 demand hours	4,468 – 4,601	98
Top 20 demand hours	4,312 – 4,601	99
Top 100 demand hours	3,883 – 4,601	99
Top 239 demand hours	3,500 – 4,601	99+

The actual availability of the solar resource across the top 10 demand hours in 2007 was 98 percent. It was 99 percent in the top 20 demand hours, and 99+ percent for the top 239 demand hours. As noted, the top 239 demand hours represent all one-hour SDG&E

demand at or above 3,500 MW. 3,500 MW is over 1,150 MW below the all-time peak one-hour demand recorded to date in SDG&E territory, 4,687 MW in September 2010.[17]

There will be times during the on-peak period, which covers weekdays June 1 – October 1, 11 am – 6 pm, when skies are overcast and the NEM operator will draw all electricity from SDG&E. However, these are modest or low demand periods with system loads less than 3,500 MW where there is no stress on the distribution system and no peaking units are operational.[18] A subset of this on-peak period is the 100 highest demand hours of the year that determine the allocation of capacity costs among commercial customers. During this critical peak demand subset, commercial NEM PV is at least 98 percent available.

Q: Does rooftop PV provide reliable capacity during the top 100 hours of peak demand?

A: Yes. NEM PV systems provide capacity at an availability of at least 98 percent in aggregate during critical peak demand. This high availability is as good or better than natural gas-fired peaking resources. As SDG&E's states, the addition of 750 MW of new NEM PV capacity in SDG&E service territory would be expected to reduce the average peak hour load in August (3-4 pm) by over 400 MW.[19] Scattered cloud conditions do exist on occasion in SDG&E service territory during the top 100 hours of demand. However, the aggregate availability of the solar resource during these infrequent scattered cloud conditions is approximately 80 per cent or greater. A detailed analysis of solar resource availability during the 100 peak hours in SDG&E territory is provided in Attachment A.

Distributed PV is also predictably available in aggregate on days with scattered clouds, when the output of multiple geographically-dispersed PV systems is combined.[20] This output characteristic of multiple-geographically dispersed distributed PV systems is shown in Figure 6.

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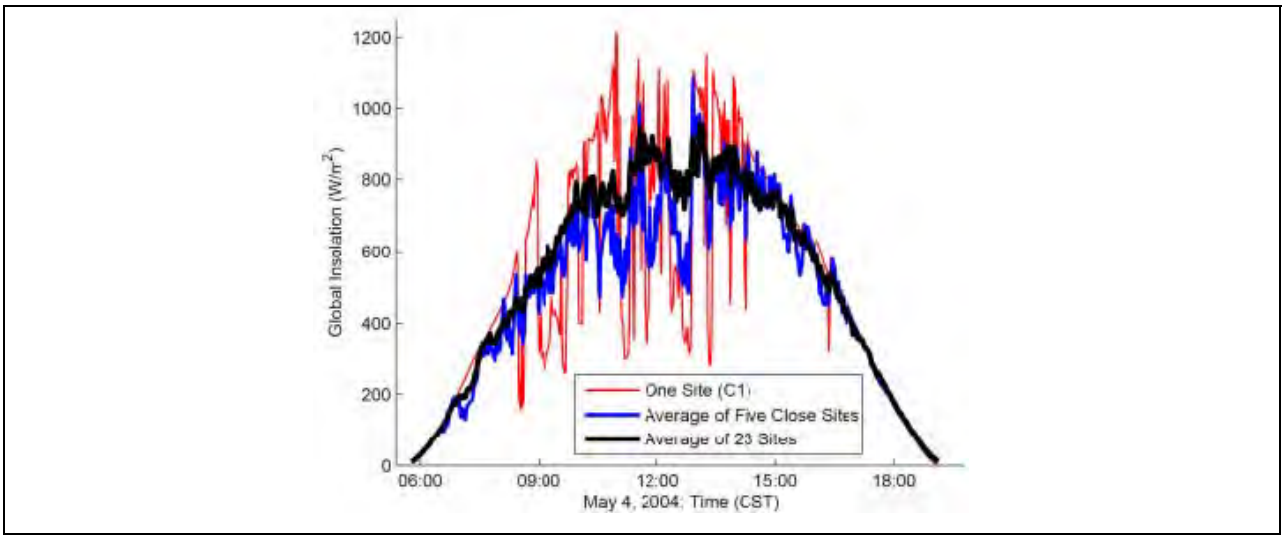
[17] SDG&E Comments on the Proposed Decision of Commission Peevey Regarding the Calculation of the Net Energy Metering Cap, May 1, 2012 in CPUC Docket R.10-05-044.
[18] See Powers Engineering hour-by-hour comparison of load and weather conditions in SDG&E service territory in 2007 with demand at or above 3,500 MW, included with this testimony as Attachment B.
[19] *See* Ex. SDG&E-105, Table 5A-2 at DTB-5-A and Table 5A-6 at DTB-7-A.
[20] Lawrence Berkeley National Laboratory, *Implications of Wide-Area Geographic Diversity for Short-Term Variability of Solar Power*, September 2010, p. 25. See: http://eetd.lbl.gov/ea/emp/reports/lbnl-3884e.pdf.

The San Diego area already has at least 15,000 distributed PV systems.[21] The output from these dispersed PV systems on days with scattered clouds is reliable in aggregate due to the dispersion of these PV systems over hundreds of square kilometers of developed areas in San Diego County.

Figure 6. Multiple PV Sites Smooth Aggregate PV Output on Partly Cloudy Days



NEM PV is reliably available during the top 100 demand hours in SDG&E service territory. As a practical matter, NEM PV systems will automatically provide electricity, individually on clear days and in aggregate on days with scattered clouds, at very high availability during periods of critical peak demand. Whether this electricity is used on-site or exported, it reduces demand on the grid.

Lawrence Berkeley National Laboratory (LBNL) recently completed an analysis of the capacity value of PV, solar thermal, and wind generation. The authors identify the purpose of the study as the quantification of the economic value of these renewable resources, noting that "Resource procurement and investment decisions are made more difficult by the variable and unpredictable nature of variable generation. Part of what is

[21] J.C Thomas – SDG&E, *San Diego/Solar Stakeholder Collaboration Rates & Educational Overview*, January 25 & 27. 2012, p. 48.

missing from simple comparisons is an evaluation of the economic value of the energy generated." [22]

The LBNL study states that the marginal value of PV is high at low penetration due to high capacity value. The economic significance of this high capacity value is described as:

> This high value at low penetration is largely due to the ability of solar resources to reduce the amount of new non-renewable capacity that is built, leading to a high capacity value. The magnitude of the capacity value of solar resources depends on the coincidence of solar generation with times of high system need, the cost of generation resources that would otherwise be built, and decisions regarding the retirement of older, less efficient conventional generation.[23]

Specifically LBNL indicates the capacity value of PV is higher than the capacity value of a combined cycle gas turbine until the PV penetration rate reaches the 5 to 10 percent penetration level. The penetration of NEM PV in SDG&E's territory is currently about 1 percent.

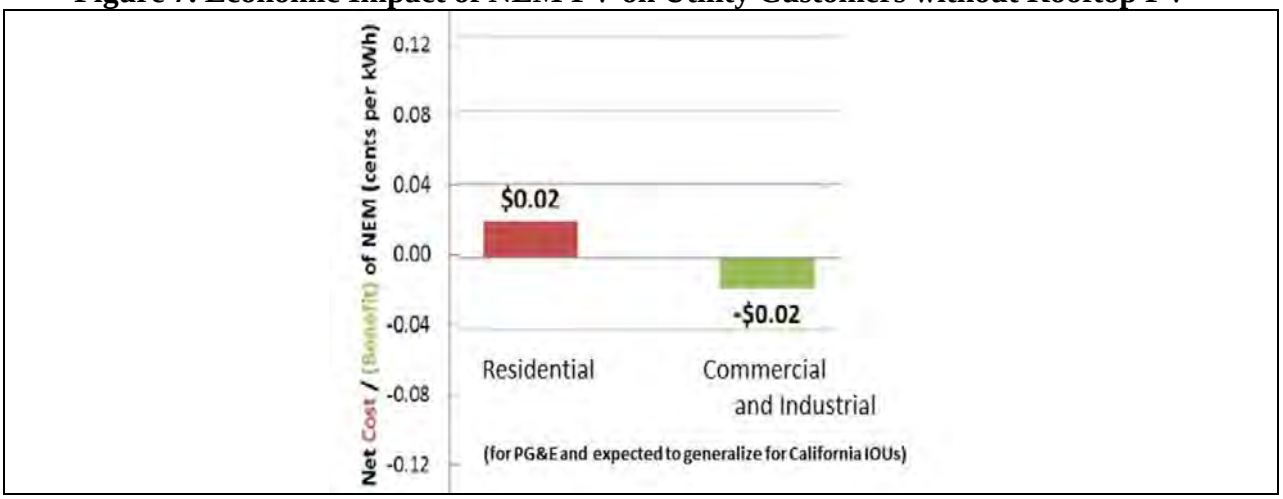
Q. Would rooftop solar impose new costs on non-solar ratepayers?

A. No. Despite SDG&E claims to the contrary, net metering (NEM) imposes no net costs on utility customers without NEM PV systems, as shown in Figure 7.

SDG&E co-authored a study of that estimates the 2010 rooftop PV potential in San Diego County at more than 4,400 MWac.[24] 4,400 MWac is equivalent to SDG&E's one-hour peak load. [25] The only potential brake on continued rapid growth of NEM rooftop PV in the San Diego local area is the NEM cap. Assuming California continues to increase its NEM cap as it has done in the past to accommodate foreseeable near-term growth

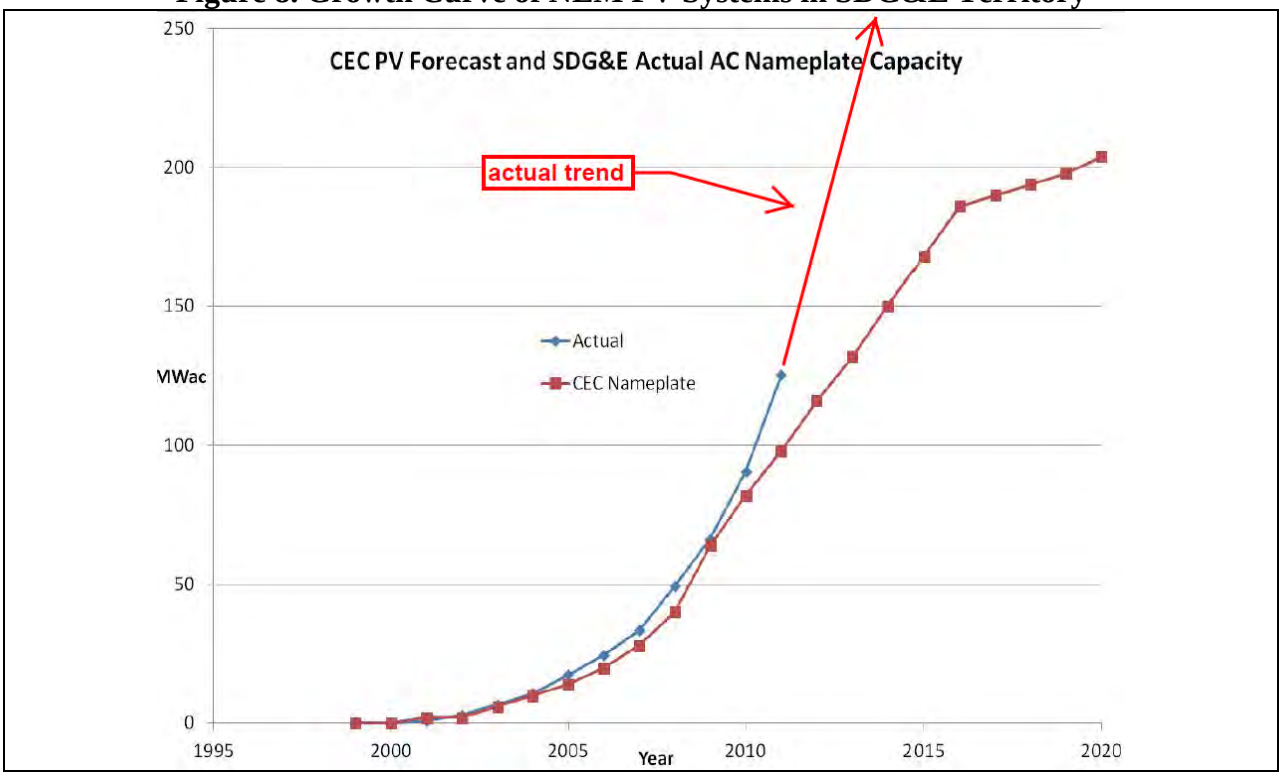
[22] A. Miller and R. Wiser – Lawrence Berkeley National Laboratory, *Changes in the Economic Value of Variable Generation with Increasing Penetration Levels: A Pilot Study of California* (PowerPoint summary), June 2012.
[23] A. Miller and R. Wiser – Lawrence Berkeley National Laboratory, *Changes in the Economic Value of Variable Generation with Increasing Penetration Levels: A Pilot Study of California* (report), June 2012, p. 6.
[24] San Diego Regional Renewable Energy Study Group, *Potential for Renewable Energy in the San Diego Region*, August 2005, Chapter 2: Solar Photovoltaic Electric. See: www.renewablesg.org.
[25] CAISO OASIS database. SDG&E 2011one-hour peak was 4,355 MW on September 7, 2011 (HE 16).

Figure 7. Economic Impact of NEM PV on Utility Customers without Rooftop PV[26]



in NEM PV systems, SDG&E territory would add in the range of 1,000 MW of NEM PV systems by 2020. Figure 8 shows the growth curve for NEM PV systems in San Diego.

Figure 8. Growth Curve of NEM PV Systems in SDG&E Territory[27]



[26] GreenTech Media, *CPUC on verge of major decision about solar's net metering*, May 15, 2012. Graphic from: Crossborder Energy, *Re-evaluating the Cost-Effectiveness of Net Energy Metering in California*, December 22, 2011, Figure 3, p. 10. See: http://votesolar.org/wp-content/uploads/2012/01/Re-evaluating-the-Cost-effectiveness-of-Net-Energy-Metering-in-California-1-9-2012.pdf.

[27] J.C Thomas – SDG&E, *San Diego/Solar Stakeholder Collaboration Rates & Educational Overview*, January 25 & 27. 2012, p. 48.

SDG&E currently has about 15,000 customers with NEM PV systems.[28] This is about 1 percent of SDG&E's 1.4 million customers. SDG&E projects that at a 15 percent NEM adoption level, the cost to non-NEM customers would be $120 million in additional transmission and distribution charges shifted from NEM customers to non-NEM customers.[29] As shown in Figure 7, at a 1 percent penetration rate, NEM PV systems are producing 120 MW of nameplate capacity. At 15 percent penetration, assuming a linear relationship, NEM PV systems will have a nameplate capacity of 1,800 MW in SDG&E territory. Without questioning here the validity of the SDG&E "cost shift" dollar amount, if 1,800 MW of NEM PV capacity imposes $120 million per year in cost shift to non-NEM customers, then 600 MW of NEM PV capacity would impose a proportionately smaller cost shift of $40 million per year.

The CEC estimates the fixed cost of new peaking capacity at approximately $283/kW-yr.[30] 300 MW of new peaking resources have fixed cost, which will be borne by SDG&E ratepayers, of $85 million per year over 20 years.[31] 600 MW of NEM PV capacity in the San Diego local area would provide at least 300 MW of capacity that is reliably available at times of peak demand. It would be far more economically beneficial to SDG&E ratepayers collectively to locate 600 MW of NEM PV capacity in the San Diego local area under the existing NEM tariff structure and not build 300 MW of peaking natural gas-fired resources to address the lack of solar resources in the local area.

Regarding distributed PV generally, the Commission observed with its approval of the PG&E 500 PV project that:[32]

> "This solar development program has many benefits and can help the state meet its aggressive renewable power goals," said CPUC President Michael R. Peevey. "Smaller scale projects can avoid many of the pitfalls that have plagued larger renewable projects in California, including permitting and transmission challenges. Because of this, programs targeting these resources can serve as a valuable complement to the existing Renewables Portfolio Standard program."

[28] Ibid, p. 48.
[29] Ibid. p. 51.
[30] CEC, *Comparative Costs of California Central Station Electricity Generation*, January 2010, Table B-4, p. B-5.
[31] $300/kW-yr x 450,000 kW = $135 million per year.
[32] CPUC Press Release – Docket A.09-02-019, *CPUC Approves Solar PV Program for PG&E,* April 22, 2010.

PV should be counted towards meeting Resource Adequacy peak needs. The CEC has recognized the value of energy generated from distributed PV as a cost-effective substitute for natural gas-fired peaking generation. The CEC denied an application for a 100 MW natural gas-fired peaking gas turbine plant, the Chula Vista Energy Upgrade Project (CVEUP) in San Diego County, in June 2009. The application was denied in part because the CEC opined that rooftop PV could potentially achieve the same objectives for comparable cost.[33]

This June 2009 CEC decision implies that any future applications for gas-fired generation in California should be measured against using distributed PV to meet the demand. The final CEC decision in the CVEUP proceeding states:[34]

"Photovoltaic arrays mounted on existing flat warehouse roofs or on top of vehicle shelters in parking lots do not consume any acreage. The warehouses and parking lots continue to perform those functions with the PV in place. (Ex. 616, p. 11.). . . . Mr. Powers (expert for intervenor) provided detailed analysis of the costs of such PV, concluding that there was little or no difference between the cost of energy provided by a project such as the CVEUP (gas turbine peaking plant) compared with the cost of energy provided by PV. (Ex. 616, pp. 13 – 14.). . . . PV does provide power at a time when demand is likely to be high—on hot, sunny days. Mr. Powers acknowledged on cross-examination that the solar peak does not match the demand peak, but testified that storage technologies exist which could be used to manage this. The essential points in Mr. Powers' testimony about the costs and practicality of PV were uncontroverted."

The CEC concluded in the CVEUP final decision that PV solar arrays on rooftops and over parking lots may be a viable alternative to the gas turbine project proposed in that case, and that if the gas turbine project proponent opted to file a new application, a much more detailed analysis of the rooftop PV alternative would be required.

Numbers from the California Solar Initiative demonstrate high on-peak availability for distributed PV, at least 50 percent.[35] Solar PV is predictably available during periods of peak demand. The Commission FEIR/FEIS for the Powerlink project conservatively

[33] CEC, Chula Vista Energy Upgrade Project - Application for Certification (07-AFC-4) San Diego County, *Final Commission Decision*, June 2009.
[34] *Id.* at pp. 29-30.
[35] *See* Itron, *CPUC CSI Report* at p. 5-6 to 5-10 (June 2010) http://www.cpuc.ca.gov/NR/rdonlyres/70B3F447-ADF5-48D3-8DF0 5DCE0E9DD09E/0/2009_CSI_Impact_Report.pdf

assumes 50 percent of nameplate PV capacity is available at peak.[36] The reason for this is the fact that peak production from a fixed PV array occurs at mid-day and the demand peak generally occurs in mid-afternoon.

Q. Do remote wind and solar projects impose high indirect costs on ratepayers that are not imposed by local solar?

A. Yes. SDG&E's $2 billion Sunrise Powerlink transmission was largely justified on importing solar power from Imperial County. Expansion of the Sunrise Powerlink and Southwest Powerlink transmission corridors is proposed to increase imports of wind and solar from East County and Imperial County. The high cost of new transmission lines and transmission upgrades to move remote wind and solar to San Diego, and the justification of new local gas-fired peaking plants due in part to the failure to add sufficient local solar, make the emphasis on remote wind and solar resources more costly to the consumer than local solar.

Q. Is the San Diego County wind resource available during summer peak demand period?

A. No. Due to the nature of the wind resource in the San Diego area, there is relatively less wind power generated in the summer months when electricity demand is highest, and even less produced during the summer mid-afternoon peak hours. This phenomenon is shown in Figure 10, the month-to-month wind energy production from the 50 MW Kumeyaay wind farm in eastern San Diego County, and Figure 11, a SDG&E peak summer day demand curve and 24-hour summer wind output curve for San Diego-area wind resources.[37] What this data means is that relatively little of potential San Diego area wind power will be operating during summer peak demand periods.

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[36] CPUC FEIR/FEIS for SDG&E Sunrise Powerlink Project, *E.5 New In-Area Renewable Generation Alternative*, October 2008, p. E.5-8. "In its PEA, SDG&E discounts the nameplate rated capacity of solar PV systems by 50 percent because only a fraction of a PV system's rated capacity is available during the utility's hour of peak demand." See: http://www.cpuc.ca.gov/environment/info/aspen/sunrise/toc-feir.htm. See also SDG&E 5/10/12 Response to CEJA's Second Set of Data Requests, Q14. The NQC of the NRG Borrego Solar project will be: 16 MW ÷ 26 MW = 0.62 (62 percent).

[37] The summer wind output curve in Figure 11 assumes a hypothetical future scenario where San Diego County's full wind potential of 1,350 to 1,530 MW is developed (see: www.renewablesg.org). Even with this high level of installed wind capacity, the wind output during summer afternoon peak demand hours is no more than 300 MW as shown in Figure 11.

