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Testimony of Valerie Rauluk

Before the U.S. House of Representatives Subcommittee on Energy and Environment Hearing on "Utility-Scale Solar Power: Opportunities and Obstacles"

March 17, 2008

Madame Chairman, Members of the Committee, distinguished guests I am honored to offer my testimony concerning Utility Scale Solar Power. My comments will address the following

1. Grand Solar Plan as a viable option. The technical & regulatory obstacles.
2. Current solar energy market and expected changes over the next 10 years.
3. Current regulatory environment and incentive structures conducive to large scale solar development & recommended improvements.
4. Distributed PV and concentrating PV compared with solar thermal technology.
   Areas of government research that can play a critical role not met by private sector.
   Other recommendations and priorities.

1. *The Grand Solar Plan as a viable option. The technical & regulatory obstacles.*

The Grand Solar Plan calls out a vision of nearly 70% of our electricity generation from solar energy by 2050. It also calls for a technology mix of five times as much solar photovoltaic ("PV) as solar thermal. This vision is highly probable, with the right development framework and investment incentives.

Additionally, the Grand Solar Plan calls out for a development format of large-scale remote solar energy generation, compressed air storage, and direct current transmission. My colleagues at the University of Arizona have convinced me that compressed air storage and direct current transmission are more than science fiction, although there is much that needs to be assessed for both approaches to be viable. It is important to note that designing, financing and implementing a large-scale adoption of such strategies is no minor feat. As such, I would see, from my experience and understanding of technology adoption cycles, that such approaches will not be available for commercial adoption for 10 or more years. Other witnesses could clarify the risks, timing and benefits better than I. Beginning the process of assessing and designing such approaches is useful, but I would caution that we focus on the approaches that can deliver large amounts of market driven solar generation into the mix quickly, with the lowest risk and the greatest benefits.

As you will see, my comments focus on the first ten years of a Grand Solar Plan. The first steps will be difficult. Large amounts of investment capital from public and private sectors will be needed. And the skeptics concerning solar energy and its primary role in the greening and cleaning of our energy system will be numerous and loud. That is why in the first years, we should focus on efforts that lower risk and maximize the benefits.

In addressing the technical and regulatory obstacles to achieving the Grand Plan the following critical factors will be addressed.

- Critical factor #1 – Productively framing the definition of "utility scale solar" and supporting with regulatory requirements.
- Critical Factor #2: Technology improvements, including improvements in business model.
- Critical factors #3 – Effectively structuring the multi-billion dollar investment to be made by ratepayers, investors and the government.

Critical Factor #1: Productively framing the definition of "utility scale solar" and supporting with regulatory requirements
Although the Grand Solar Plan does not make specific recommendations regarding the development format, it seems to imply, with the recommendation for large scale storage and specialty transmission, that solar energy should be developed under the model of the last 50 years: large scale, remotely located, dependent on extensive transmission for delivery to consumers.. This is commonly referred to as the "central station" model.

There is a more market driven way to develop solar energy and the successes of the last few years highlight the approach. That approach consists of smaller generation facilities, on otherwise unused real estate (roof-tops and sites of 10 to 500 acres of land, 2% to 80% of a square mile), located near the load demand, and dispersed throughout many communities. That approach is called distributed generation or "DG."

DG is not only a path of more rapid, less risky development, it is also the path for a more robust power network. There is an inherent resiliency in networked systems where resources are at the point of use (like the internet) instead of a hub and spoke development (like the land-line telephone system). This resiliency can be enhanced with the addition of small scale, on-site intelligent controls and storage, increasing reliability and dependability and improving the fit between resource generation and needs across the local grid. When developed in a strategic and coordinated fashion, DG can delay or eliminate the need for distribution and transmission infrastructure investment.

Although DG includes very small generating systems, much larger DG systems (up to 20MW in a single location) can be clearly characterized as "utility scale" as can a systematic aggregation of many smaller generators. Utility scale can be more productively thought of as any project/ program offering high volume, lower-cost, reliable, and dependable renewable energy for 20 years plus at fixed prices for large numbers of customers. Utilizing this more expansive definition of utility scale offers more options for maximizing solar energy deployment at the best cost-benefit trade-off, starting now.