Figure 10. Month-to-Month 2008 Wind Energy Production, Kumeyaay Wind Farm[38]

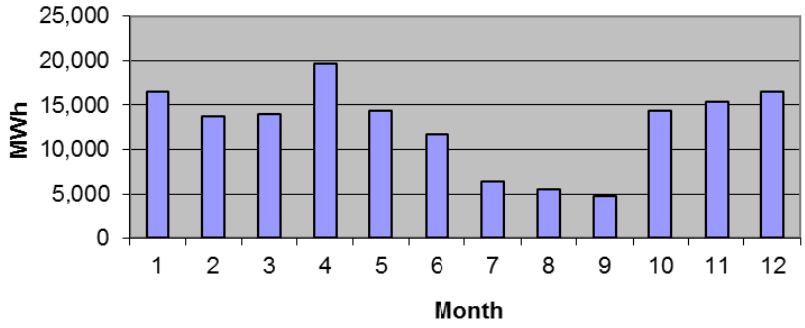
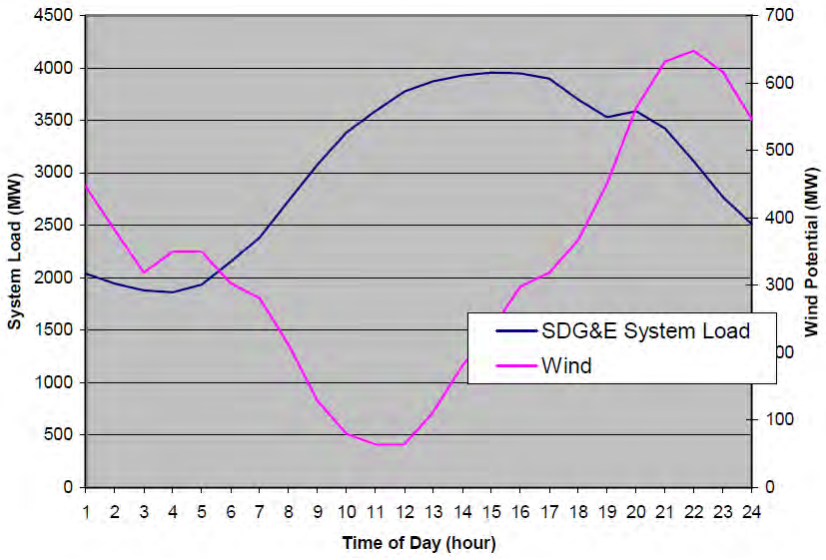


Figure 11. SDG&E Peak Summer Load and Summer Wind Profile[39]



[38] U.S. DOE, Energy Information Administration, 2008 Form 923 Monthly Time Series, Kumeyaay Wind Farm.
[39] San Diego Regional Renewable Energy Study Group, *Potential for Renewable Energy in the San Diego Region – Chapter 4: Wind*, August 2005. The wind output shown on the right hand vertical axis assumes a total potential installed wind capacity of 1,350 to 1,530 MW. The near-term installed wind potential in the San Diego region is 206 MW, one-seventh the wind potential assumed in creating the purple wind output curve in Figure 4. See: http://www.renewablesg.org/.

EXHIBIT 2

NRG Energy's CEO Discusses Q4 2010 Results - Earnings Call Transcript

February 22, 2011 | about: NRG

Executives

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Christian Schade - Chief Financial Officer and Executive Vice President

Mauricio Gutierrez - Chief Operating Officer and Executive Vice President

Nahla Azmy - Vice President of Investor Relations

Jason Few - SVP of Mass Markets and Operations, Reliant Energy, Inc.

Analysts

Anthony Crowdell - Jefferies & Co

Dan Eggers - Crédit Suisse AG

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

Charles Fishman - Pritchard Capital Partners, LLC

Jonathan Arnold - Deutsche Bank AG

Ameet Thakkar - BofA Merrill Lynch

Theodore Durbin - Goldman Sachs Group Inc.

James Dobson - Wunderlich Securities Inc.

Brian Chin - Citigroup Inc

NRG Energy (NRG) Q4 2010 Earnings Call February 22, 2011 9:00 AM ET

Operator

Good day, ladies and gentlemen, and welcome to the Fourth Quarter and Full Year 2010 NRG Energy Earnings Conference Call. My name is Deanna, and I'll be your operator for today. [Operator Instructions] And I would now like to turn the call over to your host for today, Ms. Nahla Azmy, Senior Vice President of Investor Relations. Please proceed.

Nahla Azmy

Thank you, Deanna. Good morning, and welcome to our Fourth Quarter and Full Year 2010 Earnings Call.

This call is being broadcast live over the phone and from our website at www.nrgenergy.com. You can access the call presentation and press release through a link on the Investor Relations page of our website. A replay of the call will also be available on our website. This call, including the formal presentation and the question-and-answer session, will be limited to one hour. In the interest of time, we ask that you please limit yourself to one question with just one follow-up.

And now for the obligatory Safe Harbor statement. During the course of this morning's presentation, management will reiterate forward-looking statements made in today's press release regarding future events and financial performance. These forward-looking statements are subject to material risks and uncertainties that could cause actual results to differ materially from those in the forward-looking statements. We caution you to consider the important risk factors contained in our press release and other filings with the SEC that could cause actual results to differ materially from those in the forward-looking statements in the press release and this conference call.

In addition, please note that the date of this conference call is February 22, 2011, and any forward-looking statements that we make today are based on assumptions that we believe to be reasonable as of this date. We undertake no obligation to update these statements as the result of future events except as required by law.

During this morning's call, we will refer to both GAAP and non-GAAP financial measures of the company's operating financial results. For complete information regarding our non-GAAP financial information, the most directly comparable GAAP measures and a quantitative reconciliation of those figures, please refer to today's press release and this presentation.

And now with that, I'd like to turn the call over to David Crane, NRG's President and Chief Executive

Officer.

David Crane

Thank you, Nahla, and good morning, everyone, and welcome to our year-end 2010 earnings call. Today, with me, and participating in the presentation is Mauricio Gutierrez, the company's Chief Operating Officer; and Chris Schade, the company's Chief Financial Officer. Also with me today and available to answer questions are Jason Few, who runs NRG's retail company, Reliant; and Chris Moser, who runs the commercial operations function for this company.

So without further ado, to begin -- so ladies and gentlemen, current and perspective shareholders of NRG, as we speak today, it's now been 32 months since natural gas prices began their relentless fall and the economy at large entered into a great recession, the likes of which, I'm sure none of us wish to experience again in our lifetimes, yet the financial performance of NRG during this period has been superb. And that financial performance has been built on the foundation of an equally exceptional operating performance across all phases of our operations and across all our regions.

In 2010, the second full year of the great recession, our financial performance surpassed all previous years of company results, save for fiscal year 2009, which was of course the first year of the great recession, a year in which we performed spectacularly, achieving both record financial performance and the acquisition of Reliant.

While I am, for the most part, extremely pleased with both the company's financial and its operating performance during 2010, I am acutely mindful of the fact that NRG shareholders did not see any of the benefits of our exceptional performance and share price appreciation during that year. As a management team, we recognize that we have a long way to go in presenting NRG's present value and future potential to the market.

In this presentation and in subsequent presentations that Mauricio, Chris and I will be making during the spring Investor Relations season, we intend to make a concerted effort to explain the NRG value proposition. From the competitive strength of our core businesses, even in a low commodity price environment, to the meaningful and measurable value of our growth opportunities, as well as our effective risk mitigation in areas which we believe to be of concern to the investment community.

So starting with 2010, as summarized on Slide 3, the company continued to generate a very high level of EBITDA in excess of $2.5 billion and also throw off a substantial amount of free cash flow. Indeed, in regard to what should perhaps be the most important metric to shareholders, free cash flow yield, our free cash flow yield for 2010 was a robust 29%, making our seven-year average exceed 23%. And in response to some people who said that we should measure free cash flow for these purposes after both maintenance and environmental CapEx, we have done it in that way but before growth CapEx.

A substantial amount of that free cash flow yield was redeployed back to stakeholders in the form of debt repayment and through our 2010 share buyback program and also into various growth initiatives, which we'll discuss in a minute. But over $650 million of excess free cash flow was returned as cash into the company's coffers, with the result being that our liquidity position at the end of 2010, $4.3 billion of total liquidity with $3 billion of cash on hand, is stronger than it has ever been.

It has always been my position that next to safety, the most important thing that we do as executive management at NRG is capital allocation, and given the amount that we are investing on an annual basis and the record amount that we currently have available either to invest in growth or to return to our equity and debt stakeholders, capital allocation has never been more important than it is now. As

such, I'm going to focus the greater part of my remaining remarks on capital, which we expect to invest in our growth initiatives in the months and years to come. Chris will focus a good deal of his comments on capital to be returned to stakeholders.

In terms of the allocation of capital to our growth initiatives, it's important to start with the obvious point that we want to invest the company's capital in assets and initiatives that not only are likely to yield a return significantly in excess of our risk-adjusted weighted average cost of capital, but also in businesses and initiatives which advance the company's strategy.

As depicted on Slide 4, the company's long-term strategy for some time has been twin-tracked. First, to strengthen and enhance our generation to retail business in our core markets through superior operating performance, continued implementation of our first-lean-enabled, long-term hedging program and pursuit of both select acquisitions and the repowering of our older facilities with advantage locations inside load pockets in our core markets. This comply of our strategy which we have pursued with relentless consistency and a high degree of effectiveness for the past five years was joined a couple years ago with a supplemental strategy that is overtly green and designed to take advantage of the societal trend towards sustainability.

This sustainability trend is, in our opinion, about to accelerate as a result of the emergence of various consumer-oriented disruptive technologies, which will make green energy at the consumer level the focal point of sustainability. We made considerable progress on both strategic fronts during 2010, with substantial advances across every facet of our sustainability initiative.

From our rollout of our eVgo network in Houston, which is centered around an innovative fueling package in approach to electric vehicle infrastructure that is already being replicated in other locations through the smart meter e-Sense applications now being sold by Reliant in quantity, to our unique approach to CCS/EOR being funded in collaboration with the DOE at our Parish facility in Texas. All of these initiatives are exciting and off to a good start. All will, I am confident, return considerable value to NRG to shareholders in the medium term.

You will hear more about these initiatives in the future but not today, because today, consistent with my theme, I want to concentrate my comments on the growth initiatives which are more immediate and which are key priorities for deployment of your investment capital during 2011. This is shown on Slide 6.

By way of background, in 2010, we committed substantial growth capital in four general areas: Zero carbon renewables, with an emphasis on solar; new advanced nuclear development; conventional gas-fired acquisitions and repowerings; and green retail acquisitions in the form of Green Mountain Energy. All four are likely to be areas of additional capital expenditure in 2011 but with very different investment profiles from 2010.

First, we expect an acceleration and significant expansion in our equity capital invested in high-growth, high-return solar projects. At the greater part of our utility scale, solar portfolio should achieve financial close and enter the construction phase during 2011.

Second, investment in conventional generation assets should be relatively flat year-on-year, as spending on GenConn and Cottonwood should give way to spending on El Segundo, but conventional CapEx could increase depending on our development success at Astoria, Saguaro or Encina and also, whether we find any strategic assets that can be acquired at value.

Third, capital invested in green retail should drop precipitously as obviously the big expenditure in this

area in 2010 with the acquisition of Green Mountain. The amount of capital that we will be investing in and around Green Mountains business in 2011 or to expand into new geographic markets, bigger customers segments and new complimentary green product offerings is fairly minimal.

And finally, and similarly and perhaps, contrary to popular investor belief, even if the STP nuclear development project stays on course, the development capital projected to be required of NRG in 2011 will be far less than half of what we invested in 2010 and will be a mere fraction of what we will be investing in solar projects and other capital allocation alternatives.

So this is a lot to digest, so let's go through a little bit more slowly, starting on Slide 7 with Green Mountain. Four months ago, we paid $357 million for a business that we expect to contribute $70 million, $80 million of EBITDA in 2011, plus, we expect Green Mountain to continue to deliver on a 20-plus percent compound annual growth rate trajectory that they have delivered for the past decade. But we didn't acquire Green Mountain just to continue with business as usual. We wanted to take advantage, and we wanted them to take advantage of what we believe are very substantial synergies between Green Mountain and NRG.

Essentially, we want Green Mountain to accelerate the depth and breadth of their growth in close cooperation with us on the same path that they were following on their own, which means expansion into a high retail price Northeast markets, where they start with a natural green-leaning constituency, also, expansion into the larger Commercial segment of the C&I market than they have previously sought to access. And finally, expansion of their value-added product offerings to include distributed green generation.

It's early days yet, but on at least the first two of these, they are already beginning to bear fruit. Green Mountain has established a small but fast-growing footprint in New York Zone J, and in terms of larger C&I customers, they have won landmark business like the Empire State Building. We expect to be reporting on these and many more successes from and with Green Mountain as the year progresses.

Turning to conventional generation on Slide 8. 2010 was an uneven year, with the successful acquisition of Cottonwood and the repowering at Devon and Middletown, balanced by the missed opportunities surrounding Dynegy's California asset. Cottonwood and Devon have been smoothly integrated into our South Central and NEPOOL lineups respectively, and we are very pleased with the results today.

Looking forward to 2011, we're very focused on the successful repowering of El Segundo, an advantage which we hope to derive from having a modern, fast-start, low-heat rate, combined-cycle plant inside the Los Angeles basin load pocket. Beyond El Segundo, we hope to make progress on similar repowering efforts at Astoria in New York City and Encina in San Diego County. Beyond our own Repowering pipeline, the capital we deploy in the acquisition of conventional power plants, obviously, will depend on market conditions and asset availability in our core regions.

While the acquisition market is lumpy, generalities are difficult and predictions are often proved wrong, the optimism I once held at the first half of 2011 would be a buyer's market for CCGTs in the United States has largely dissipated. I see no sign of a flood of assets on the market and the combined cycle of transactions which have been announced recently have been priced at levels significantly above what we could justify to ourselves or explain to our shareholders.

With respect to our nuclear project, while important steps forward have occurred in several areas since our last earnings call, very little of it can be seen with the naked eye. As before, really all critical

aspects of the STP 3 & 4 project run off of our receipt of an acceptable conditional loan guarantee from the government. Certainly, it is a challenge for us to complete meaningful discussions about PPAs with potential off-takers, while the loan guarantee application remains pending.

So our exit ramp analysis, which is set forth on Slide 9, remains largely unchanged from the previous quarter. Likewise, our viewpoint with respect to NRG's continued participation in the project remains at the most challenging of these hurdles, which is the long-term off-take requirement, effectively needs to be addressed no later than the third quarter of 2011 before the project enters the substantial pre-construction phase.

As such, we reiterate the view which is clearly articulated in both our 10-K and in today's earnings release, that NRG will be in a position by late this summer to make a final decision on our continued financial participation in this project. At that point, the market should have substantially greater clarity about the prospects for this project and NRG's role in it.

While we understand that there is skepticism amongst some investors that the project can go forward in the current low gas price environment, we nonetheless, believe it might be helpful to you for us to outline as shown on Slide 10 the future capital commitment of NRG in respect to this project, should it stay on track, with NRG continuing to support it financially.

The overall message is that due to a combination of first, the very substantial sum that NRG has previously committed to the project development, particularly during the first half of 2010 after the settlement with CPS. Second, taking into account our expectation of an optimal hold amount in the project for NRG of approximately 40%, which is down from the 67% that we will own if and when TEPCO invests in a project post-loan guarantee award. And third, due to the value ascribed to NRG for its contribution of the site, NRG's cash commitment to the project going forward is less than what otherwise would be suggested by our projected ownership level.

In summary, should the project proceed to financial closing, the total cash commitment for NRG at our 40% hold level should be something just short of $800 million in aggregate, including cash invested to date. Beyond that, we are likely to have an LC commitment to a standby equity crossover line facility that will be fixed. And while that number has not yet been finally fixed, you should be thinking in the range of a few hundred million dollars maximum.

In exchange for this size investment in STP 3 & 4, we expect cash flow from dividends and tax benefits in the range of $500 million a year for the first several years of operations. Obviously, this is a very attractive return but one which we believe is well just justified given the extraordinary challenges of the undertaking.

Now pulling it back from where we hope the project will be in 2016 or 2017 to where we are here in the first quarter of 2011, you should be focused on what happens after announcements of acceptance of the loan guarantee. As the loan guarantee acceptance naturally will trigger certain funding obligations from our partners, NRG's share of cash development spent for the remainder of the development phase should approximate $50 million for all of 2011 and half that for 2012.

While our perspective 2011, 2012 development standard is perhaps substantially less than many in the market were anticipating, it remains a lot of money to us, and we're taking very seriously our commitment to retain our financial discipline around this project and prevent exposure of our balance sheet beyond the specific commitments that I've outlined in this presentation.

Now turning to Slide 11, last but certainly not least, there is the solar pipeline. I've said many times,

and I'll repeat here, that in my 20 years in this business, I had never seen investment opportunities in this sector that offer more attractive combination of high returns, low construction risks, long-term PPAs and repeatable business opportunities than the utility-sized solar projects that we currently have in our advanced development portfolio.

As such, we intend to do as much of this business as we can get our hands on, with the result being that by the end of this year, we may well have a total initial equity investment in our solar portfolio that exceeds the total amount that we may ever invest in STP 3 & 4 at very attractive near-term returns. The limiting item for us in terms of these solar investments is our ability on our own to make optimal use of the considerable tax benefits which will be generated by these projects. This is a topic that Chris Schade will discuss in a few minutes.

What I will end by saying is that this extraordinary pipeline of utility-sized solar projects, which our colleagues at NRG Solar have managed to develop or acquire, provides us with a truly unique opportunity to develop over the next few years a solar portfolio of true scale and significant benefit, even in the context of the larger portfolio of NRG.

Ultimately, however, we fully recognize that the current generation of utility-sized solar and wind projects in the United States is largely enabled by favorable government policies and financial assistance. It seems likely that much of that special assistance is going to be phased out over the next few years, leaving renewable technologies to fend for themselves in the open market.

We do not believe that this will be the end of the flourishing market for solar generation. We do believe it will lead to a stronger and more accelerated transition from an industry that is currently biased towards utility-sized solar plants to one that's focused more on distributed and even residential solar solutions on rooftops and in parking lots.

We are already planning for this transition now within NRG, so that any potential decline in either the availability of utility-sized solar projects or in the attractiveness of the returns being realized on these projects, will be exceeded in aggregate by the increase in the business we are doing on smaller distributed and residential solar projects through our Green Mountain and even our Reliant retail sales channel.

With that, I'll turn it over to Mauricio.

Mauricio Gutierrez

Thank you, David, and good morning, everyone. NRG continued its strong operating and commercial performance during the fourth quarter, making 2010 one of NRG's best years. Slide 13 highlights a few of the key accomplishments achieved in 2010.

Starting with safety, we're particularly pleased with our record performance this year. Our OSHA recordable rate improved 26% over 2009. Our top performance remained strong with 90% availability of our baseload fleet, just shy of our 2009 level. This performance was achieved despite a forced outage event on our STP nuclear plant in November, which I will cover in more detail in the next slide.

On the environmental front, we delivered our second best year, and our FORNRG program far exceeded our 2010 goal. As I mentioned to you on our last call, controlling our cost is a priority, given the challenging economic environment our industry is facing.

Our Commercial Operations Group increased our hedge levels in 2011 and continues to look for opportunities to catch the odd years of favorable prices. We successfully transitioned to the Nodal Market in ERCOT and began integrating Green Mountain Energy and the Cottonwood combined cycle plant into our portfolio.

With respect to our projects under construction, the Indian River Unit 4 environmental back-end control project continues to be on track and on budget to be operational by January 2012. Our Middletown project in Connecticut received all major equipments in the fourth quarter and continues to be on schedule for operation this summer. Finally, the El Segundo Energy Center completed aboveground demolition of two existing units and secured major equipment orders. El Segundo is on track to be operational by the summer of 2013.

Turning to our plant performance metrics on Slide 14. Safety continues to be our number one priority. We are very proud to report that we achieved top decile in the industry, making 2010 our best OSHA recordable year. We have 25 sites with no injuries and nine sites certified or recertified as OSHA VPP Star worksites.

Net generation decreased by 6% in the fourth quarter due to mild weather across Texas and a 22-day on-plan outage at STP Unit 2 during the month of November. The forced outage event was the result of a breaker failure during routine testing and was extended to repair a reactor coolant pump seal. In order to prevent recurrence, similar electric components were checked in both units. Unit 2 has operated without any issues since it was brought back to service on November 26.

For the full year, net generation was flat from 2009 levels. Increased generation in the Northeast and South Central regions driven by the strong summer weather and the addition of Cottonwood, were offset by lower generation in California and Texas.

For 2010, our coal fleet availability finished the year above the sub-quarter performance level for the industry. WA Parish led the fleet with 92.6% availability factor, and Limestone had the best reliability for the year, with a 1.6% forced outage rate.

Our FORNRG 2.0 program exceeded the 2010 goal by $49 million, and it is on track to achieve our goal of $150 million by 2011, one year earlier than planned. Savings were achieved through a combination of reliability, capacity and efficiency improvements at generating assets and cost savings across our corporate and regional groups.

Turning to our retail operations on Slide 15, we closed out the year with another strong quarter. Volumes and margins were consistent with our forecast, while Operations delivered better-than-expected asset management and lower operational costs.

The Mass segment continues to drive segment improvement in net customer attrition with a 57% reduction in the fourth quarter versus 2009. This result was driven by marketing, sales and introduction of innovative products to meet our customer needs.

In 2010, we led Texas in innovation, enrolling over 175,000 customers on our Reliant e-Sense product and services that utilize smart grid technology. We also introduced new and unique offers like carbon-state [ph] and home protection products, adding not only incremental EBITDA but increased customer stickiness.

We continue to maintain the lowest PUC customer complaint rate while balancing customer counterpricing. Throughout 2010, we aligned to successfully demonstrate that we have stabilized

customer attrition and expect to achieve zero net attrition in 2011.

In the C&I segment, both renewal and new deal win rates continue to improve. We have expanded our business in several Northeast states where we can leverage existing energy assets and increase product offerings to include products such as backlog generation. These provides a solid platform to grow our business in 2011.

Business continues to show some fundamentals as you can see on Slide 16. Weather-normalized demand grew by 2% year-on-year and ERCOT set a new winter peak low of 57 kilowatts in February, an increase of almost 2.5% from the previous record. I'd like to take this opportunity to address the events in Texas on February 2.

The men and women of NRG Texas worked very hard to help meet the high demand for electricity due to the extreme cold conditions, increasing our generation by more than 60% from the previous day. Although we had some operational issues, of the approximately 9,500 megawatts of power we had available in Texas during the low-shed event, we maintained between 97% and 91% of that capacity online. I want to thank all our employees in Texas for their dedication and extraordinary efforts during these events.

Now moving on to reserve volumes in ERCOT, we see a positive feature of our generation portfolio with reserved margins tightening faster than expected. This is to some extent reflected in the forward heat rates, as you can see on the chart on the lower right-hand quarter. We believe this trend will continue, given the robust growth and the expectation that asset retirement will outpace new builds. We have not seen as much coal-to-gas switching in Texas as we have in the Northeast and Southeast regions. In fact, cash generation was down year-on-year due to increases in new coal and wind generation in Texas.

In the Northeast, the back-end market continues to make some news. In New York, the recent FERC order to increase cost of new entry should provide a boost to capacity prices in New York City and rest of state, benefiting our New York portfolio. In PJM, prices remain uncertain until more clarity is given around the minimum offer price rule, the subsidized generation in New Jersey and Maryland and review demand outlook.

Moving on to Slide 17, you can see our detailed plan to control air emissions for each of our coal plants. As stated in our last earnings call, our plan is to invest approximately $720 million through 2015 in environmental projects tailored to comply with future regulations.

Just to remind everyone, the proposed CAIR rule does not require additional capital for compliance. The HAP MACT proposed rule should be released in mid-March, and as you can see in the table, our plant considers mercury controls on all our coal units.

Intake modifications and repowering are expected to meet once for cooling requirements. We only have dry fly ash disposals at our all coal facilities. And finally, in most of our facilities, we burn low sulfur, low chlorine PRB coal.

Moving on to our hedge profile and commodity sensitivities on Slide 18. Our baseload portfolio is now 100% hedged in 2011 and 50% hedged in 2012, providing the protection in the short term where gas prices continue to be weaker given the oversupply situation. Beyond 2012, we choose to remain significantly open.

After two years of low gas prices, we believe the downside risk is limited. Our combination of

incremental demand from the power sector, particularly in light of possible coal plant retirements, some signs of the interest rate by producers, indication that drilling to home acreage may be ending, and a move from dry to wet gas production will provide better opportunities to catch our baseload portfolio in the future.

With respect to retail, we have increased our pipe load to 66% in 2011 from 57% in the third quarter. We continue to match as much generation load as possible to start maximum synergies between our retail and wholesale portfolios.

Our power and coal hedges continue to be well managed in 2011 and 2012. Given the shape of the coal curve and steep contango, we have not added any additional occasions since the last quarter. We also remain well hedged in terms of coal transportation now for some time.

Our sensitivity to commodity prices is agreeable for 2011, with 2012 to 2015 largely unchanged from last quarter. Let me remind you that this sensitivity is around our baseload portfolio. Interest expense, our portfolio is well-positioned to benefit, particularly, in the Texas and South Central regions.

With that, I will turn it over to Chris who will discuss our financial results.

Christian Schade

Thank you, Mauricio, and good morning. Beginning with the financial summary on Slide 20, full-year 2010 adjusted EBITDA was $2.514 billion, just shy of the record 2009 adjusted EBITDA of $2.618 billion and within our previously stated guidance of $2.5 billion to $2.55 billion. As a result of our continued strong operating performance, adjusted cash flow from operations for 2010 was robust at $1.76 billion.

The company's liquidity position at year end, excluding funds deposited by counterparties, stood at nearly $4.3 billion, a $458 million increase from December 31, 2009, liquidity of approximately $3.8 billion. Our cash balance at year end 2010 available for both working capital as well as our 2011 capital allocation program was approximately $2.9 billion.

Now turning to a summary of our 2011 guidance in Capital Allocation Plan. First, we reaffirmed the preliminary 2011 EBITDA guidance range of $1.75 billion to $1.95 billion. Second, and as part of our 2011 capital allocation program, we are planning to repurchase $180 million of common stock, and complete $240 million of term loan debt repayments and $39 million for additional facilities, all of which is consistent with NRG's commitment to return excess capital to its stakeholders. Third, in 2011, in addition to the amount deferred from 2010 as a result of extending the cash grant availability, we are currently planning to commit an additional $640 million of net investment to advance our Repowering and renewable development program, particularly, utility-scale solar.

Now turning to a more detailed review of 2010 adjusted EBITDA result from Slide 21. The company reported near record results of $2.514 billion adjusted EBITDA, only $104 million lower than the 2009 adjusted EBITDA of $2.618 billion. These results were achieved despite the decline in forward prices across all of our regions and clearly benefited from our wholesale generation hedging program and the continued strong performance of Reliant Energy.

During the year, Reliant Energy contributed $711 million of adjusted EBITDA. Comparatively, these results are lower by $158 million from 2009 as we overlined for only eight months of that year. The year-on-year decline was driven by an 18% decline in Mass margins, which were the direct result of price reductions enacted following the acquisition, as well as lower margins on customer renewals and

new customer acquisitions reflective of the competitive market. All told, for 2010, Reliant saw net customer attrition rates improve to 0.4% from 0.7% in 2009 with total customers at year end steady at 1.5 million.

The wholesale business meanwhile generated $1.8 billion in adjusted EBITDA, $173 million lower as compared to a record 2009 EBITDA of $1.976 billion. The comparative year-to-date decline is largely explained by a 32% drop in baseload hedge prices in the Northeast, as well as lower margins in Texas, caused by a 60% increase in fuel costs, due largely to higher coal transportation costs at our WA Parish facility. These results were partially offset by an increase in adjusted EBITDA of $28 million from the South Central region due to increases in generation and contracted sales.

Also increasing adjusted EBITDA were our newly acquired assets, including Green Mountain Energy, Cottonwood, Northwind Phoenix, South Trent Wind Farm, as well as the full year of operations from the Blythe solar project.

For the fourth quarter, the company reported adjusted EBITDA results of $444 million, a $45 million decline versus 2009. Reliant Energy contributed $117 million of adjusted EBITDA compared to $104 million for the fourth quarter of 2009. Reliant's quarterly results were favorable $13 million driven by an improvement in operating costs primarily due to better customer payment habits as related to a decrease in bad debt expense.

In the fourth quarter of 2010, our Wholesale Generation business contributed $327 million of adjusted EBITDA, a $58 million decline compared to fourth quarter '09. The change in results can largely be attributed to the following items: In the Northeast region, 35% lower hedge prices and a 25% decrease in generation resulting in a $57 million decline in energy margins quarter-over-quarter. The decrease in generation was largely a result of coal-to-natural gas switching and offsetting this decline in energy margins were favorable year-on-year operating and maintenance expenses of $13 million.

In Texas, the 10% decline in generation at the Limestone and WA Parish facilities due to lower power prices and reduced demand led to a 6% decline in overall generation for the region. Offsetting this decline were favorable year-on-year operating expenses of $17 million that included gain on land sales of $6 million in 2010.

Now turning to Slide 22. As I mentioned a moment ago, total liquidity at year-end 2010 excluding funds deposited by hedged counterparts remained strong at nearly $4.252 billion. Total cash stood at $2.959 billion, an increase of $653 million as compared to the 2009 year-end cash balance of $2.3 billion. The drivers of the cash increase included adjusted cash from operations of $1.76 billion and debt proceeds of $1.317 billion.

These increases were offset by several items: First, five completed acquisitions totaling about $1 billion, which included $507 million for Cottonwood generation station, $357 million for Green Mountain, $100 million for Northwind Phoenix, $32 million for South Trent Wind Farm and for the U.S. solar portfolio, 720 megawatts of development projects in nine states in California and Arizona. Second, debt and fee payments totaling $813 million, including Term Loan B payments of $453 million and a repayment of a common stock fund or CSF of $190 million.

And third, capital expenditures excluding NINA of $445 million, including $199 million of maintenance, $184 million of environmental, primarily related to the Indian River Air Quality Control System project, and $62 million of growth investments. For the full year, we made cash contributions to NINA totaling $170 million primarily in the first half of 2010. And finally, we completed share

repurchases of 8.5 million shares, totaling $180 million.

Now turning to 2011 guidance on Slide 23. Our EBITDA guidance remains unchanged from our November 24 range of $1.75 billion to $1.95 billion. Included in this guidance range are wholesale expectations of $1.2 billion to $1.3 billion, retail expectations of $480 million to $570 million, and Green Mountain of $70 million to $80 million. As Mauricio discussed earlier, we are about 100% hedged on our baseload generation for 2011 and are thus comfortable with our forecasted results.

As we look forward to our Wholesale business in 2012, we are currently in excess 50% hedged with a higher average price in 2011 as indicated in our SEC filings. Due to this position and based on the current forward curves, we expect flat to marginally lower year-on-year wholesale results in 2012 from 2011. These results will be supplemented with adjusted EBITDA of $85 million from our repowering and solar investments in 2012 that are not subject to market fluctuations.

For our retail business in 2011, our current expectations, assuming normal weather, are an EBITDA range of $480 million to $570 million, the decrease in 2011 guidance compared to current 2010 results is largely explained by lower unit margins in Reliant's Mass business. Reliant's C&I business margins are also expected to decline slightly, but be directly offset by higher terawatt-hours served, reflecting our continued dedication to this growing client base in both Texas and PJM.

Finally, we expect Green Mountain Energy to contribute $70 million to $80 million of EBITDA. We are very excited about enhancing the growth prospects for our Green Energy Retail business during the process of integrating the business with our growing renewables portfolio to enhance these future growth prospects.

During our Q3 earnings call, we discussed the 2011 free cash flow guidance of $425 million to $625 million, and we now currently anticipate free cash flow for 2011 to be in a range of $150 million to $350 million. The difference in guidance is largely explained by certain timing of solar projects, due to Congress extending the availability of cash grants for renewable projects through 2011. NRG postponed its large investments in solar projects from 2010 to 2011, resulting in $267 million of solar expenditures pushed into '11 and relates primarily to our Agua Caliente, Ivanpah and CVSR solar projects.

As we often like to emphasize, we are in a strong cash flow position based on Friday's closing stock price of $20.89 and our affirmed outlook. Free cash flow before growth yield currently stands at between 16% to 20%, or $3.36 to $4.17 per share.

Slide 24 shows the company's projected 2011 year-end cash position which we project to be about $2.5 billion. Beginning with the portion of the Capital Allocation Plan that includes share repurchases and debt repayments in 2011, the company intends to repurchase $180 million of common stock, which is within the constraint of the restricted payments basket; repay $240 million of debt related to our Term Loan B agreement; and approximately $39 million in other facilities. It's important to note that the company made a Term Loan B prepayment in November that totaled $200 million.

And finally, complete $907 million of capital allocation in the following projects: $50 million in NINA; $219 million for other Repowering investments including El Segundo, GenConn Middletown, eVgo, Texas Reliability and Princeton Hospital and $638 million for solar projects, net of cash grant proceeds, and including the $267 million of deferred payments from 2010.

During the third quarter conference call, I also mentioned that we usually maintain a minimum cash balance of $700 million largely for working capital margin requirements, the timing of cash payments,

of interests, property taxes, as well as equity for projects we have under construction throughout the year. Thus, for 2011, we estimate a balance of just over $1.8 billion to allocate between perhaps additional share repurchases, contingent on the restricted payments basket expansion, further investments of high-growth opportunities and continued opportunistic management of our debt structure.

On January 11, the company issued $1.2 billion of 7 5/8 senior notes due 2018 and announced the simultaneous cash tender for $1.2 billion of the outstanding 7 1/4 senior notes due 2014. As of January 25, nearly 945 million bonds have tendered, and the remaining 250 million will be redeemed by the end of February pursuant to the embedded coal price. As a result, we've improved our debt maturity profile, all of our public debt matures after 2016, and replace the restricted covenant package with one permitting greater efficiency and flexibility to return value to all NRG stakeholders.

On a go forward basis, we will continue to moderately embed in calls in the 2016 and '17 maturities and be opportunistic about replacing those bonds with less restricted covenant packages, similarly to how we handle the 2014 maturity.

Looking at NRG's combined Repowering and Solar portfolio and our EBITDA contribution on Slide 25, you can clearly see the benefit of the program with nearly $550 million of recurring contribution by 2015.

During the fourth quarter, our El Segundo Repowering project received prior approval from the California Public Utilities Commission for a ten-year Power Purchase Agreement with Southern California Edison. Commercial operation's expected in the summer of 2013.

Our large utility-scale solar projects will also begin to reach commercial operations between the summer of '13 and the first quarter of 2014, and these projects collectively are driving this EBITDA growth. These solar investments are attractive for their high-teens returns, very low construction risks and offtake agreement of 20-plus years with highly rated counterparties. We will continue to provide updates on the progress of these projects as they move into construction and operation.

As we continue to invest and grow our solar portfolio, it's important to highlight a few economic benefits created with these projects. Slide 26 shows how the combination of cash grant, maker's depreciation and strong cash flows from the PPAs for our projects result in a payback for our investments, in some cases by 2014, and retain stable cash flows for the remaining term of the PPAs.

Though we believe there will be a turnaround in commodity markets, we are mindful of our ability to create enough taxable income for us to fully absorb tax benefits created by these solar investments. There is clearly a limit to how much tax efficiency we could absorb in any one year before reducing the total project returns. As such, to both minimize the tax leakage and enhance our returns, in 2011, we will pursue new equity investors for our solar portfolio, who have both the appetite for tax benefits and seek investment to one of the largest utility-scale solar portfolios in the world. New equity investors would not only help to optimize our existing tax position but allow us to continue to invest in future projects with high returns.

We expect to launch this initiative soon and look forward to sharing the progress in the future. Now I'll pass it back to David for final comments.

David Crane

Thank you, Chris, and thank you, Mauricio. And so in conclusion, on Slide 28, we put what we think

are some of the value drivers around the investment proposition at NRG. And it starts with the fact that 2 1/2 years into the commodity price down cycle, it appears to us that the end is in sight, the bottom of the trough has been reached, and the only way to go is up. When or how quickly gas prices will recover remains open to conjecture, but the case for rising heat rates in our core market of Texas is clear and compelling. And we've positioned our portfolio and our hedge both to benefit from that upturn.

Second, even in a political environment that has turned more conservative in the past year, market mandates for renewable generation and for solar power in particular, remain well supported in both the red and blue states. And the result for us has been a fast-growing portfolio of projects that will contribute substantially to shareholder value creation over the short to medium-term.

Finally, there's the inherent value unique amongst our peer group of Wholesale generation combined with the leading retail position. While we have executed to such great success in Texas, together with Reliant, we are now in position to replicate with Green Mountain in the fast-growing green and retail energy sector. It's a bright future indeed, and for all of us at NRG, we'll strive to realize its vantage on behalf of the shareholders of NRG.

So Deanna, with that, we'd be happy to take some questions.

Question-and-Answer Session

Operator

[Operator Instructions] The first question will come from the line of Daniel Eggers, Crédit Suisse.

Dan Eggers - Crédit Suisse AG

David, I was just trying to marry up some of the comments made about some of the solar investment opportunities. If I look at Slides 25 and 26, the cash investment and then the earnings contribution you guys show there, is that based on the things that are in hand right now, or is there a assumption of the amount of incremental projects who would have to get signed this year to help get to those numbers?

David Crane

I think what we're showing, Chris, correct me if I'm wrong, is the Tier 1, which are projects, which in my personal estimation are ones that have a 90-plus percent chance of achieving financial closure.

Christian Schade

Yes, that's actually correct, Dan.

Dan Eggers - Crédit Suisse AG

So these are things that are already in place, and this would be less contribution than what you said in your comments earlier, David, about having equity investment and solar greater than what you do see in South Texas ultimately?

David Crane

I'm sorry. Say it again?

Dan Eggers - Crédit Suisse AG

So this earnings contribution represents an investment less than what you think you can get to from the solar perspective based on your comments earlier in the presentation?

David Crane

I mean there are more projects behind this portfolio.

Dan Eggers - Crédit Suisse AG

When do you see the opportunity this year to announce off projects? And how would you see this sell down equity go as far as changing the earnings contribution profile from these projects? And how much could you sell down, do you think?

Christian Schade

Well, we're going to get to how much we can sell down as we move through the process. But very clearly, any amount we sell down will sort of be a pro rata reduction in EBITDA. And so depending on how much we do, we'll certainly let you know. But we do believe that the sell down will allow us to provide incremental more equity into other projects we have yet to announce. But what David said, we're on the bubble given the benefits from the government largesse, which we think still exist but perhaps will run out in the next couple years. And those projects will also be assumed as sort of returns consistent with what we've seen to date.

Dan Eggers - Crédit Suisse AG

And I guess one last question just on South Texas. David, if you could maybe just -- we go through the numbers as far as how much cash you expect to throw off in the project, and then to clarify that, contribution's based on kind of the pricing you'd need it to be able to receive in order to earn economic return on that project?

David Crane

Well, so you're saying you're -- Dan, you're actually looking forward to 2016 and '17? Yes, I mean, looking at Page 10, I mean, through the first few years, when we've talked about receiving $500 million of cash, that's based on our view on where gas prices go, which is, obviously, some way up from where they are now, sort of into the $6 to $7 range. Having said that, Dan, we've stressed the returns on the nuclear project from an IRR perspective, sort of $4 gas in perpetuity model. And the IRR in the project, it would still be in double digits, but obviously, the higher gas prices, the better we do. But it works, the numbers work even at a $4 gas environment. And the reason that is the case, Dan, is because, obviously, the tax benefits associated with nuclear project, particularly, the production tax credits, meaning that through the first several years of the nuclear project, the economics are more driven actually by the tax benefits than they are by the price of electricity.

Dan Eggers - Crédit Suisse AG

Do you see IRR as working in $4 gas to the equivalent of a mid-30s power price, you would see the plant being economic?

David Crane

In a $4 gas, the plant is, yes. I mean, again, it's a low-teen return. I'm not sure that -- it's not the return we're seeking, but it's not a single digit return or a negative return.

Operator

The next question will come from the line of Ameet Thakkar, Bank of America Merrill Lynch.

Ameet Thakkar - BofA Merrill Lynch

Mauricio, you kind of indicated that the path with hedging, despite, I guess, some uptick in heat rates in Texas and you also didn't do much in the way of coal as well. I mean is your expectation that PRB prices should follow gas down? Or are you guys a little bit more neutral on gas at this point?

Mauricio Gutierrez

Well, I mean, if you look at our hedge profile, the next few years, we're pretty well hedged on both sides, so power and coal. We can justify the contango that exists with the coal curve. And given the inventory that we have and the hedge profile, we think that we can weigh to be more opportunistic about when to catch the coal prices. With respect to gas, we continue to see further declines in the front part of the curve, which we've been pretty well insulated. But as I mentioned in my remarks, I mean, I think when you look at 2012 and beyond, and where those price levels are, we see very little downside risk from that. And we think that there are several factors that are converging that could potentially move gas prices, assuming they could be higher than where they are today.

Ameet Thakkar - BofA Merrill Lynch

And then David, real quick on STP. I just want to make sure I understood, I guess, some of your answers to the previous questions. You see returns in kind of the teens area, given the $4 gas for STP?

David Crane

Yes, so the returns would be in the teens area in the $4, in perpetuity model. Again, this is based on the idea that we're running a model where there's roughly 1,000 megawatts of power sold by long-term contract, and the rest is taken into the merchant market. So the $4 gas would apply to the 2,000 in the merchant market. And yes, you're right, what it shows is a return in the teens, in that sensitivity. I would also tell you, Ameet, both in response to your question and I should say to Dan, also, we run this with no value associated to the zero-carbon aspect of it, so the price on carbon directly or indirectly would be on top of this.

Ameet Thakkar - BofA Merrill Lynch

And then so is like the 1,000 megawatts of PPA cover, I guess, under that analysis, is that really kind of the goal to kind of continue to move forward and not exit, I guess, exit land for on Slide 9?

David Crane

Well, Ameet, almost as a -- I mean, from the beginning, I think that we have said to our investor base that we, at least, would not proceed with the project unless there was a significant amount of long-term offtake associated with the project. And so, roughly 1,000 megawatts has been something we talked about from the beginning. On top of that, Ameet, the conditional loan guarantee, if and when it's announced, it's called a conditional loan guarantee because there are conditions associated

with it. And probably the most substantive condition, the condition we would be focused on is that the government would require us to have approximately that same amount of long-term offtake agreement contracted, which was a condition, again that we were happy to agree with the government on since we had said that we wouldn't go forward with it either. So that's why we would be doing that.

Operator

And the next question will come from the line of Ted Durbin, Goldman Sachs.

Theodore Durbin - Goldman Sachs Group Inc.

If I could just ask a little bit about the capital allocation. You're obviously coming out of 2010 here with a high cash balance. I'm just trying to understand a little bit better the allocation of the capital towards the renewables and whatnot, maybe extending that relative to between cash to stakeholders. Could you just talk a little bit more about that?

Christian Schade

As we said, we're committing to a $180 million stock repurchase, and that's within the confines of our restrictive payment basket. We're also going to be making required debt repayments under our term loan program, Term Loan B program. We've also earmarked potential investment in our solar projects, and these are projects which we had -- some of which we're announced late last year and early this year and would be subject to the cash grant program under the government. So all of those projects and repowering projects from El Segundo and GenConn Middletown. But those are the programs at least that were part of the capital allocation program for this year. That's what we've announced. We have $1.8 billion after which we would be able to deploy into additional repowering should they be available and new solar projects that we see on the horizon, as I've said before, all of which offer us the opportunity for very attractive returns.

David Crane

And just to add, Ted, I think you phrased the question almost as if it was an either/or, and I guess that may be a little different. I mean, given the company's free cash flow generation and the cash we have on hand, we haven't really seen it as an either/or. In terms of returning capital to shareholders through the share buyback, we do as much as we can under the restrictive payment basket. Over the past years, we've constantly evaluated whether or not we could negotiate a way to have more room to do more, but the expense of doing that has always made that impractical. So from our perspective, it has not been an either/or decision. It's been do both.

Theodore Durbin - Goldman Sachs Group Inc.

Does that cost of getting the ability to do more of a buyback, you're still seeing that as not worth the expense of getting that?

Christian Schade

That's right. We think the expense to negotiate with the bondholders is being punitive. And as I said in the prepared remarks, the approach that we took on the 2014 maturity to wait for the calls to come due than to call away and refinance was we felt unattractive and a cost-beneficial way to do it. We have calls coming up in February for the 2016 maturity which we'll keep an eye on. The 2017 are not yet callable, will be so within a year. The high-yield market remains very attractive from financing

perspectives, so we'll continue to look at that closely. But just to further what David said, with the excess cash in addition to the $180 million as we said, we'll certainly consider future stock repurchases if it can fall within the confines of hedging expansion we see in our restrictive payments basket throughout the year as well.

Theodore Durbin - Goldman Sachs Group Inc.

I appreciate the commentary on sort of the assets side. It sounds like you're not seeing the values on the CCGT side that you were before, but you did do the Cottonwood transaction. Are there other holes in your portfolio, where you say, "Geez, we'd really like to add some mid-merit assets whether it's more in South Central or whatnot?" And kind of talk about where you'd like to build up the portfolio.

David Crane

Well, I think the place where we'd like to build up the portfolio, and again, we've been fairly -- well, it took us six years to execute on the idea that we needed a load following plant in South Central. So just because I say this, I don't want you to think any sort of announcement's around the corner, because I'm actually skeptical that we can achieve anything. But we would definitely like to have some more baseload-following capability in PJM, particularly Eastern PJM. Having said that, we don't have any optimism about anything coming available in that footprint that we would find probably at a reasonable price. But we keep our ear to the ground. I would say that has been our single greatest priority second to backing up Big Cajun, which we've now achieved with Cotton.

Operator

And the next question will come from the line of Jonathan Arnold, Deutsche Bank.

Jonathan Arnold - Deutsche Bank AG

My question is, on STP, you believe the option for the second 10%, the TEPCO would take -- had a May expiration date on it, we recall from the original 8-K. But is there a similar date around the base 10% investment that's contingent on the loan guarantee acceptance? Is May a kind of drop-dead date for that whole arrangement with TEPCO?

David Crane

I don't believe there's a drop-dead date. And John, Tokyo Electric well understands the pace of development. I don't want to speak to them, but I think their enthusiasm for participating in this project is unchanged from when we announced the deal a year ago. So I don't remember any sense of date, but I have a very high level of confidence that if the loan guarantee comes that Tokyo Electric will participate in the project.

Jonathan Arnold - Deutsche Bank AG

And can you also give us a sense of -- well, obviously, your contribution is relatively small over this '11, '12 period. What would the $25 million in '12 be absent additional sell downs? And maybe some kind of sense of how much is actually being spent on the project itself during this next couple of years.

Christian Schade

Well, what it would be without the sell down, I'll have to get back to you on that. The amount of money that has to be invested towards in order for us to proceed is it's several hundred million dollars. But Jonathan, it's really hard to put it in those terms. Because like a good portion of it is long lead time materials in Japan which are actually funded with the credit facility from Toshiba. So maybe we can break out and provide it to you or do it next quarter. Just the development spend for now, in order for us to proceed against the sources of capital, because it's really not useful if you look at it as one-lump sum, because various things are paid for with different buckets of money.

Jonathan Arnold - Deutsche Bank AG

And if I may just on one other topic, what indications are you getting from DOE on these discussions at a level of hedging through PPAs that would be acceptable to them on the project?

David Crane

Well, I think that the condition is very specific. And I think back, it's the same as I answered to Ameet. It's something just less than 1,000 megawatts.

Operator

The next question will come from the line of Jay Dobson, Wunderlich Securities.

James Dobson - Wunderlich Securities Inc.

I was hoping you could give us some insight into the offtake discussions. The local media's covered some interesting transactions, or at least, proposals that you had. So I'm just wondering if you can give us some insight into where things stand and sort of what your level of optimism is currently.

David Crane

It's a good question, and I think what I would say without -- I mean, it's difficult to comment with discussions that are underway. And in fact, normally, we don't comment on it but since as you said, there's been discussions by the public, I guess I should say some things. I would say, first of all, I think there's an openness, a willingness, and interest on several load-serving entities, large load-serving entities in the Texas market to talk about long-term offtake. And I would also say that the events of early February in Texas, where a part of the reason the state had rolling brownouts or even blackouts is because people couldn't get gas to some power plants, I think has reinforced the idea that having fuel diversity in the state is something that load-serving entities want to have. So there's a fairly high level of interest from various parties, but the big qualifier I always put on this question is, right now, as you say, it's really discussions. I mean, the project isn't really real to off-takers until we have a loan guarantee. So I would describe anything that we're doing with any counterparty at this point is being preliminary. And so that's what I would tell you. And based on what we're being told by the camp, their interest level, I'm guardedly optimistic. But mainly, my main attitude towards all this is, let's wait and see what happens when the loan guarantee's announced, because that's when ourselves and our counterparties are going to have to get down to business, and people are going to have to make commitments on both sides. So that's the main thing, and what we're trying to empathize here is that, that phase, and hopefully that phase will begin within the coming weeks, is something that basically needs to be resolved by the summer so that we can all have clarity as within the company and U.S. investors and analysts as to where we stand vis-à-vis this project.

James Dobson - Wunderlich Securities Inc.

As an unrelated follow-up, on the solar side, I'm not sure if this is good for your or for Chris. I assume in addition to selling an equity stake, you'd consider selling a tax equity there, and how do you consider those two alternatives?

Christian Schade

Yes, very much so. I think the equity stake that we are contemplating is tax equity, it's a structuring issue. But we're certainly looking to pass off the tax attributes that are generated from this portfolio to tax equity investors. I think, one thing as a follow-up to a question before is that we'd certainly be looking to sell this equity at a premium. The returns that we're seeing perhaps from these investors are below the expected returns that we see in the high-teens, and so that sort of premium or IRR arbitrage gain will certainly benefit us in having development premium for this. But our goal here both is to bring equity into these projects and also, to lay off some of the tax that perhaps, does not necessarily accrue to NRG.

James Dobson - Wunderlich Securities Inc.

And Chris just a last follow-up, the capacity of the RP basket at year end?

Christian Schade

It was about $160 million. So the $180 million that we announced today will be spread out for a couple of quarters.

Operator

The next question will come from the line of Brandon Blossman, Tudor, Pickering Holt & Co.

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

I guess just a follow-up on the tax equity question, probably for Chris. Just to be clear, is the tax equity partner or sell down required to optimize the tax benefits of the current solar portfolio, or is that something you need to do to increase the size of that portfolio?

Christian Schade

I think it's not necessarily required. I think it benefits the returns of the portfolio and allows us to continue to invest in the space. As David said, we're seeing a lot of opportunities elsewhere, and I think when we start to layer on other utility-sized projects in addition to what we have, there is a limit to the capacity of tax attributes that we can assume. So we think it's important. We're seeing a lot of interest and opportunities to invest in this space by sort of nontraditional investors who want to get green, and so we think it's a big opportunity for us, who are certain taxpayers as well. So it's for us to check a lot of boxes along the way. First and foremost to optimize our tax position in appropriate years, as well as to allow us to continue to invest in the space.

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

And how does that dovetail with STP's tax attributes? Is that far enough out so that there's no overlap here or concerns about maximizing that value?

Christian Schade

It is far enough out that we're not perspiring about the tax attributes that it generates. But certainly, it's a topic that we will address at due time. And also, would speak to our underlying business that we hope and certainly think will grow enough to burn through these NOLs and to continue to generate the taxable asset side in those years. So we're confident of that.

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

And David, as a follow up, not that anyone wants this to happen, but if there is an exit ramp for STP, can you describe what that looks like? Is there a project to be had at some point in the future, given that this is a particularly attractive development project?

David Crane

Well, Brandon, I guess, what I would say, on a few fronts. I mean it sort of depends on which exit ramp you're talking about. And I'm just speculating on things which of course, we don't hope to happen. I mean from my perspective, I think if something happens during this year that caused the entire project to go away, we would probably finish the licensing process, which is a small fraction of the overall development spend. But we're so far along with the NRC that to stop it this close to the end would not make sense. But beyond that, would the project go forward? I think it depends on which exit ramp it is. And again, I don't mean to speak for the other partners, because I want to emphasize every NRG investor on the call. We do not have the right to kill the STP 3 & 4 project. We just have the right to stop our own financial contribution to it. But I would say, if the exit ramp is that, actually it turns out that there is no loan guarantee in the offing -- I haven't actually asked this question directly, but I think our partners in Japan -- and we would be aligned that there would be, that the project would stop if there's no hope of a federal loan guarantee. If on the other hand, there was a federal loan guarantee, but we were taking the exit ramp because we were unable to lineup the offtake, I don't know what our partners would do in that circumstance. Maybe they would continue with the project, that would be their prerogative to do. I just know that if we don't have that offtake arrangement, then we will stop funding.

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

And that would be not the 1,000 megawatts, but isn't that predicated on the loan guarantee or the loan guarantee predicated on the 1,000 megawatts?

David Crane

It is, but one of the reasons why I don't know -- I don't remember the exact terms, the exact words of the conditional loan guarantee, but I know that we do not have the opportunity at NRG to solve for the offtake arrangement, because I think the condition is offtake agreements with investment grade offtakers. Our Japanese partners who are investment grade would have that opportunity should they so choose to correct that on their own. We don't have that type of power, so that's not a question for us.

Operator

The next question will come from the line of Brian Chin, Citigroup.

Brian Chin - Citigroup Inc

What's the rough range of construction cost estimates in dollar per KW for the solar PV facilities that

you are seeing, and also for the solar thermal side?

Christian Schade

The range, well, I think we would say that the range right now is 3,500 to 4,000 per KW, and I don't know, that would be for the PV -- I can't tell you -- the solar thermal would probably be in the same range.

Brian Chin - Citigroup Inc

And then would it be fair to say that $4 sustaining perpetual natural gas price environment that you'd still see solar generating returns in the double digits as well? And is it higher or lower than nuclear?

David Crane

Well, we haven't compared them side-by-side. I think it's fair to say that like nuclear, the solar projects, at this point, the economics are very heavily driven by the tax benefits. But beyond that, the real difference between the two is that every solar project we're doing is completely not merchant. It's totally PPA. So I don't think -- in fact, when we talk about taking the company's financial performance and sort of de-linking it to natural gas prices, we put renewables together with retail in parts of our EBITDA stream that are not associated with natural gas prices, because of the fact that all of the economics are derived from long-term PPAs.

Brian Chin - Citigroup Inc

Can you talk just a little bit about from your perspective, what the FERC's order in the New York ISO and the capacity market situation up there? What's changed longer-term, and how much of a positive is that for you guys, or is that even material?

Mauricio Gutierrez

Well, I mean it's definitely material. It's difficult to say what is the ultimate impact, because I think the variables are still being flushed out. But the three main changes was the recognition of state taxes and the cost of new entry calculation, inter-connection costs and then the energy offsets. So when you put those three together, you basically have higher cost of new entry, which will push capacity prices for both New York City and the whole state. This will benefit our New York portfolio, but at this point I can't give you the specific mind into it.

Operator

And the next question will come from the line of Anthony Crowdell, Jefferies.

Anthony Crowdell - Jefferies & Co

Just a quick question on the, I guess, the cold stub that hit Texas earlier this month. And it seem like there wasn't much of an impact on the generation side, but was there any impact to the margins that Reliant expected or anything on the quarter?

Jason Few

This is Jason. From the retail side, we actually, faired fairly well through this event. I mean, our hedging strategy and risk policies served as well during the event. We did not see material impact to

our business.

Operator

In interest of time, we have time for two more callers. And the next question will come from the line of Charles Fishman, Pritchard Capital Partners.

Charles Fishman - Pritchard Capital Partners, LLC

Your five-year environmental capital plan, Page 17, I want to make sure I understand this. The $720 million includes your view of what the math might be, which is less than worst-case, number one. And number two is there are no dollars in the $720 million to address once thru cooling. Is that correct?

David Crane

No, actually, there is some dollars for 316(b) through the installation of extremes. We've been very successful in New York, in Arthur Kill and Huntley and Dunkirk to address this issue. So while it addresses the Mercury and asymmetric controls across all our coal assets, it also addresses the 316(b).

Charles Fishman - Pritchard Capital Partners, LLC

And if we do end up with the worst case math, I mean could this number increase 50%? Or do you have any feel for that?

Mauricio Gutierrez

Well, we actually disclosed that on our last earnings call. And I believe it's about $1 billion -- just shy of $1 billion. If it was the worst case scenario, in terms of unit-specific controls, no averaging. And we just don't believe the EPA will go that route. But the rule is going to come out, the proposal is going to come out in about a month, and I think it's just prudent to wait before we make any changes.

Operator

And there are no more questions in queue at this time.

David Crane

Okay, well, good. Well, thank you all very much, and we look forward to talking to you in the next quarter. Thank you, operator.

Operator

And ladies and gentlemen, this concludes today's presentation. Thank you very much for your participation. You may now disconnect, and have a great day.

Executives

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Christian Schade - Chief Financial Officer and Executive Vice President

Mauricio Gutierrez - Chief Operating Officer and Executive Vice President

Nahla Azmy - Vice President of Investor Relations

Jason Few - SVP of Mass Markets and Operations, Reliant Energy, Inc.

Analysts

Anthony Crowdell - Jefferies & Co

Dan Eggers - Crédit Suisse AG

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

Charles Fishman - Pritchard Capital Partners, LLC

Jonathan Arnold - Deutsche Bank AG

Ameet Thakkar - BofA Merrill Lynch

Theodore Durbin - Goldman Sachs Group Inc.

James Dobson - Wunderlich Securities Inc.

Brian Chin - Citigroup Inc

NRG Energy (NRG) Q4 2010 Earnings Call February 22, 2011 9:00 AM ET

Operator

Good day, ladies and gentlemen, and welcome to the Fourth Quarter and Full Year 2010 NRG Energy Earnings Conference Call. My name is Deanna, and I'll be your operator for today. [Operator Instructions] And I would now like to turn the call over to your host for today, Ms. Nahla Azmy, Senior Vice President of Investor Relations. Please proceed.

Nahla Azmy - Vice President of Investor Relations

Thank you, Deanna. Good morning, and welcome to our Fourth Quarter and Full Year 2010 Earnings Call.

This call is being broadcast live over the phone and from our website at www.nrgenergy.com. You can access the call presentation and press release through a link on the Investor Relations page of our website. A replay of the call will also be available on our website. This call, including the formal presentation and the question-and-answer session, will be limited to one hour. In the interest of time, we ask that you please limit yourself to one question with just one follow-up.

And now for the obligatory Safe Harbor statement. During the course of this morning's presentation, management will reiterate forward-looking statements made in today's press release regarding future events and financial performance. These forward-looking statements are subject to material risks and uncertainties that could cause actual results to differ materially from those in the forward-looking statements. We caution you to consider the important risk factors contained in our press release and other filings with the SEC that could cause actual results to differ materially from those in the forward-looking statements in the press release and this conference call.

In addition, please note that the date of this conference call is February 22, 2011, and any forward-looking statements that we make today are based on assumptions that we believe to be reasonable as of this date. We undertake no obligation to update these statements as the result of future events except as required by law.

During this morning's call, we will refer to both GAAP and non-GAAP financial measures of the company's operating financial results. For complete information regarding our non-GAAP financial information, the most directly comparable GAAP measures and a quantitative reconciliation of those figures, please refer to today's press release and this presentation.

And now with that, I'd like to turn the call over to David Crane, NRG's President and Chief Executive Officer.

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Thank you, Nahla, and good morning, everyone, and welcome to our year-end 2010 earnings call. Today, with me, and participating in the presentation is Mauricio Gutierrez, the company's Chief Operating Officer; and Chris Schade, the company's Chief Financial Officer. Also with me today and available to answer questions are Jason Few, who runs NRG's retail company, Reliant; and Chris Moser, who runs the commercial operations function for this company.

So without further ado, to begin -- so ladies and gentlemen, current and perspective shareholders of NRG, as we speak today, it's now been 32 months since natural gas prices began their relentless fall and the economy at large entered into a great recession, the likes of which, I'm sure none of us wish to experience again in our lifetimes, yet the financial performance of NRG during this period has been superb. And that financial performance has been built on the foundation of an equally exceptional

operating performance across all phases of our operations and across all our regions.

In 2010, the second full year of the great recession, our financial performance surpassed all previous years of company results, save for fiscal year 2009, which was of course the first year of the great recession, a year in which we performed spectacularly, achieving both record financial performance and the acquisition of Reliant.

While I am, for the most part, extremely pleased with both the company's financial and its operating performance during 2010, I am acutely mindful of the fact that NRG shareholders did not see any of the benefits of our exceptional performance and share price appreciation during that year. As a management team, we recognize that we have a long way to go in presenting NRG's present value and future potential to the market.

In this presentation and in subsequent presentations that Mauricio, Chris and I will be making during the spring Investor Relations season, we intend to make a concerted effort to explain the NRG value proposition. From the competitive strength of our core businesses, even in a low commodity price environment, to the meaningful and measurable value of our growth opportunities, as well as our effective risk mitigation in areas which we believe to be of concern to the investment community.

So starting with 2010, as summarized on Slide 3, the company continued to generate a very high level of EBITDA in excess of $2.5 billion and also throw off a substantial amount of free cash flow. Indeed, in regard to what should perhaps be the most important metric to shareholders, free cash flow yield, our free cash flow yield for 2010 was a robust 29%, making our seven-year average exceed 23%. And in response to some people who said that we should measure free cash flow for these purposes after both maintenance and environmental CapEx, we have done it in that way but before growth CapEx.

A substantial amount of that free cash flow yield was redeployed back to stakeholders in the form of debt repayment and through our 2010 share buyback program and also into various growth initiatives, which we'll discuss in a minute. But over $650 million of excess free cash flow was returned as cash into the company's coffers, with the result being that our liquidity position at the end of 2010, $4.3 billion of total liquidity with $3 billion of cash on hand, is stronger than it has ever been.

It has always been my position that next to safety, the most important thing that we do as executive management at NRG is capital allocation, and given the amount that we are investing on an annual basis and the record amount that we currently have available either to invest in growth or to return to our equity and debt stakeholders, capital allocation has never been more important than it is now. As such, I'm going to focus the greater part of my remaining remarks on capital, which we expect to invest in our growth initiatives in the months and years to come. Chris will focus a good deal of his comments on capital to be returned to stakeholders.

In terms of the allocation of capital to our growth initiatives, it's important to start with the obvious point that we want to invest the company's capital in assets and initiatives that not only are likely to yield a return significantly in excess of our risk-adjusted weighted average cost of capital, but also in businesses and initiatives which advance the company's strategy.

As depicted on Slide 4, the company's long-term strategy for some time has been twin-tracked. First, to strengthen and enhance our generation to retail business in our core markets through superior operating performance, continued implementation of our first-lean-enabled, long-term hedging program and pursuit of both select acquisitions and the repowering of our older facilities with advantage locations inside load pockets in our core markets. This comply of our strategy which we

have pursued with relentless consistency and a high degree of effectiveness for the past five years was joined a couple years ago with a supplemental strategy that is overtly green and designed to take advantage of the societal trend towards sustainability.

This sustainability trend is, in our opinion, about to accelerate as a result of the emergence of various consumer-oriented disruptive technologies, which will make green energy at the consumer level the focal point of sustainability. We made considerable progress on both strategic fronts during 2010, with substantial advances across every facet of our sustainability initiative.

From our rollout of our eVgo network in Houston, which is centered around an innovative fueling package in approach to electric vehicle infrastructure that is already being replicated in other locations through the smart meter e-Sense applications now being sold by Reliant in quantity, to our unique approach to CCS/EOR being funded in collaboration with the DOE at our Parish facility in Texas. All of these initiatives are exciting and off to a good start. All will, I am confident, return considerable value to NRG to shareholders in the medium term.

You will hear more about these initiatives in the future but not today, because today, consistent with my theme, I want to concentrate my comments on the growth initiatives which are more immediate and which are key priorities for deployment of your investment capital during 2011. This is shown on Slide 6.

By way of background, in 2010, we committed substantial growth capital in four general areas: Zero carbon renewables, with an emphasis on solar; new advanced nuclear development; conventional gas-fired acquisitions and repowerings; and green retail acquisitions in the form of Green Mountain Energy. All four are likely to be areas of additional capital expenditure in 2011 but with very different investment profiles from 2010.

First, we expect an acceleration and significant expansion in our equity capital invested in high-growth, high-return solar projects. At the greater part of our utility scale, solar portfolio should achieve financial close and enter the construction phase during 2011.

Second, investment in conventional generation assets should be relatively flat year-on-year, as spending on GenConn and Cottonwood should give way to spending on El Segundo, but conventional CapEx could increase depending on our development success at Astoria, Saguaro or Encina and also, whether we find any strategic assets that can be acquired at value.

Third, capital invested in green retail should drop precipitously as obviously the big expenditure in this area in 2010 with the acquisition of Green Mountain. The amount of capital that we will be investing in and around Green Mountains business in 2011 or to expand into new geographic markets, bigger customers segments and new complimentary green product offerings is fairly minimal.

And finally, and similarly and perhaps, contrary to popular investor belief, even if the STP nuclear development project stays on course, the development capital projected to be required of NRG in 2011 will be far less than half of what we invested in 2010 and will be a mere fraction of what we will be investing in solar projects and other capital allocation alternatives.

So this is a lot to digest, so let's go through a little bit more slowly, starting on Slide 7 with Green Mountain. Four months ago, we paid $357 million for a business that we expect to contribute $70 million, $80 million of EBITDA in 2011, plus, we expect Green Mountain to continue to deliver on a 20-plus percent compound annual growth rate trajectory that they have delivered for the past decade. But we didn't acquire Green Mountain just to continue with business as usual. We wanted to take

advantage, and we wanted them to take advantage of what we believe are very substantial synergies between Green Mountain and NRG.

Essentially, we want Green Mountain to accelerate the depth and breadth of their growth in close cooperation with us on the same path that they were following on their own, which means expansion into a high retail price Northeast markets, where they start with a natural green-leaning constituency, also, expansion into the larger Commercial segment of the C&I market than they have previously sought to access. And finally, expansion of their value-added product offerings to include distributed green generation.

It's early days yet, but on at least the first two of these, they are already beginning to bear fruit. Green Mountain has established a small but fast-growing footprint in New York Zone J, and in terms of larger C&I customers, they have won landmark business like the Empire State Building. We expect to be reporting on these and many more successes from and with Green Mountain as the year progresses.

Turning to conventional generation on Slide 8. 2010 was an uneven year, with the successful acquisition of Cottonwood and the repowering at Devon and Middletown, balanced by the missed opportunities surrounding Dynegy's California asset. Cottonwood and Devon have been smoothly integrated into our South Central and NEPOOL lineups respectively, and we are very pleased with the results today.

Looking forward to 2011, we're very focused on the successful repowering of El Segundo, an advantage which we hope to derive from having a modern, fast-start, low-heat rate, combined-cycle plant inside the Los Angeles basin load pocket. Beyond El Segundo, we hope to make progress on similar repowering efforts at Astoria in New York City and Encina in San Diego County. Beyond our own Repowering pipeline, the capital we deploy in the acquisition of conventional power plants, obviously, will depend on market conditions and asset availability in our core regions.

While the acquisition market is lumpy, generalities are difficult and predictions are often proved wrong, the optimism I once held at the first half of 2011 would be a buyer's market for CCGTs in the United States has largely dissipated. I see no sign of a flood of assets on the market and the combined cycle of transactions which have been announced recently have been priced at levels significantly above what we could justify to ourselves or explain to our shareholders.

With respect to our nuclear project, while important steps forward have occurred in several areas since our last earnings call, very little of it can be seen with the naked eye. As before, really all critical aspects of the STP 3 & 4 project run off of our receipt of an acceptable conditional loan guarantee from the government. Certainly, it is a challenge for us to complete meaningful discussions about PPAs with potential off-takers, while the loan guarantee application remains pending.

So our exit ramp analysis, which is set forth on Slide 9, remains largely unchanged from the previous quarter. Likewise, our viewpoint with respect to NRG's continued participation in the project remains at the most challenging of these hurdles, which is the long-term off-take requirement, effectively needs to be addressed no later than the third quarter of 2011 before the project enters the substantial pre-construction phase.

As such, we reiterate the view which is clearly articulated in both our 10-K and in today's earnings release, that NRG will be in a position by late this summer to make a final decision on our continued financial participation in this project. At that point, the market should have substantially greater clarity about the prospects for this project and NRG's role in it.

While we understand that there is skepticism amongst some investors that the project can go forward in the current low gas price environment, we nonetheless, believe it might be helpful to you for us to outline as shown on Slide 10 the future capital commitment of NRG in respect to this project, should it stay on track, with NRG continuing to support it financially.

The overall message is that due to a combination of first, the very substantial sum that NRG has previously committed to the project development, particularly during the first half of 2010 after the settlement with CPS. Second, taking into account our expectation of an optimal hold amount in the project for NRG of approximately 40%, which is down from the 67% that we will own if and when TEPCO invests in a project post-loan guarantee award. And third, due to the value ascribed to NRG for its contribution of the site, NRG's cash commitment to the project going forward is less than what otherwise would be suggested by our projected ownership level.

In summary, should the project proceed to financial closing, the total cash commitment for NRG at our 40% hold level should be something just short of $800 million in aggregate, including cash invested to date. Beyond that, we are likely to have an LC commitment to a standby equity crossover line facility that will be fixed. And while that number has not yet been finally fixed, you should be thinking in the range of a few hundred million dollars maximum.

In exchange for this size investment in STP 3 & 4, we expect cash flow from dividends and tax benefits in the range of $500 million a year for the first several years of operations. Obviously, this is a very attractive return but one which we believe is well just justified given the extraordinary challenges of the undertaking.

Now pulling it back from where we hope the project will be in 2016 or 2017 to where we are here in the first quarter of 2011, you should be focused on what happens after announcements of acceptance of the loan guarantee. As the loan guarantee acceptance naturally will trigger certain funding obligations from our partners, NRG's share of cash development spent for the remainder of the development phase should approximate $50 million for all of 2011 and half that for 2012.

While our perspective 2011, 2012 development standard is perhaps substantially less than many in the market were anticipating, it remains a lot of money to us, and we're taking very seriously our commitment to retain our financial discipline around this project and prevent exposure of our balance sheet beyond the specific commitments that I've outlined in this presentation.

Now turning to Slide 11, last but certainly not least, there is the solar pipeline. I've said many times, and I'll repeat here, that in my 20 years in this business, I had never seen investment opportunities in this sector that offer more attractive combination of high returns, low construction risks, long-term PPAs and repeatable business opportunities than the utility-sized solar projects that we currently have in our advanced development portfolio.

As such, we intend to do as much of this business as we can get our hands on, with the result being that by the end of this year, we may well have a total initial equity investment in our solar portfolio that exceeds the total amount that we may ever invest in STP 3 & 4 at very attractive near-term returns. The limiting item for us in terms of these solar investments is our ability on our own to make optimal use of the considerable tax benefits which will be generated by these projects. This is a topic that Chris Schade will discuss in a few minutes.

What I will end by saying is that this extraordinary pipeline of utility-sized solar projects, which our colleagues at NRG Solar have managed to develop or acquire, provides us with a truly unique

opportunity to develop over the next few years a solar portfolio of true scale and significant benefit, even in the context of the larger portfolio of NRG.

Ultimately, however, we fully recognize that the current generation of utility-sized solar and wind projects in the United States is largely enabled by favorable government policies and financial assistance. It seems likely that much of that special assistance is going to be phased out over the next few years, leaving renewable technologies to fend for themselves in the open market.

We do not believe that this will be the end of the flourishing market for solar generation. We do believe it will lead to a stronger and more accelerated transition from an industry that is currently biased towards utility-sized solar plants to one that's focused more on distributed and even residential solar solutions on rooftops and in parking lots.

We are already planning for this transition now within NRG, so that any potential decline in either the availability of utility-sized solar projects or in the attractiveness of the returns being realized on these projects, will be exceeded in aggregate by the increase in the business we are doing on smaller distributed and residential solar projects through our Green Mountain and even our Reliant retail sales channel.

With that, I'll turn it over to Mauricio.

Mauricio Gutierrez - Chief Operating Officer and Executive Vice President

Thank you, David, and good morning, everyone. NRG continued its strong operating and commercial performance during the fourth quarter, making 2010 one of NRG's best years. Slide 13 highlights a few of the key accomplishments achieved in 2010.

Starting with safety, we're particularly pleased with our record performance this year. Our OSHA recordable rate improved 26% over 2009. Our top performance remained strong with 90% availability of our baseload fleet, just shy of our 2009 level. This performance was achieved despite a forced outage event on our STP nuclear plant in November, which I will cover in more detail in the next slide.

On the environmental front, we delivered our second best year, and our FORNRG program far exceeded our 2010 goal. As I mentioned to you on our last call, controlling our cost is a priority, given the challenging economic environment our industry is facing.

Our Commercial Operations Group increased our hedge levels in 2011 and continues to look for opportunities to catch the odd years of favorable prices. We successfully transitioned to the Nodal Market in ERCOT and began integrating Green Mountain Energy and the Cottonwood combined cycle plant into our portfolio.

With respect to our projects under construction, the Indian River Unit 4 environmental back-end control project continues to be on track and on budget to be operational by January 2012. Our Middletown project in Connecticut received all major equipments in the fourth quarter and continues to be on schedule for operation this summer. Finally, the El Segundo Energy Center completed aboveground demolition of two existing units and secured major equipment orders. El Segundo is on track to be operational by the summer of 2013.

Turning to our plant performance metrics on Slide 14. Safety continues to be our number one priority. We are very proud to report that we achieved top decile in the industry, making 2010 our best OSHA

recordable year. We have 25 sites with no injuries and nine sites certified or recertified as OSHA VPP Star worksites.

Net generation decreased by 6% in the fourth quarter due to mild weather across Texas and a 22-day on-plan outage at STP Unit 2 during the month of November. The forced outage event was the result of a breaker failure during routine testing and was extended to repair a reactor coolant pump seal. In order to prevent recurrence, similar electric components were checked in both units. Unit 2 has operated without any issues since it was brought back to service on November 26.

For the full year, net generation was flat from 2009 levels. Increased generation in the Northeast and South Central regions driven by the strong summer weather and the addition of Cottonwood, were offset by lower generation in California and Texas.

For 2010, our coal fleet availability finished the year above the sub-quarter performance level for the industry. WA Parish led the fleet with 92.6% availability factor, and Limestone had the best reliability for the year, with a 1.6% forced outage rate.

Our FORNRG 2.0 program exceeded the 2010 goal by $49 million, and it is on track to achieve our goal of $150 million by 2011, one year earlier than planned. Savings were achieved through a combination of reliability, capacity and efficiency improvements at generating assets and cost savings across our corporate and regional groups.

Turning to our retail operations on Slide 15, we closed out the year with another strong quarter. Volumes and margins were consistent with our forecast, while Operations delivered better-than-expected asset management and lower operational costs.

The Mass segment continues to drive segment improvement in net customer attrition with a 57% reduction in the fourth quarter versus 2009. This result was driven by marketing, sales and introduction of innovative products to meet our customer needs.

In 2010, we led Texas in innovation, enrolling over 175,000 customers on our Reliant e-Sense product and services that utilize smart grid technology. We also introduced new and unique offers like carbon-state [ph] and home protection products, adding not only incremental EBITDA but increased customer stickiness.

We continue to maintain the lowest PUC customer complaint rate while balancing customer counterpricing. Throughout 2010, we aligned to successfully demonstrate that we have stabilized customer attrition and expect to achieve zero net attrition in 2011.

In the C&I segment, both renewal and new deal win rates continue to improve. We have expanded our business in several Northeast states where we can leverage existing energy assets and increase product offerings to include products such as backlog generation. These provides a solid platform to grow our business in 2011.

Business continues to show some fundamentals as you can see on Slide 16. Weather-normalized demand grew by 2% year-on-year and ERCOT set a new winter peak low of 57 kilowatts in February, an increase of almost 2.5% from the previous record. I'd like to take this opportunity to address the events in Texas on February 2.

The men and women of NRG Texas worked very hard to help meet the high demand for electricity due to the extreme cold conditions, increasing our generation by more than 60% from the previous

day. Although we had some operational issues, of the approximately 9,500 megawatts of power we had available in Texas during the low-shed event, we maintained between 97% and 91% of that capacity online. I want to thank all our employees in Texas for their dedication and extraordinary efforts during these events.

Now moving on to reserve volumes in ERCOT, we see a positive feature of our generation portfolio with reserved margins tightening faster than expected. This is to some extent reflected in the forward heat rates, as you can see on the chart on the lower right-hand quarter. We believe this trend will continue, given the robust growth and the expectation that asset retirement will outpace new builds. We have not seen as much coal-to-gas switching in Texas as we have in the Northeast and Southeast regions. In fact, cash generation was down year-on-year due to increases in new coal and wind generation in Texas.

In the Northeast, the back-end market continues to make some news. In New York, the recent FERC order to increase cost of new entry should provide a boost to capacity prices in New York City and rest of state, benefiting our New York portfolio. In PJM, prices remain uncertain until more clarity is given around the minimum offer price rule, the subsidized generation in New Jersey and Maryland and review demand outlook.

Moving on to Slide 17, you can see our detailed plan to control air emissions for each of our coal plants. As stated in our last earnings call, our plan is to invest approximately $720 million through 2015 in environmental projects tailored to comply with future regulations.

Just to remind everyone, the proposed CAIR rule does not require additional capital for compliance. The HAP MACT proposed rule should be released in mid-March, and as you can see in the table, our plant considers mercury controls on all our coal units.

Intake modifications and repowering are expected to meet once for cooling requirements. We only have dry fly ash disposals at our all coal facilities. And finally, in most of our facilities, we burn low sulfur, low chlorine PRB coal.

Moving on to our hedge profile and commodity sensitivities on Slide 18. Our baseload portfolio is now 100% hedged in 2011 and 50% hedged in 2012, providing the protection in the short term where gas prices continue to be weaker given the oversupply situation. Beyond 2012, we choose to remain significantly open.

After two years of low gas prices, we believe the downside risk is limited. Our combination of incremental demand from the power sector, particularly in light of possible coal plant retirements, some signs of the interest rate by producers, indication that drilling to home acreage may be ending, and a move from dry to wet gas production will provide better opportunities to catch our baseload portfolio in the future.

With respect to retail, we have increased our pipe load to 66% in 2011 from 57% in the third quarter. We continue to match as much generation load as possible to start maximum synergies between our retail and wholesale portfolios.

Our power and coal hedges continue to be well managed in 2011 and 2012. Given the shape of the coal curve and steep contango, we have not added any additional occasions since the last quarter. We also remain well hedged in terms of coal transportation now for some time.

Our sensitivity to commodity prices is agreeable for 2011, with 2012 to 2015 largely unchanged from

last quarter. Let me remind you that this sensitivity is around our baseload portfolio. Interest expense, our portfolio is well-positioned to benefit, particularly, in the Texas and South Central regions.

With that, I will turn it over to Chris who will discuss our financial results.

Christian Schade - Chief Financial Officer and Executive Vice President

Thank you, Mauricio, and good morning. Beginning with the financial summary on Slide 20, full-year 2010 adjusted EBITDA was $2.514 billion, just shy of the record 2009 adjusted EBITDA of $2.618 billion and within our previously stated guidance of $2.5 billion to $2.55 billion. As a result of our continued strong operating performance, adjusted cash flow from operations for 2010 was robust at $1.76 billion.

The company's liquidity position at year end, excluding funds deposited by counterparties, stood at nearly $4.3 billion, a $458 million increase from December 31, 2009, liquidity of approximately $3.8 billion. Our cash balance at year end 2010 available for both working capital as well as our 2011 capital allocation program was approximately $2.9 billion.

Now turning to a summary of our 2011 guidance in Capital Allocation Plan. First, we reaffirmed the preliminary 2011 EBITDA guidance range of $1.75 billion to $1.95 billion. Second, and as part of our 2011 capital allocation program, we are planning to repurchase $180 million of common stock, and complete $240 million of term loan debt repayments and $39 million for additional facilities, all of which is consistent with NRG's commitment to return excess capital to its stakeholders. Third, in 2011, in addition to the amount deferred from 2010 as a result of extending the cash grant availability, we are currently planning to commit an additional $640 million of net investment to advance our Repowering and renewable development program, particularly, utility-scale solar.

Now turning to a more detailed review of 2010 adjusted EBITDA result from Slide 21. The company reported near record results of $2.514 billion adjusted EBITDA, only $104 million lower than the 2009 adjusted EBITDA of $2.618 billion. These results were achieved despite the decline in forward prices across all of our regions and clearly benefited from our wholesale generation hedging program and the continued strong performance of Reliant Energy.

During the year, Reliant Energy contributed $711 million of adjusted EBITDA. Comparatively, these results are lower by $158 million from 2009 as we overlined for only eight months of that year. The year-on-year decline was driven by an 18% decline in Mass margins, which were the direct result of price reductions enacted following the acquisition, as well as lower margins on customer renewals and new customer acquisitions reflective of the competitive market. All told, for 2010, Reliant saw net customer attrition rates improve to 0.4% from 0.7% in 2009 with total customers at year end steady at 1.5 million.

The wholesale business meanwhile generated $1.8 billion in adjusted EBITDA, $173 million lower as compared to a record 2009 EBITDA of $1.976 billion. The comparative year-to-date decline is largely explained by a 32% drop in baseload hedge prices in the Northeast, as well as lower margins in Texas, caused by a 60% increase in fuel costs, due largely to higher coal transportation costs at our WA Parish facility. These results were partially offset by an increase in adjusted EBITDA of $28 million from the South Central region due to increases in generation and contracted sales.

Also increasing adjusted EBITDA were our newly acquired assets, including Green Mountain Energy, Cottonwood, Northwind Phoenix, South Trent Wind Farm, as well as the full year of operations from the Blythe solar project.

For the fourth quarter, the company reported adjusted EBITDA results of $444 million, a $45 million decline versus 2009. Reliant Energy contributed $117 million of adjusted EBITDA compared to $104 million for the fourth quarter of 2009. Reliant's quarterly results were favorable $13 million driven by an improvement in operating costs primarily due to better customer payment habits as related to a decrease in bad debt expense.

In the fourth quarter of 2010, our Wholesale Generation business contributed $327 million of adjusted EBITDA, a $58 million decline compared to fourth quarter '09. The change in results can largely be attributed to the following items: In the Northeast region, 35% lower hedge prices and a 25% decrease in generation resulting in a $57 million decline in energy margins quarter-over-quarter. The decrease in generation was largely a result of coal-to-natural gas switching and offsetting this decline in energy margins were favorable year-on-year operating and maintenance expenses of $13 million.

In Texas, the 10% decline in generation at the Limestone and WA Parish facilities due to lower power prices and reduced demand led to a 6% decline in overall generation for the region. Offsetting this decline were favorable year-on-year operating expenses of $17 million that included gain on land sales of $6 million in 2010.

Now turning to Slide 22. As I mentioned a moment ago, total liquidity at year-end 2010 excluding funds deposited by hedged counterparts remained strong at nearly $4.252 billion. Total cash stood at $2.959 billion, an increase of $653 million as compared to the 2009 year-end cash balance of $2.3 billion. The drivers of the cash increase included adjusted cash from operations of $1.76 billion and debt proceeds of $1.317 billion.

These increases were offset by several items: First, five completed acquisitions totaling about $1 billion, which included $507 million for Cottonwood generation station, $357 million for Green Mountain, $100 million for Northwind Phoenix, $32 million for South Trent Wind Farm and for the U.S. solar portfolio, 720 megawatts of development projects in nine states in California and Arizona. Second, debt and fee payments totaling $813 million, including Term Loan B payments of $453 million and a repayment of a common stock fund or CSF of $190 million.

And third, capital expenditures excluding NINA of $445 million, including $199 million of maintenance, $184 million of environmental, primarily related to the Indian River Air Quality Control System project, and $62 million of growth investments. For the full year, we made cash contributions to NINA totaling $170 million primarily in the first half of 2010. And finally, we completed share repurchases of 8.5 million shares, totaling $180 million.

Now turning to 2011 guidance on Slide 23. Our EBITDA guidance remains unchanged from our November 24 range of $1.75 billion to $1.95 billion. Included in this guidance range are wholesale expectations of $1.2 billion to $1.3 billion, retail expectations of $480 million to $570 million, and Green Mountain of $70 million to $80 million. As Mauricio discussed earlier, we are about 100% hedged on our baseload generation for 2011 and are thus comfortable with our forecasted results.

As we look forward to our Wholesale business in 2012, we are currently in excess 50% hedged with a higher average price in 2011 as indicated in our SEC filings. Due to this position and based on the current forward curves, we expect flat to marginally lower year-on-year wholesale results in 2012 from 2011. These results will be supplemented with adjusted EBITDA of $85 million from our repowering and solar investments in 2012 that are not subject to market fluctuations.

For our retail business in 2011, our current expectations, assuming normal weather, are an EBITDA

range of $480 million to $570 million, the decrease in 2011 guidance compared to current 2010 results is largely explained by lower unit margins in Reliant's Mass business. Reliant's C&I business margins are also expected to decline slightly, but be directly offset by higher terawatt-hours served, reflecting our continued dedication to this growing client base in both Texas and PJM.

Finally, we expect Green Mountain Energy to contribute $70 million to $80 million of EBITDA. We are very excited about enhancing the growth prospects for our Green Energy Retail business during the process of integrating the business with our growing renewables portfolio to enhance these future growth prospects.

During our Q3 earnings call, we discussed the 2011 free cash flow guidance of $425 million to $625 million, and we now currently anticipate free cash flow for 2011 to be in a range of $150 million to $350 million. The difference in guidance is largely explained by certain timing of solar projects, due to Congress extending the availability of cash grants for renewable projects through 2011. NRG postponed its large investments in solar projects from 2010 to 2011, resulting in $267 million of solar expenditures pushed into '11 and relates primarily to our Agua Caliente, Ivanpah and CVSR solar projects.

As we often like to emphasize, we are in a strong cash flow position based on Friday's closing stock price of $20.89 and our affirmed outlook. Free cash flow before growth yield currently stands at between 16% to 20%, or $3.36 to $4.17 per share.

Slide 24 shows the company's projected 2011 year-end cash position which we project to be about $2.5 billion. Beginning with the portion of the Capital Allocation Plan that includes share repurchases and debt repayments in 2011, the company intends to repurchase $180 million of common stock, which is within the constraint of the restricted payments basket; repay $240 million of debt related to our Term Loan B agreement; and approximately $39 million in other facilities. It's important to note that the company made a Term Loan B prepayment in November that totaled $200 million.

And finally, complete $907 million of capital allocation in the following projects: $50 million in NINA; $219 million for other Repowering investments including El Segundo, GenConn Middletown, eVgo, Texas Reliability and Princeton Hospital and $638 million for solar projects, net of cash grant proceeds, and including the $267 million of deferred payments from 2010.

During the third quarter conference call, I also mentioned that we usually maintain a minimum cash balance of $700 million largely for working capital margin requirements, the timing of cash payments, of interests, property taxes, as well as equity for projects we have under construction throughout the year. Thus, for 2011, we estimate a balance of just over $1.8 billion to allocate between perhaps additional share repurchases, contingent on the restricted payments basket expansion, further investments of high-growth opportunities and continued opportunistic management of our debt structure.

On January 11, the company issued $1.2 billion of 7 5/8 senior notes due 2018 and announced the simultaneous cash tender for $1.2 billion of the outstanding 7 1/4 senior notes due 2014. As of January 25, nearly 945 million bonds have tendered, and the remaining 250 million will be redeemed by the end of February pursuant to the embedded coal price. As a result, we've improved our debt maturity profile, all of our public debt matures after 2016, and replace the restricted covenant package with one permitting greater efficiency and flexibility to return value to all NRG stakeholders.

On a go forward basis, we will continue to moderately embed in calls in the 2016 and '17 maturities

and be opportunistic about replacing those bonds with less restricted covenant packages, similarly to how we handle the 2014 maturity.

Looking at NRG's combined Repowering and Solar portfolio and our EBITDA contribution on Slide 25, you can clearly see the benefit of the program with nearly $550 million of recurring contribution by 2015.

During the fourth quarter, our El Segundo Repowering project received prior approval from the California Public Utilities Commission for a ten-year Power Purchase Agreement with Southern California Edison. Commercial operation's expected in the summer of 2013.

Our large utility-scale solar projects will also begin to reach commercial operations between the summer of '13 and the first quarter of 2014, and these projects collectively are driving this EBITDA growth. These solar investments are attractive for their high-teens returns, very low construction risks and offtake agreement of 20-plus years with highly rated counterparties. We will continue to provide updates on the progress of these projects as they move into construction and operation.

As we continue to invest and grow our solar portfolio, it's important to highlight a few economic benefits created with these projects. Slide 26 shows how the combination of cash grant, maker's depreciation and strong cash flows from the PPAs for our projects result in a payback for our investments, in some cases by 2014, and retain stable cash flows for the remaining term of the PPAs.

Though we believe there will be a turnaround in commodity markets, we are mindful of our ability to create enough taxable income for us to fully absorb tax benefits created by these solar investments. There is clearly a limit to how much tax efficiency we could absorb in any one year before reducing the total project returns. As such, to both minimize the tax leakage and enhance our returns, in 2011, we will pursue new equity investors for our solar portfolio, who have both the appetite for tax benefits and seek investment to one of the largest utility-scale solar portfolios in the world. New equity investors would not only help to optimize our existing tax position but allow us to continue to invest in future projects with high returns.

We expect to launch this initiative soon and look forward to sharing the progress in the future. Now I'll pass it back to David for final comments.

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Thank you, Chris, and thank you, Mauricio. And so in conclusion, on Slide 28, we put what we think are some of the value drivers around the investment proposition at NRG. And it starts with the fact that 2 1/2 years into the commodity price down cycle, it appears to us that the end is in sight, the bottom of the trough has been reached, and the only way to go is up. When or how quickly gas prices will recover remains open to conjecture, but the case for rising heat rates in our core market of Texas is clear and compelling. And we've positioned our portfolio and our hedge both to benefit from that upturn.

Second, even in a political environment that has turned more conservative in the past year, market mandates for renewable generation and for solar power in particular, remain well supported in both the red and blue states. And the result for us has been a fast-growing portfolio of projects that will contribute substantially to shareholder value creation over the short to medium-term.

Finally, there's the inherent value unique amongst our peer group of Wholesale generation combined

with the leading retail position. While we have executed to such great success in Texas, together with Reliant, we are now in position to replicate with Green Mountain in the fast-growing green and retail energy sector. It's a bright future indeed, and for all of us at NRG, we'll strive to realize its vantage on behalf of the shareholders of NRG.

So Deanna, with that, we'd be happy to take some questions.

Question-and-Answer Session

Operator

[Operator Instructions] The first question will come from the line of Daniel Eggers, Crédit Suisse.

Dan Eggers - Crédit Suisse AG

David, I was just trying to marry up some of the comments made about some of the solar investment opportunities. If I look at Slides 25 and 26, the cash investment and then the earnings contribution you guys show there, is that based on the things that are in hand right now, or is there a assumption of the amount of incremental projects who would have to get signed this year to help get to those numbers?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

I think what we're showing, Chris, correct me if I'm wrong, is the Tier 1, which are projects, which in my personal estimation are ones that have a 90-plus percent chance of achieving financial closure.

Christian Schade - Chief Financial Officer and Executive Vice President

Yes, that's actually correct, Dan.

Dan Eggers - Crédit Suisse AG

So these are things that are already in place, and this would be less contribution than what you said in your comments earlier, David, about having equity investment and solar greater than what you do see in South Texas ultimately?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

I'm sorry. Say it again?

Dan Eggers - Crédit Suisse AG

So this earnings contribution represents an investment less than what you think you can get to from the solar perspective based on your comments earlier in the presentation?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

I mean there are more projects behind this portfolio.

Dan Eggers - Crédit Suisse AG

When do you see the opportunity this year to announce off projects? And how would you see this sell down equity go as far as changing the earnings contribution profile from these projects? And how much could you sell down, do you think?

Christian Schade - Chief Financial Officer and Executive Vice President

Well, we're going to get to how much we can sell down as we move through the process. But very clearly, any amount we sell down will sort of be a pro rata reduction in EBITDA. And so depending on how much we do, we'll certainly let you know. But we do believe that the sell down will allow us to provide incremental more equity into other projects we have yet to announce. But what David said, we're on the bubble given the benefits from the government largesse, which we think still exist but perhaps will run out in the next couple years. And those projects will also be assumed as sort of returns consistent with what we've seen to date.

Dan Eggers - Crédit Suisse AG

And I guess one last question just on South Texas. David, if you could maybe just -- we go through the numbers as far as how much cash you expect to throw off in the project, and then to clarify that, contribution's based on kind of the pricing you'd need it to be able to receive in order to earn economic return on that project?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Well, so you're saying you're -- Dan, you're actually looking forward to 2016 and '17? Yes, I mean, looking at Page 10, I mean, through the first few years, when we've talked about receiving $500 million of cash, that's based on our view on where gas prices go, which is, obviously, some way up from where they are now, sort of into the $6 to $7 range. Having said that, Dan, we've stressed the returns on the nuclear project from an IRR perspective, sort of $4 gas in perpetuity model. And the IRR in the project, it would still be in double digits, but obviously, the higher gas prices, the better we do. But it works, the numbers work even at a $4 gas environment. And the reason that is the case, Dan, is because, obviously, the tax benefits associated with nuclear project, particularly, the production tax credits, meaning that through the first several years of the nuclear project, the economics are more driven actually by the tax benefits than they are by the price of electricity.

Dan Eggers - Crédit Suisse AG

Do you see IRR as working in $4 gas to the equivalent of a mid-30s power price, you would see the plant being economic?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

In a $4 gas, the plant is, yes. I mean, again, it's a low-teen return. I'm not sure that -- it's not the return we're seeking, but it's not a single digit return or a negative return.

Operator

The next question will come from the line of Ameet Thakkar, Bank of America Merrill Lynch.

Ameet Thakkar - BofA Merrill Lynch

Mauricio, you kind of indicated that the path with hedging, despite, I guess, some uptick in heat rates in Texas and you also didn't do much in the way of coal as well. I mean is your expectation that PRB prices should follow gas down? Or are you guys a little bit more neutral on gas at this point?

Mauricio Gutierrez - Chief Operating Officer and Executive Vice President

Well, I mean, if you look at our hedge profile, the next few years, we're pretty well hedged on both sides, so power and coal. We can justify the contango that exists with the coal curve. And given the inventory that we have and the hedge profile, we think that we can weigh to be more opportunistic about when to catch the coal prices. With respect to gas, we continue to see further declines in the front part of the curve, which we've been pretty well insulated. But as I mentioned in my remarks, I mean, I think when you look at 2012 and beyond, and where those price levels are, we see very little downside risk from that. And we think that there are several factors that are converging that could potentially move gas prices, assuming they could be higher than where they are today.

Ameet Thakkar - BofA Merrill Lynch

And then David, real quick on STP. I just want to make sure I understood, I guess, some of your answers to the previous questions. You see returns in kind of the teens area, given the $4 gas for STP?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Yes, so the returns would be in the teens area in the $4, in perpetuity model. Again, this is based on the idea that we're running a model where there's roughly 1,000 megawatts of power sold by long-term contract, and the rest is taken into the merchant market. So the $4 gas would apply to the 2,000 in the merchant market. And yes, you're right, what it shows is a return in the teens, in that sensitivity. I would also tell you, Ameet, both in response to your question and I should say to Dan, also, we run this with no value associated to the zero-carbon aspect of it, so the price on carbon directly or indirectly would be on top of this.

Ameet Thakkar - BofA Merrill Lynch

And then so is like the 1,000 megawatts of PPA cover, I guess, under that analysis, is that really kind of the goal to kind of continue to move forward and not exit, I guess, exit land for on Slide 9?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Well, Ameet, almost as a -- I mean, from the beginning, I think that we have said to our investor base that we, at least, would not proceed with the project unless there was a significant amount of long-term offtake associated with the project. And so, roughly 1,000 megawatts has been something we talked about from the beginning. On top of that, Ameet, the conditional loan guarantee, if and when it's announced, it's called a conditional loan guarantee because there are conditions associated with it. And probably the most substantive condition, the condition we would be focused on is that the government would require us to have approximately that same amount of long-term offtake agreement contracted, which was a condition, again that we were happy to agree with the government on since we had said that we wouldn't go forward with it either. So that's why we would be doing that.

Operator

And the next question will come from the line of Ted Durbin, Goldman Sachs.

Theodore Durbin - Goldman Sachs Group Inc.

If I could just ask a little bit about the capital allocation. You're obviously coming out of 2010 here with a high cash balance. I'm just trying to understand a little bit better the allocation of the capital towards the renewables and whatnot, maybe extending that relative to between cash to stakeholders. Could you just talk a little bit more about that?

Christian Schade - Chief Financial Officer and Executive Vice President

As we said, we're committing to a $180 million stock repurchase, and that's within the confines of our restrictive payment basket. We're also going to be making required debt repayments under our term loan program, Term Loan B program. We've also earmarked potential investment in our solar projects, and these are projects which we had -- some of which we're announced late last year and early this year and would be subject to the cash grant program under the government. So all of those projects and repowering projects from El Segundo and GenConn Middletown. But those are the programs at least that were part of the capital allocation program for this year. That's what we've announced. We have $1.8 billion after which we would be able to deploy into additional repowering should they be available and new solar projects that we see on the horizon, as I've said before, all of which offer us the opportunity for very attractive returns.

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

And just to add, Ted, I think you phrased the question almost as if it was an either/or, and I guess that may be a little different. I mean, given the company's free cash flow generation and the cash we have on hand, we haven't really seen it as an either/or. In terms of returning capital to shareholders through the share buyback, we do as much as we can under the restrictive payment basket. Over the past years, we've constantly evaluated whether or not we could negotiate a way to have more room to do more, but the expense of doing that has always made that impractical. So from our perspective, it has not been an either/or decision. It's been do both.

Theodore Durbin - Goldman Sachs Group Inc.

Does that cost of getting the ability to do more of a buyback, you're still seeing that as not worth the expense of getting that?

Christian Schade - Chief Financial Officer and Executive Vice President

That's right. We think the expense to negotiate with the bondholders is being punitive. And as I said in the prepared remarks, the approach that we took on the 2014 maturity to wait for the calls to come due than to call away and refinance was we felt unattractive and a cost-beneficial way to do it. We have calls coming up in February for the 2016 maturity which we'll keep an eye on. The 2017 are not yet callable, will be so within a year. The high-yield market remains very attractive from financing perspectives, so we'll continue to look at that closely. But just to further what David said, with the excess cash in addition to the $180 million as we said, we'll certainly consider future stock repurchases if it can fall within the confines of hedging expansion we see in our restrictive payments basket throughout the year as well.

Theodore Durbin - Goldman Sachs Group Inc.

I appreciate the commentary on sort of the assets side. It sounds like you're not seeing the values on the CCGT side that you were before, but you did do the Cottonwood transaction. Are there other holes in your portfolio, where you say, "Geez, we'd really like to add some mid-merit assets whether it's more in South Central or whatnot?" And kind of talk about where you'd like to build up the portfolio.

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Well, I think the place where we'd like to build up the portfolio, and again, we've been fairly -- well, it took us six years to execute on the idea that we needed a load following plant in South Central. So just because I say this, I don't want you to think any sort of announcement's around the corner, because I'm actually skeptical that we can achieve anything. But we would definitely like to have some more baseload-following capability in PJM, particularly Eastern PJM. Having said that, we don't have any optimism about anything coming available in that footprint that we would find probably at a reasonable price. But we keep our ear to the ground. I would say that has been our single greatest priority second to backing up Big Cajun, which we've now achieved with Cotton.

Operator

And the next question will come from the line of Jonathan Arnold, Deutsche Bank.

Jonathan Arnold - Deutsche Bank AG

My question is, on STP, you believe the option for the second 10%, the TEPCO would take -- had a May expiration date on it, we recall from the original 8-K. But is there a similar date around the base 10% investment that's contingent on the loan guarantee acceptance? Is May a kind of drop-dead date for that whole arrangement with TEPCO?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

I don't believe there's a drop-dead date. And John, Tokyo Electric well understands the pace of development. I don't want to speak to them, but I think their enthusiasm for participating in this project is unchanged from when we announced the deal a year ago. So I don't remember any sense of date, but I have a very high level of confidence that if the loan guarantee comes that Tokyo Electric will participate in the project.

Jonathan Arnold - Deutsche Bank AG

And can you also give us a sense of -- well, obviously, your contribution is relatively small over this '11, '12 period. What would the $25 million in '12 be absent additional sell downs? And maybe some kind of sense of how much is actually being spent on the project itself during this next couple of years.

Christian Schade - Chief Financial Officer and Executive Vice President

Well, what it would be without the sell down, I'll have to get back to you on that. The amount of money that has to be invested towards in order for us to proceed is it's several hundred million dollars. But Jonathan, it's really hard to put it in those terms. Because like a good portion of it is long lead time materials in Japan which are actually funded with the credit facility from Toshiba. So maybe we can break out and provide it to you or do it next quarter. Just the development spend for now, in order for

us to proceed against the sources of capital, because it's really not useful if you look at it as one-lump sum, because various things are paid for with different buckets of money.

Jonathan Arnold - Deutsche Bank AG

And if I may just on one other topic, what indications are you getting from DOE on these discussions at a level of hedging through PPAs that would be acceptable to them on the project?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Well, I think that the condition is very specific. And I think back, it's the same as I answered to Ameet. It's something just less than 1,000 megawatts.

Operator

The next question will come from the line of Jay Dobson, Wunderlich Securities.

James Dobson - Wunderlich Securities Inc.

I was hoping you could give us some insight into the offtake discussions. The local media's covered some interesting transactions, or at least, proposals that you had. So I'm just wondering if you can give us some insight into where things stand and sort of what your level of optimism is currently.

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

It's a good question, and I think what I would say without -- I mean, it's difficult to comment with discussions that are underway. And in fact, normally, we don't comment on it but since as you said, there's been discussions by the public, I guess I should say some things. I would say, first of all, I think there's an openness, a willingness, and interest on several load-serving entities, large load-serving entities in the Texas market to talk about long-term offtake. And I would also say that the events of early February in Texas, where a part of the reason the state had rolling brownouts or even blackouts is because people couldn't get gas to some power plants, I think has reinforced the idea that having fuel diversity in the state is something that load-serving entities want to have. So there's a fairly high level of interest from various parties, but the big qualifier I always put on this question is, right now, as you say, it's really discussions. I mean, the project isn't really real to off-takers until we have a loan guarantee. So I would describe anything that we're doing with any counterparty at this point is being preliminary. And so that's what I would tell you. And based on what we're being told by the camp, their interest level, I'm guardedly optimistic. But mainly, my main attitude towards all this is, let's wait and see what happens when the loan guarantee's announced, because that's when ourselves and our counterparties are going to have to get down to business, and people are going to have to make commitments on both sides. So that's the main thing, and what we're trying to empathize here is that, that phase, and hopefully that phase will begin within the coming weeks, is something that basically needs to be resolved by the summer so that we can all have clarity as within the company and U.S. investors and analysts as to where we stand vis-à-vis this project.

James Dobson - Wunderlich Securities Inc.

As an unrelated follow-up, on the solar side, I'm not sure if this is good for your or for Chris. I assume in addition to selling an equity stake, you'd consider selling a tax equity there, and how do you

consider those two alternatives?

Christian Schade - Chief Financial Officer and Executive Vice President

Yes, very much so. I think the equity stake that we are contemplating is tax equity, it's a structuring issue. But we're certainly looking to pass off the tax attributes that are generated from this portfolio to tax equity investors. I think, one thing as a follow-up to a question before is that we'd certainly be looking to sell this equity at a premium. The returns that we're seeing perhaps from these investors are below the expected returns that we see in the high-teens, and so that sort of premium or IRR arbitrage gain will certainly benefit us in having development premium for this. But our goal here both is to bring equity into these projects and also, to lay off some of the tax that perhaps, does not necessarily accrue to NRG.

James Dobson - Wunderlich Securities Inc.

And Chris just a last follow-up, the capacity of the RP basket at year end?

Christian Schade - Chief Financial Officer and Executive Vice President

It was about $160 million. So the $180 million that we announced today will be spread out for a couple of quarters.

Operator

The next question will come from the line of Brandon Blossman, Tudor, Pickering Holt & Co.

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

I guess just a follow-up on the tax equity question, probably for Chris. Just to be clear, is the tax equity partner or sell down required to optimize the tax benefits of the current solar portfolio, or is that something you need to do to increase the size of that portfolio?

Christian Schade - Chief Financial Officer and Executive Vice President

I think it's not necessarily required. I think it benefits the returns of the portfolio and allows us to continue to invest in the space. As David said, we're seeing a lot of opportunities elsewhere, and I think when we start to layer on other utility-sized projects in addition to what we have, there is a limit to the capacity of tax attributes that we can assume. So we think it's important. We're seeing a lot of interest and opportunities to invest in this space by sort of nontraditional investors who want to get green, and so we think it's a big opportunity for us, who are certain taxpayers as well. So it's for us to check a lot of boxes along the way. First and foremost to optimize our tax position in appropriate years, as well as to allow us to continue to invest in the space.

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

And how does that dovetail with STP's tax attributes? Is that far enough out so that there's no overlap here or concerns about maximizing that value?

Christian Schade - Chief Financial Officer and Executive Vice President

It is far enough out that we're not perspiring about the tax attributes that it generates. But certainly, it's a topic that we will address at due time. And also, would speak to our underlying business that we

hope and certainly think will grow enough to burn through these NOLs and to continue to generate the taxable asset side in those years. So we're confident of that.

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

And David, as a follow up, not that anyone wants this to happen, but if there is an exit ramp for STP, can you describe what that looks like? Is there a project to be had at some point in the future, given that this is a particularly attractive development project?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Well, Brandon, I guess, what I would say, on a few fronts. I mean it sort of depends on which exit ramp you're talking about. And I'm just speculating on things which of course, we don't hope to happen. I mean from my perspective, I think if something happens during this year that caused the entire project to go away, we would probably finish the licensing process, which is a small fraction of the overall development spend. But we're so far along with the NRC that to stop it this close to the end would not make sense. But beyond that, would the project go forward? I think it depends on which exit ramp it is. And again, I don't mean to speak for the other partners, because I want to emphasize every NRG investor on the call. We do not have the right to kill the STP 3 & 4 project. We just have the right to stop our own financial contribution to it. But I would say, if the exit ramp is that, actually it turns out that there is no loan guarantee in the offing -- I haven't actually asked this question directly, but I think our partners in Japan -- and we would be aligned that there would be, that the project would stop if there's no hope of a federal loan guarantee. If on the other hand, there was a federal loan guarantee, but we were taking the exit ramp because we were unable to lineup the offtake, I don't know what our partners would do in that circumstance. Maybe they would continue with the project, that would be their prerogative to do. I just know that if we don't have that offtake arrangement, then we will stop funding.

Brandon Blossman - Tudor, Pickering, Holt & Co. Securities, Inc.

And that would be not the 1,000 megawatts, but isn't that predicated on the loan guarantee or the loan guarantee predicated on the 1,000 megawatts?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

It is, but one of the reasons why I don't know -- I don't remember the exact terms, the exact words of the conditional loan guarantee, but I know that we do not have the opportunity at NRG to solve for the offtake arrangement, because I think the condition is offtake agreements with investment grade offtakers. Our Japanese partners who are investment grade would have that opportunity should they so choose to correct that on their own. We don't have that type of power, so that's not a question for us.

Operator

The next question will come from the line of Brian Chin, Citigroup.

Brian Chin - Citigroup Inc

What's the rough range of construction cost estimates in dollar per KW for the solar PV facilities that

you are seeing, and also for the solar thermal side?

Christian Schade - Chief Financial Officer and Executive Vice President

The range, well, I think we would say that the range right now is 3,500 to 4,000 per KW, and I don't know, that would be for the PV -- I can't tell you -- the solar thermal would probably be in the same range.

Brian Chin - Citigroup Inc

And then would it be fair to say that $4 sustaining perpetual natural gas price environment that you'd still see solar generating returns in the double digits as well? And is it higher or lower than nuclear?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Well, we haven't compared them side-by-side. I think it's fair to say that like nuclear, the solar projects, at this point, the economics are very heavily driven by the tax benefits. But beyond that, the real difference between the two is that every solar project we're doing is completely not merchant. It's totally PPA. So I don't think -- in fact, when we talk about taking the company's financial performance and sort of de-linking it to natural gas prices, we put renewables together with retail in parts of our EBITDA stream that are not associated with natural gas prices, because of the fact that all of the economics are derived from long-term PPAs.

Brian Chin - Citigroup Inc

Can you talk just a little bit about from your perspective, what the FERC's order in the New York ISO and the capacity market situation up there? What's changed longer-term, and how much of a positive is that for you guys, or is that even material?

Mauricio Gutierrez - Chief Operating Officer and Executive Vice President

Well, I mean it's definitely material. It's difficult to say what is the ultimate impact, because I think the variables are still being flushed out. But the three main changes was the recognition of state taxes and the cost of new entry calculation, inter-connection costs and then the energy offsets. So when you put those three together, you basically have higher cost of new entry, which will push capacity prices for both New York City and the whole state. This will benefit our New York portfolio, but at this point I can't give you the specific mind into it.

Operator

And the next question will come from the line of Anthony Crowdell, Jefferies.

Anthony Crowdell - Jefferies & Co

Just a quick question on the, I guess, the cold stub that hit Texas earlier this month. And it seem like there wasn't much of an impact on the generation side, but was there any impact to the margins that Reliant expected or anything on the quarter?

Jason Few - SVP of Mass Markets and Operations, Reliant Energy, Inc.

This is Jason. From the retail side, we actually, faired fairly well through this event. I mean, our

hedging strategy and risk policies served as well during the event. We did not see material impact to our business.

Operator

In interest of time, we have time for two more callers. And the next question will come from the line of Charles Fishman, Pritchard Capital Partners.

Charles Fishman - Pritchard Capital Partners, LLC

Your five-year environmental capital plan, Page 17, I want to make sure I understand this. The $720 million includes your view of what the math might be, which is less than worst-case, number one. And number two is there are no dollars in the $720 million to address once thru cooling. Is that correct?

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

No, actually, there is some dollars for 316(b) through the installation of extremes. We've been very successful in New York, in Arthur Kill and Huntley and Dunkirk to address this issue. So while it addresses the Mercury and asymmetric controls across all our coal assets, it also addresses the 316(b).

Charles Fishman - Pritchard Capital Partners, LLC

And if we do end up with the worst case math, I mean could this number increase 50%? Or do you have any feel for that?

Mauricio Gutierrez - Chief Operating Officer and Executive Vice President

Well, we actually disclosed that on our last earnings call. And I believe it's about $1 billion -- just shy of $1 billion. If it was the worst case scenario, in terms of unit-specific controls, no averaging. And we just don't believe the EPA will go that route. But the rule is going to come out, the proposal is going to come out in about a month, and I think it's just prudent to wait before we make any changes.

Operator

And there are no more questions in queue at this time.

David Crane - Chief Executive Officer, President, Executive Director and Member of Nuclear Oversight Committee

Okay, well, good. Well, thank you all very much, and we look forward to talking to you in the next quarter. Thank you, operator.

Operator

And ladies and gentlemen, this concludes today's presentation. Thank you very much for your participation. You may now disconnect, and have a great day.

EXHIBIT 3

Campo-Cottonwood Sole Source Aquifer

Designated Area

Notes and Explanation:

The Campo-Cottonwood Sole Source Aquifer was designated under the authority of Section 1424(e) of the Safe Drinking Water Act, Federal Register Citiation-49 FR 2948, Publication Date - 01/24/84. Please contact US EPA Region 9 (Jamelya Curtis, 415-972-3529) for assistance in determining place locations with respect to the project review area.

Map Status and Disclaimer:

Please note that this working map is a computer representation compiled by the Environmental Protection Agency (EPA) from sources which have supplied data or information that may not have been verified by the EPA. This data is offered here as a general representation only, and is not to be used for commercial purposes without verification by an independent professional qualified to verify such data or information. The EPA does not guarantee the accuracy, completeness, or timeliness of the information shown, and shall not be liable for any loss or injury resulting from reliance upon the information shown.

Legend

- Designation Boundary
- Highways
- Major Roads
- Streams
- Tribal Lands
- Cities, Towns

Descanso
Descanso Junction
Los Terrenitos
Guatay
Cuyapaipe
La Posta
Manzanita
La Posta
Live Oak Springs
Campo
Manzanita
Campo
Tierra del Sol
Doghouse Junction
Potrero
Campo
MEXICO

0 1.5 3 6 9 12 Miles

N W E S

EPA
Region 9 GIS Center

WTR0801656.4 Oct. 2008

EXHIBIT 4

Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States

JEFFREY E. LOVICH AND JOSHUA R. ENNEN

Large areas of public land are currently being permitted or evaluated for utility-scale solar energy development (USSED) in the southwestern United States, including areas with high biodiversity and protected species. However, peer-reviewed studies of the effects of USSED on wildlife are lacking. The potential effects of the construction and the eventual decommissioning of solar energy facilities include the direct mortality of wildlife; environmental impacts of fugitive dust and dust suppressants; destruction and modification of habitat, including the impacts of roads; and off-site impacts related to construction material acquisition, processing, and transportation. The potential effects of the operation and maintenance of the facilities include habitat fragmentation and barriers to gene flow, increased noise, electromagnetic field generation, microclimate alteration, pollution, water consumption, and fire. Facility design effects, the efficacy of site-selection criteria, and the cumulative effects of USSED on regional wildlife populations are unknown. Currently available peer-reviewed data are insufficient to allow a rigorous assessment of the impact of USSED on wildlife.

Keywords: solar energy development, Mojave Desert, Sonoran Desert, wildlife, desert tortoises

The United States is poised to develop new renewable energy facilities at an unprecedented rate, including in potentially large areas of public land in the Southwest. This quantum leap is driven by escalating costs and demand for traditional energy sources from fossil fuels and by concerns over global climate change. Attention is focused largely on renewable forms of energy, especially solar energy. The potential for utility-scale solar energy development (USSED) and operation (USSEDO) is particularly high in the southwestern United States, where solar energy potential is high (USDOI and USDOE 2011a) and is already being harnessed in some areas. However, the potential for USSEDO conflicts with natural resources, especially wildlife, is also high, given the exceptional biodiversity (Mittermeier et al. 2002) and sensitivity (Lovich and Bainbridge 1999) of arid Southwest ecosystems, especially the Mojave (Randall et al. 2010) and Sonoran Deserts, which are already stressed by climate and human changes (CBI 2010). In addition, the desert Southwest is identified as a "hotspot" for threatened and endangered species in the United States (Flather et al. 1998). For these reasons, planning efforts should consider ways to minimize USSEDO impacts on wildlife (CBI 2010). Paradoxically, the implementation of large-scale solar energy development as an "environmentally friendly" alternative to conventional energy sources may actually increase environmental degradation on a local and on a regional scale (Bezdek 1993, Abbasi and Abbasi 2000) with concomitant negative effects on wildlife.

A logical first step in evaluating the effects of USSEDO on wildlife is to assess the existing scientific knowledge. As renewable energy development proceeds rapidly worldwide, information is slowly accumulating on the effects of USSEDO on the environment (for reviews, see Harte and Jassby 1978, Pimentel et al. 1994, Abbasi and Abbasi 2000). Gill (2005) noted that although the number of peer-reviewed publications on renewable energy has increased dramatically since 1991, only 7.6% of all publications on the topic covered environmental impacts, only 4.0% included discussions of ecological implications, and less than 1.0% contained information on environmental risks. A great deal of information on USSEDO exists in environmental compliance documents and other unpublished, non-peer-reviewed "gray" literature sources. Published scientific information on the effects on wildlife of any form of renewable energy development, including that of wind energy, is scant (Kuvlesky et al. 2007). The vast majority of the published research on wildlife and renewable energy development has been focused on the effects of wind energy development on birds (Drewitt and Langston 2006) and bats (Kunz et al. 2007) because of their sensitivity to aerial impacts. In contrast, almost no information is available on the effects of solar energy development on wildlife.

From a conservation standpoint, one of the most important species in the desert Southwest is Agassiz's desert

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tortoise (*Gopherus agassizii*; figure 1). Distributed north and west of the Colorado River, the species was listed as *threatened* under the US Endangered Species Act in 1990. Because of its protected status, Agassiz's desert tortoise acts as an "umbrella species," extending protection to other plants and animals within its range (Tracy and Brussard, 1994). The newly described Morafka's desert tortoise (*Gopherus morafkai*; Murphy et al. 2011) is another species of significant conservation concern in the desert Southwest, found east of the Colorado River. Both tortoises are important as ecological engineers who construct burrows that provide shelter to many other animal species, which allows them to escape the temperature extremes of the desert (Ernst and Lovich 2009). The importance of these tortoises is thus greatly disproportionate to their intrinsic value as species. By virtue of their protected status, Agassiz's desert tortoises have a significant impact on regulatory issues in the listed portion of their range, yet little is known about the effects of USSEDO on the species, even a quarter century after the recognition of that deficiency (Pearson 1986). Large areas of habitat occupied by Agassiz's desert tortoise in particular have potential for development of USSED (figure 2).

Figure 1. Agassiz's desert tortoise (*Gopherus agassizii*). Large areas of desert tortoise habitat are developed or being evaluated for renewable energy development, including for wind and solar energy. Photograph: Jeffrey E. Lovich.

In this article, we review the state of knowledge about the known and potential effects, both direct and indirect, of USSEDO on wildlife (table 1). Our review is based on information published primarily in peer-reviewed scientific journals for both energy and wildlife professionals. Agassiz's desert tortoise is periodically highlighted in our review because of its protected status, wide distribution in areas considered for USSEDO in the desert Southwest, and well-studied status (Ernst and Lovich 2009). In addition, we identify gaps in our understanding of the effects of USSEDO on wildlife and suggest questions that will guide future research toward a goal of mitigating or minimizing the negative effects on wildlife.

Background on proposed energy-development potential in the southwestern United States

The blueprint for evaluating and permitting the development of solar energy on public land in the region, as is required under the US National Environmental Policy Act (USEPA 2010), began in a draft environmental impact statement (EIS) prepared by two federal agencies (USDOI and USDOE 2011a). The purpose of the EIS is to "develop a new Solar Energy Program to further support utility-scale solar energy development on BLM [US Bureau of Land

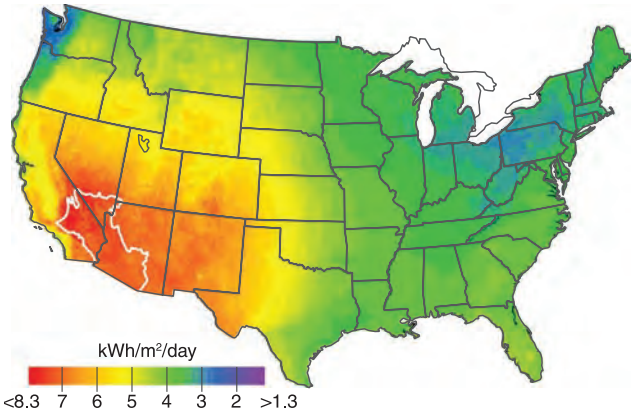

Figure 2. Concentrating solar energy potential (in kilowatt-hours per square meter per day [kWh/m²/day]) of the United States. The map shows the annual average direct normal solar resource data based on a 10-kilometer satellite-modeled data set for the period from 1998 to 2005. Refer to NREL (2011) for additional details and data sources. The white outline defines the approximate composite ranges of Agassiz's (west of the Colorado River) and Morafka's (east of the Colorado River) desert tortoises (Murphy et al. 2011) in the United States, both species of significant conservation concern. This figure was prepared by the National Renewable Energy Laboratory for the US Department of Energy (NREL 2011). The image was authored by an employee of the Alliance for Sustainable Energy, LLC, under Contract no. DE-AC36-08GO28308 with the US Department of Energy. Reprinted with permission from NREL 2011.

Table 1. List of known and potential impacts of utility-scale solar energy development on wildlife in the desert Southwest.

Impacts due to facility construction and decommissioning	Impacts due to facility presence, operation, and maintenance
Destruction and modification of wildlife habitat	Habitat fragmentation and barriers to movement and gene flow
Direct mortality of wildlife	Noise effects
Dust and dust-suppression effects	Electromagnetic field effects
Road effects	Microclimate effects
Off-site impacts	Pollution effects from spills
Destruction and modification of wildlife habitat	Water consumption effects
	Fire effects
	Light pollution effects, including polarized light
	Habitat fragmentation and barriers to movement and gene flow
	Noise effects

Management] -administered lands… and to ensure consistent application of measures to avoid, minimize, or mitigate the adverse impacts of such development" (p. ES-2). As of February 2010, the BLM had 127 active applications for solar facilities on lands that the BLM administers. According to USDOI and USDOE (2011a), all of the BLM-administered land in six states (California, Arizona, Utah, Nevada, New Mexico, and Colorado) was considered initially, for a total of 178 million hectares (ha). Not all of that land is compatible with solar energy development, so three alternative configurations are listed by USDOI and USDOI (2011a) for consideration, ranging from 274,244 to 39,972,558 ha. The larger figure is listed under the *no action alternative* where BLM would continue to use existing policy and guidance to evaluate applications. Of the area being considered under the two action alternatives, approximately 9 million ha meet the criteria established under the BLM's preferred action alternative to support solar development. Twenty-five criteria were used to exclude certain areas of public land from solar development and include environmental, social, and economic factors. The preferred alternative also included the identification of proposed *solar energy zones* (SEZs), defined as "area[s] with few impediments to utility-scale production of solar energy" (USDOI and USDOE 2011a, p. ES-7). By themselves, these SEZs constitute the nonpreferred action alternative of 274,244 ha listed above. Maps of SEZs are available at *http://solareis.anl.gov/documents/dpeis/index.cfm*.

Several sensitive, threatened, or endangered species are being considered within the EIS, but Agassiz's desert tortoise is one of only four species noted whose very presence at a site may be sufficient to exclude USSED in special cases (see table ES.2-2 in USDOI and USDOE 2011a). The potential effects of USSEDO are not trivial for tortoises or other wildlife species. Within the area covered in the draft EIS by USDOI and USDOE (2011a), it is estimated that approximately 161,943 ha of Agassiz's desert tortoise habitat will be directly affected. However, when including direct and indirect impacts on habitat (excluding transmission lines and roads that would add additional impacts; see Lovich and Bainbridge 1999, Kristan and Boarman 2007), it is estimated that approximately 769,230 ha will be affected. Some SEZs are adjacent to critical habitat designated for the recovery of Agassiz's desert tortoise, and this proximity is considered part of the indirect impacts.

On 28 October 2011, while this paper was in press, the BLM and US Department of Energy released a supplement to the EIS (USDOI and USDOE 2011b, 2011c) after receiving more than 80,500 comments. The no action alternative remains the same as in the EIS. The new preferred alternative (slightly reduced to 8,225,179 ha as the modified program alternative) eliminates or adjusts SEZs (now reduced to 115,335 ha in 17 zones as the modified SEZ alternative) to ensure that they are not in high-conflict areas and provides incentives for their use. The new plan also proposes a process to accommodate additional solar energy development outside of SEZs and to revisit ongoing state-based planning efforts to allow consideration of additional SEZs in the future.

The impacts of USSED on wildlife: Effects due to construction and decommissioning

The construction and eventual decommissioning of solar energy facilities will have impacts on wildlife, including rare and endangered species, and on their habitats in the desert (Harte and Jassby 1978). These activities involve significant ground disturbance and direct (e.g., mortality) and indirect (e.g., habitat loss, degradation, modification) impacts on wildlife and their habitat (Kuvlesky et al. 2007). Solar energy facilities require large land areas to harness sunlight and convert it to electrical energy. According to Wilshire and colleagues (2008), photovoltaic panels with a 10% conversion efficiency would need to cover an area of about 32,000 square kilometers, or an area a little smaller than the state of Maryland, to meet the current electricity demands of the United States. Many of the areas being considered for the development of solar energy in the Mojave and Sonoran Deserts are, at present, relatively undisturbed (USDOI and USDOE 2011a).

The extent of surface disturbance of USSED is related to the cooling technology used. Because of the scarcity of water in the desert Southwest region, dry-cooling systems, which consume 90%–95% less water than wet-cooling systems (EPRI 2002), are becoming a more viable option for concentrating solar facilities. Although wet-cooling systems are more economical and efficient, they consume larger amounts of water per kilowatt-hour (Torcellini et al. 2003). Unlike wet-cooling systems, dry-cooling systems use ambient air, instead of water, to cool the exhaust steam from the turbines. However, to achieve a heat-rejection efficiency similar to that in a wet-cooling system, Khalil and colleagues (2006) estimated that a direct dry-cooling system will require a larger footprint and would thus affect more wildlife habitat.

Although we found no information in the scientific literature about the direct effects of USSED on wildlife, the ground-disturbance impacts are expected to be similar to those caused by other human activities in the desert (Lovich and Bainbridge 1999).

Dust and dust suppressants. USSED transforms the landscape substantially through site preparation, including the construction of roads and other infrastructure. In addition, many solar facilities require vegetation removal and grading. These construction activities produce dust emissions, especially in arid environments (Munson et al. 2011), which already have the potential for natural dust emission. Dust can have dramatic effects on ecological processes at all scales (reviewed by Field et al. 2010). At the smallest scale, wind erosion, which powers dust emission, can alter the fertility and water-retention capabilities of the soil. Physiologically, dust can adversely influence the gas exchange, photosynthesis, and water usage of Mojave Desert shrubs (Sharifi et al. 1997). Depending on particle size, wind speed, and other factors, dust emission can physically damage plant species through root exposure, burial, and abrasions to their leaves and stems. The physiological and physical damage to plant species inflicted by dust emissions could ultimately reduce the plants' primary production and could indirectly affect wildlife food plants and habitat quality.

From an operational perspective, dust particles reduce mirror and panel efficiency in converting solar energy into heat or electricity. To combat dust, solar energy facilities apply various dust suppressants to surfaces with exposed soil (e.g., graded areas, areas with vegetation removed, roads). There are eight categories of common dust suppressants used for industrial applications: water, salts and brines, organic nonpetroleum products, synthetic polymers, organic petroleum, electrochemical substances, clay additives, and mulch and fiber mixtures (reviewed in Piechota et al. 2004). In a study conducted in the Mojave Desert in which the hydrological impacts of dust suppressants were compared, Singh and colleagues (2003) reported that changes did occur in the volume, rate, and timing of runoff when dust suppressants were used. In particular, petroleum-based and acrylic-polymer dust suppressants drastically influenced the hydrology of disturbed areas by increasing runoff volume and changing its timing. When it is applied to disturbed desert soils, magnesium chloride ($MgCl_2$), a commonly used salt-based dust depressant, does not increase runoff volume but does, however, increase the total suspended solids loads in runoff (Singh et al. 2003).

Others have highlighted the fact that there is a dearth of scientific research and literature on the effects of dust suppressants on wildlife, including the most commonly used category of dust depressant: brines and salts (Piechota et al. 2004, Goodrich et al. 2008). However, the application of $MgCl_2$ to roads was correlated with a higher frequency of plant damage (Goodrich et al. 2008). Because chloride salts, including $MgCl_2$, are not confined to the point of application but have the ability to be transported in runoff (White and Broadly 2001), the potential exists for a loss of primary production associated with plant damage in the habitats surrounding a solar facility, which could directly affect wildlife habitat.

Mortality of wildlife. We are not aware of any published studies documenting the direct effects of USSED on the survival of wildlife. However, subterranean animals can be affected by USSED, including species that hibernate underground. In the Sonoran Desert portion of California, Cowles (1941) observed that most reptiles in the Coachella Valley hibernated at depths of less than 33 centimeters (cm), with many at considerably shallower depths. Included in his observations were flat-tailed horned lizards (*Phrynosoma mcallii*)—a species of special concern in the region because of solar energy development (USDOI and USDOE 2011a)—and the federally protected Coachella Valley fringe-toed lizard (*Uma inornata*). Even lightweight vehicles like motorcycles are capable of causing greatly increased soil density (soil compaction) at a depth of 30–60 cm as their tires pass over the surface (Webb 1983). These observations suggest that vehicular activities in the desert have the potential to kill or entrap large numbers of subterranean animals (Stebbins 1995) through compressive forces or burrow collapse. Similar or greater impacts would be expected from the heavy equipment associated with the construction activities at an energy facility.

Destruction and modification of wildlife habitat. Despite the absence of published, peer-reviewed information on the effects of USSED on wildlife and their habitats, a considerable body of literature exists on the effects of other ground-disturbing activities on both ecological patterns and processes that are broadly comparable. Ground-disturbing activities affect a variety of processes in the desert, including soil density, water infiltration rate, vulnerability to erosion, secondary plant succession, invasion by exotic plant species, and stability of cryptobiotic soil crusts (for reviews, see Lovich and Bainbridge 1999, Webb et al. 2009). All of these processes have the ability—individually and together—to alter habitat quality, often to the detriment of wildlife. Any disturbance and alteration to the desert landscape, including the construction and decommissioning of utility-scale solar energy facilities, has the potential to increase soil erosion. Erosion can physically and physiologically affect plant species and can thus adversely influence primary production (Sharifi et al. 1997, Field et al. 2010) and food availability for wildlife.

Solar energy facilities require substantial site preparation (including the removal of vegetation) that alters topography and, thus, drainage patterns to divert the surface flow associated with rainfall away from facility infrastructure (Abbasi and Abbasi 2000). Channeling runoff away from plant communities can have dramatic negative effects on water availability and habitat quality in the desert, as was shown by Schlesinger and colleagues (1989). Areas deprived

of runoff from sheet flow support less biomass of perennial and annual plants relative to adjacent areas with uninterrupted water-flow patterns.

The impacts of roads. Roads are required in order to provide access to solar energy infrastructure. Both paved and unpaved roads have well-documented negative effects on wildlife (Forman and Alexander 1998), and similar effects are expected in utility-scale solar energy facilities. Although road mortality is most easily detected on the actual roadway, the effects of roads extend far beyond their physical surface. In a study of the effects of roads on Agassiz's desert tortoise populations in southern Nevada, von Seckendorff Hoff and Marlow (2002) examined transects along roads with traffic volumes varying from 25 to 5000 vehicles per day. Tortoises and tortoise sign (e.g., burrows, shells, scat) decreased with their proximity to a road. On roads with high traffic volumes, tortoises and tortoise sign were reduced as far as 4000 meters from the roadside. Roads with lower traffic volumes had fewer far-reaching effects.

Another effect of roads in the desert is the edge enhancement of plants and arthropod herbivores (Lightfoot and Whitford 1991). Perennial plants along the roadside are often larger than those farther away, and annual plant germination is often greatest along the shoulders of roads. It is possible that increased runoff due to impervious pavement or compacted soil contributes to this heterogeneity of vegetation in relationship to a road. Agassiz's desert tortoises may select locations for burrow construction that are close to roads, perhaps because of this increased productivity of food plants (Lovich and Daniels 2000). Although this situation suggests potentially beneficial impacts for herbivorous species of wildlife, such as tortoises, it increases their chance of being killed by vehicle strikes, as was shown by von Seckendorff Hoff and Marlow (2002).

Off-site impacts. Direct impacts on wildlife and habitat can occur well outside the actual footprint of the energy facility. Extraction of large amounts of raw materials for the construction of solar energy facilities (e.g., aggregate, cement, steel, glass); transportation and processing of those materials; the need for large amounts of water for cooling some installations; and the potential for the production of toxic wastes, including coolants, antifreeze, rust inhibitors, and heavy metals, can affect wildlife adjacent to or far from the location of the facility (Abbasi and Abbasi 2000). Abbasi and Abbasi (2000) summarized data suggesting that the material requirements for large-scale solar facilities exceed those for conventional fossil-fuel plants on a cost-per-unit-of-energy basis. In addition, water used for steam production at one solar energy facility in the Mojave Desert of California contained selenium, and the wastewater was pumped into evaporation ponds that attracted birds that fed on invertebrates. Although selenium toxicity was not considered a threat on the basis of the results of one study, the possibility exists for harmful bioaccumulation of this toxic micronutrient (Herbst 2006). In recognition of the hazard, Pimentel and colleagues (1994) suggested that fencing should be used to keep wildlife away from these toxic ponds.

The impacts of USSED on wildlife: Effects due to operation and maintenance

This category includes the effects related to the presence and operation of the solar facility, not the physical construction and decommissioning of the same. Some of the effects (e.g., mortality of wildlife and impacts caused by roads) are similar to those discussed previously for construction and decommissioning and are not discussed further.

Habitat fragmentation. Until relatively recently, the desert Southwest was characterized by large blocks of continuous and interconnected habitat. Roads and urban development continue to contribute to habitat fragmentation in this landscape. Large-scale energy development has the potential to add to and exacerbate the situation, presenting potential barriers to movement and genetic exchange in wildlife populations, including those of bighorn sheep (*Ovis canadensis*), deer (*Odocoileus* spp.), tortoises, and other species of concern and social significance. Research conducted on the effects of oil and gas exploration and development (OGED) on wildlife in the Intermountain West provides a possible analog to USSEDO, since comparable data are not available for the desert Southwest. The potential effects on mule deer (*Odocoileus hemionus*) and other wildlife species include impediments to free movement, the creation of migration bottlenecks, and a reduction in effective winter range size. Mule deer responded immediately to OGED by moving away from disturbances, with no sign of acclimation during the three years of study by Sawyer and colleagues (2009). Some deer avoidance resulted in their use of less-preferred and presumably less-suitable habitats.

Despite a lack of data on the direct contributions of USSEDO to habitat fragmentation, USSEDO has the potential to be an impediment to gene flow for some species. Although the extent of this impact is, as yet, largely unquantified in the desert, compelling evidence for the effects of human-caused habitat fragmentation on diverse wildlife species has already been demonstrated in the adjacent coastal region of southern California (Delaney et al. 2010).

Noise effects. Industrial noise can have impacts on wildlife, including changes to their habitat use and activity patterns, increases in stress, weakened immune systems, reduced reproductive success, altered foraging behavior, increased predation risk, degraded communication with conspecifics, and damaged hearing (Barber et al. 2009, Pater et al. 2009). Changes in sound level of only a few decibels can elicit substantial animal responses. Most noise associated with USSEDO is likely to be generated during the construction phase (Suter 2002), but noise can also be produced during operation and maintenance activities. Brattstrom and Bondello (1983) documented the effects of noise on Mojave

Desert wildlife on the basis of experiments involving off-highway vehicles. Noise from some of these vehicles can reach 110 decibels—near the threshold of human pain and certainly within the range expected for various construction, operation, and maintenance activities (Suter 2002) associated with USSEDO. This level of noise caused hearing loss in animals, such as kangaroo rats (*Dipodomys* spp.), desert iguanas (*Dipsosaurus dorsalis*), and fringe-toed lizards (*Uma* spp.). In addition, it interfered with the ability of kangaroo rats to detect predators, such as rattlesnakes (*Crotalus* spp.), and caused an unnatural emergence of aestivating spadefoot toads (*Scaphiopus* spp.), which would most likely result in their deaths. Because of impacts on wildlife, Brattstrom and Bondello (1983) recommended that "all undisturbed desert habitats, critical habitats, and all ranges of threatened, endangered, or otherwise protected desert species" (p. 204) should be protected from loud noise.

Although many consider solar energy production a "quiet" endeavor, noise is associated with their operation. For example, facilities at which wet-cooling systems are used will have noises generated by fans and pumps. As for facilities with dry-cooling systems, only noise from fans will be produced during operation (EPRI 2002). Because of the larger size requirements of dry-cooling systems, there will be more noise production associated with an increase in the number of fans.

Electromagnetic field generation. When electricity is passed through cables, it generates electric and magnetic fields. USSEDO requires a large distribution system of buried and overhead cables to transmit energy from the point of production to the end user. Electromagnetic fields (EMFs) produced as energy flows through system cables are a concern from the standpoint of both human and wildlife health, yet little information is available to assess the potential impact of the EMFs associated with USSEDO on wildlife. Concerns about EMFs have persisted for a long time, in part because of controversy over whether they're the actual cause of problems and disagreement about the underlying mechanisms for possible effects. For example, there is presently a lack of widely accepted agreement about the biological mechanisms that can explain the consistent associations between extremely low-frequency EMF exposure from overhead power lines and childhood leukemia, although there is no shortage of theories (Gee 2009).

Some conclude that the effects of EMFs on wildlife will be minor because of reviews of the often conflicting and inconclusive literature on the topic (Petersen and Malm 2006). Others suggest that EMFs are a possible source of harm for diverse species of wildlife and contribute to the decline of some mammal populations. Balmori (2010) listed possible impacts of chronic exposure to athermal electromagnetic radiation, which included damage to the nervous system, disruption of circadian rhythm, changes in heart function, impairment of immunity and fertility, and genetic and developmental problems. He concluded that enough evidence exists to confirm harm to wildlife but suggested that further study is urgently needed. Other authors suggest that the generally inconsistent epidemiological evidence in support of the effects of EMFs should not be cause for inaction. Instead, they argue that the precautionary principle should be applied in order to prevent a recurrence of the "late lessons from early warnings" scenario that has been repeated throughout history (Gee 2009).

Magnetic information is used for orientation by diverse species, from insects (Sharma and Kumar 2010) to reptiles (Perry A et al. 1985). Despite recognition of this phenomenon, the direct effects of USSEDO-produced EMFs on wildlife orientation remains unknown.

Microclimate effects. The alteration of a landscape through the removal of vegetation and the construction of structures by humans not only has the potential of increasing animal mortality but also changes the characteristics of the environment in a way that affects wildlife. The potential for microclimate effects unique to solar facilities was discussed by Pimentel and colleagues (1994) and by Harte and Jassby (1978). It has been estimated that a concentrating solar facility can increase the albedo of a desert environment by 30%–56%, which could influence local temperature and precipitation patterns through changes in wind speed and evapotranspiration. Depending on their design, large concentrating solar facilities may also have the ability to produce significant amounts of unused heat that could be carried downwind into adjacent wildlife habitat with the potential to create localized drought conditions. The heat produced by central-tower solar facilities can burn or incinerate birds and flying insects as they pass through the concentrated beams of reflected light (McCrary et al. 1986, Pimentel et al. 1994, Tsoutsos et al. 2005, Wilshire et al. 2008).

A dry-cooled solar facility—in particular, one with a concentrating-trough system—could reject heated air from the cooling process with temperatures 25–35 degrees Fahrenheit higher than the ambient temperature (EPRI 2002). This could affect the microclimate on site or those in adjacent habitats. To our knowledge, no research is available to assess the effects of USSEDO on temperature or that of any other climatic variable on wildlife. However, organisms whose sex is determined by incubation temperatures, such as both species of desert tortoises, may be especially sensitive to temperature changes, because small temperature changes have the potential to alter hatchling sex ratios (Hulin et al. 2009).

Pollutants from spills. USSEDO, especially at wet-cooled solar facilities, has a potential risk for hazardous chemical spills on site, associated with the toxicants used in cooling systems, antifreeze agents, rust inhibitors, herbicides, and heavy metals (Abbasi and Abbasi 2000, Tsoutsos et al. 2005). Wet-cooling solar systems must use treatment chemicals (e.g., chlorine, bromine, selenium) and acids and bases (e.g., sulfuric acid, sodium hydroxide, hydrated lime) for the prevention of fouling and scaling and for pH control of the water used in their recirculating systems (EPRI 2002).

Solar facilities at which a recirculating system is used also have treatment and disposal issues associated with water discharge, known as *blowdown*, which is water with a high concentration of dissolved and suspended materials created by the numerous evaporation cycles in the closed system (EPRI 2002). These discharges may contain chemicals used to prevent fouling and scaling. The potentially tainted water is usually stored in evaporative ponds, which further concentrates the toxicants (Herbst 2006). Because water is an attraction for desert wildlife, numerous species could be adversely affected. The adverse effects of the aforementioned substances and similar ones on wildlife are well documented in the literature, and a full review is outside the scope of this article. However, with the decreased likelihood of wet-cooling systems for solar facilities in the desert, the risk of hazardous spills and discharges on site will be less in the future, because dry-cooling systems eliminate most of the associated water-treatment processes (EPRI 2002). However, there are still risks of spills associated with a dry-cooling system. More research is needed on the adverse effects of chemical spills and tainted-water discharges specifically related to USSEDO on wildlife.

Water consumption (wet-cooled solar). The southwestern United States is a water-poor region, and water use is highly regulated throughout the area. Because of this water limitation, the type of cooling systems installed at solar facilities is limited as well. For example, a once-through cooling system—a form of wet cooling—is generally not feasible in arid environments, because there are few permanent bodies of water (i.e., rivers, oceans, and lakes) from which to draw cool water and then into which to release hot water. Likewise, other wet-cooling options, such as recirculating systems and hybrid systems, are becoming less popular because of water shortage issues in the arid region. Therefore, the popularity of the less-efficient and less-economical dry-cooling systems is increasing on public lands. Water will also be needed at solar facilities to periodically wash dust from the mirrors or panels. Although there are numerous reports in which the costs and benefits were compared both environmentally and economically (EPRI 2002, Khalil et al. 2006) between wet- and dry-cooled solar facilities, to our knowledge no one has actually quantified the effects of water use and consumption on desert wildlife in relation to the operation of these facilities.

Fire risks. Any system that produces electricity and heat has a potential risk of fire, and renewable energy facilities are no exception. Concentrating solar energy facilities harness the sun's energy to heat oils, gases, or liquid sodium, depending on the system design (e.g., heliostat power, trough, dish). With temperatures reaching more than 300 degrees Celsius in most concentrated solar systems, spills and leaks from the coolant system increase the risk of fires (Tsoutsos et al. 2005). Even though all vegetation is usually removed from the site during construction, which reduces the risk of a fire propagating on and off site, the increase of human activity in a desert region increases the potential for fire, especially along major highways and in the densely populated western Mojave Desert (Brooks and Matchett 2006).

The Southwest deserts are not fire-adapted ecosystems: fire was historically uncommon in these regions (Brooks and Esque 2002). However, with the establishment of numerous flammable invasive annual plants in the desert Southwest (Brown and Minnich 1986), coupled with an increase in anthropogenic ignitions, fire has become more common in the deserts, which adversely affects wildlife (Esque et al. 2003). For Agassiz's desert tortoise, fire can translate into direct mortality at renewable energy facilities (Lovich and Daniels 2000) and can cause reductions in food and habitat quality. To our knowledge, however, there is no scientific literature related to the effects of USSEDO-caused fire on wildlife.

Light pollution. Two types of light pollution could be produced by solar energy facilities: ecological light pollution (ELP; Longcore and Rich 2004) and polarized light pollution (PLP; Horváth et al. 2009). The latter, PLP, could be produced at high levels at facilities using photovoltaic solar panels, because dark surfaces polarize light. ELP can also be produced at solar facilities in the form of reflected light. The reflected light from USSEDO has been suggested as a possible hazard to eyesight (Abbasi and Abbasi 2000). ELP could adversely affect the physiology, behavior, and population ecology of wildlife, which could include the alteration of predation, competition, and reproduction (for reviews, see Longcore and Rich 2004, Perry G et al. 2008). For example, the foraging behavior of some species can be adversely affected by light pollution (for a review, see Longcore and Rich 2004). The literature is limited regarding the impact of artificial lighting on amphibians and reptiles (Perry G et al. 2008), and, to our knowledge, there are no published studies in which the impacts on wildlife of light pollution produced by USSEDO have been assessed. However, light pollution is considered by G. Perry and colleagues (2008) to be a serious threat to reptiles, amphibians, and entire ecological communities that requires consideration during project planning. G. Perry and colleagues (2008) further recommended the removal of unnecessary lighting so that the lighting conditions of nearby habitats would be as close as possible to their natural state.

Numerous anthropogenic products—usually those that are dark in color (e.g., oil spills, glass panes, automobiles, plastics, paints, asphalt roads)—can unnaturally polarize light, which can have adverse effects on wildlife (for a review, see Horváth et al. 2009). For example, numerous animal species use polarized light for orientation and navigation purposes (Horváth and Varjú 2004). Therefore, the potential exists for PLP to disrupt the orientation and migration abilities of desert wildlife, including those of sensitive species. In the review by Horváth and colleagues (2009), which was focused mostly on insects but included a few avian references, they highlighted the fact that anthropogenic products that produce PLP can appear to be water bodies to wildlife and can become ecological traps for insects and, to a lesser degree, avian species. Therefore,

utility-scale solar energy facilities at which photovoltaic technology is used in the desert Southwest could create a direct effect on insects (i.e., ecological trap), which could have profound but unquantified effects on the ecological community surrounding the solar facility. In addition, there may be indirect effects on wildlife through the limitation of plant food resources, especially if pollinators are negatively affected. As was stated by Horváth and colleagues (2009), the population- and community-level effects of PLP can only be speculated on because of the paucity of data.

Unanswered questions and research needs

In our review of the peer-reviewed scientific literature, we found only one peer-reviewed publication on the specific effects of utility-scale solar energy facility operation on wildlife (McCrary et al. 1986) and none on utility-scale solar energy facility construction or decommissioning. Although it is possible that we missed other peer-reviewed publications, our preliminary assessment demonstrates that very little critically reviewed information is available on this topic. The dearth of published, peer-reviewed scientific information provides an opportunity to identify the fundamental research questions for which resource managers need answers. Without those answers, resource managers will be unable to effectively minimize the negative effects of USSEDO on wildlife, especially before permitting widespread development of this technology on relatively undisturbed public land.

Before-and-after studies. Carefully controlled studies are required in order to tease out the direct and indirect effects of USSEDO on wildlife. Pre- and postconstruction evaluations are necessary to identify the effects of renewable energy facilities and to compare results across studies (Kunz et al. 2007). In their review of wind energy development and wildlife, with an emphasis on birds, Kuvlesky and colleagues (2007) noted that experimental designs and data-collection standards were typically inconsistent among studies. This fact alone contributes measurably to the reported variability among studies or renders comparisons difficult, if not impossible. Additional studies should emphasize the need for carefully controlled before-after-control-impact (BACI) studies (Kuvlesky et al. 2007) with replication (if possible) and a detailed description of site conditions. The potential payoff for supporting BACI studies now could be significant: They could provide answers for how to mitigate the negative impacts on wildlife in a cost-effective and timely manner.

What are the cumulative effects of large numbers of dispersed or concentrated energy facilities? Large portions of the desert Southwest have the potential for solar energy development. Although certain areas are targeted for large facilities because of resource availability and engineering requirements (e.g., their proximity to existing transmission corridors), other areas may receive smaller, more widely scattered facilities. A major unanswered question is what the cumulative impacts of these facilities on wildlife are. Would it be better for wildlife if development is concentrated or if it is scattered in smaller, dispersed facilities? Modeling based on existing data would be highly suspect because of the deficiency of detailed site-level published information identified in our analysis. Except for those on habitat destruction and alteration related to other human endeavors, there are no published articles on the population genetic consequences of habitat fragmentation related to USSED, which makes this a high priority for future research.

What density or design of development maximizes energy benefits while minimizing negative effects on wildlife? We are not aware of any published peer-reviewed studies in which the impacts on wildlife of different USSED densities or designs have been assessed. For example, would it benefit wildlife to leave strips of undisturbed habitat between rows of concentrating solar arrays? Research projects in which various densities, arrays, or designs of energy-development infrastructure are considered would be extremely valuable. BACI studies would be very useful for addressing this deficiency.

What are the best sites for energy farms with respect to the needs of wildlife? The large areas of public land available for renewable energy development in the desert Southwest encompass a wide variety of habitats. Although this provides a large number of choices for USSED, not all areas have the same energy potential because of resource availability and the limitations associated with engineering requirements, as was noted above. Detailed information on wildlife distribution and habitat requirements are crucially needed for proper site location and for the design of renewable energy developments (Tsoutsos et al. 2005). Public-resource-management agencies have access to rich geospatial data sets based on many years of inventories and resource-management planning. These data could be used to identify areas of high value for both energy development and wildlife. Areas with overlapping high values could be carefully studied through risk assessment when it appears that conflicts are likely. Previously degraded wildlife habitats, such as old mine sites, overgrazed pastures, and abandoned crop fields, may be good places to concentrate USSED to minimize its impacts on wildlife (CBI 2010).

Can the impacts of solar energy development on wildlife be mitigated? The construction of solar energy facilities can cause direct mortality of wildlife. In addition, building these facilities results in the destruction and fragmentation of wildlife habitat and may increase the possibility of fire, as was discussed above. Beyond these effects, essentially nothing is known about the operational effects of solar energy facilities on wildlife. Current mitigation strategies for desert tortoises and other protected species include few alternatives other than translocation of the animals from the footprint of the development into other areas. Although this strategy may be appealing at first glance, animal translocation has a checkered history of success, especially for reptiles and amphibians (Germano and Bishop 2008, CBI 2010). Translocation

has yet to be demonstrated as a viable long-term solution that would mitigate the destruction of Agassiz's desert tortoise habitat (Ernst and Lovich 2009, CBI 2010).

Conclusions

All energy production has associated social and environmental costs (Budnitz and Holdren 1976, Bezdek 1993). In their review of the adverse environmental effects of renewable energy development, Abbasi and Abbasi (2000) stated that "renewable energy sources are not the panacea they are popularly perceived to be; indeed, in some cases, their adverse environmental impacts can be as strongly negative as the impacts of conventional energy sources" (p. 121). Therefore, responsible, efficient energy production requires both the minimization of environmental costs and the maximization of benefits to society—factors that are not mutually exclusive. Stevens and colleagues (1991) and Martín-López and colleagues (2008) suggested that the analyses of costs and benefits should include both wildlife use and existence values. On the basis of our review of the existing peer-reviewed scientific literature, it appears that insufficient evidence is available to determine whether solar energy development, as it is envisioned for the desert Southwest, is compatible with wildlife conservation. This is especially true for threatened species such as Agassiz's desert tortoise. The many other unanswered questions that remain after reviewing the available evidence provide opportunities for future research, as was outlined above.

The shift toward renewable energy is widely perceived by the public as a "green movement" intended to reduce greenhouse-gas emissions and acid rain and to curb global climate change (Abbasi and Abbasi 2000). However, as was noted by Harte and Jassby (1978), just because an energy technology is simple, thermodynamically optimal, renewable, or inexpensive does not mean that it will be benign from an ecological perspective. The issue of wildlife impacts is much more complex than is widely appreciated, especially when the various scales of impact (e.g., local, regional, global) are considered. Our analysis shows that, on a local scale, so little is known about the effects USSEDO on wildlife that extrapolation to larger scales with any degree of confidence is currently limited by an inadequate amount of scientific data. Therefore, without additional research to fill the significant information void, accurate assessment of the potential impacts of solar energy development on wildlife is largely theoretical but needs to be empirical and well-founded on supporting science.

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