Examples are:

- 2 to 20MW solar farms, strategically located in load pockets to strengthen the grid and increase community energy security in case of transmission failure.
- 1 to 5 MW solar farms on the roofs of our schools, reducing school budget exposure to volatile and rising energy prices for 20 years and pumping solar power into the grid for community use during the summer days when community demand is most pressing.
- 100kW to multiple megawatts on commercial, government, industrial sites/ buildings.

In Arizona alone, an immediate potential of multiple gigawatts of solar energy systems are available. With expected cost reductions, 65 GW of solar energy could be developed in the US over the next ten years (US Department of Energy . Solar America Initiative, http://www1.eere.energy.gov/solar/solar_america/).

Central station development has its attractions. It feeds into the 'bigger is better' syndrome. Bigger means more attention. Bigger means larger development fees. Usually bigger means cheaper. But what a great deal of research has shown, is that bigger, especially when it comes to power plants, can often be riskier: longer construction periods, higher financing cost, longer delays before a system is producing and selling energy to end users, to name just a few.

Bigger also usually means more remotely located from where the consumers are, a distance that results in additional costs for transmission: wheeling charges, transmission investment and public approval (nobody seems to want transmission lines in their backyards), and transmission losses. And last, but not least the security exposure of having a critical resource like power, vulnerable to hundreds of miles of difficult to protect delivery infrastructure.

Removing the Obstacles

Since nearly all of our existing power generation is central station, and a considerable amount of central station solar power is in the early stages of development, our focus going forward should be to diversify our resource portfolio and focus on solar DG installations.

Regulatory

Regulatory obstacles to this path are fairly straightforward and in fact, many states have established law, policy and procedure to remove them. That is how 300MW of solar energy got developed last year. But the patchwork has prevented a truly vibrant and efficient market for solar energy. Efforts at the federal level to establish the following best practices will accelerate the development of solar energy.

Level the playing field for incentives, subsidies and financing

Establish incentives at the Federal Level that match the incentives given to fossil fuels. Structure for rapid and long-term deployments with declining levels of support to encourage systematic and focused cost reduction across the whole value chain. Reward system performance and support system diversity,

Net Metering

Require full retail value for all solar energy produced by customers without restrictions on size, or special fees and tariffs.

Standard & Fair Interconnection Standards to the Grid

Interconnection standards set the rules and fees for connecting a customer generator to the grid. The standard should encourage the development of customer systems, while maintaining the safety and integrity of the grid. A fair and reasonable standard has been broadly vetted and adopted in the leading renewable energy states and should be adopted nation-wide.

Solar Fair & Friendly Rates & Utility Revenue Practices
Properly designed rates can support investment in solar energy and wise use while maintaining utility profits.
Critical Factor #2: Technology improvements, including improvements in business model

Technical
Cost and efficiency, especially of components have been perennial obstacles to widespread use of solar energy. Both of those concerns have been and are being addressed with incremental improvements. In addition, major improvements are possible in the in the 6 to 15 year time frame as research and development initiatives currently in process begin focused commercialization.

Two areas of consideration that have not received as much attention in the past are storage strategies and intelligent control technologies that facilitate integration of renewable energy into the grid. Storage is important for solar energy. It expands its flexibility by extending access to the power produced during sunlight hours. Storage schemes can be grand and large, like compressed-air energy storage. Because of scale and site limitation this approach is not being actively integrated into deployment projects. Other forms of storage such as flow batteries, inverter based micro storage, and flywheels are being considered. The storage industry is currently at a stage of development very similar to where PV was less than 10 years ago. Low volume market demand has meant low volume manufacturing and all of the cost premiums that entails. Properly incentivized storage options will bring investment and scale to its manufacture with the concomitant cost reduction. From the perspective of solar energy deployment in the near term, these forms of storage should receive both research and incentive support, while core research continues on large scale, big bite strategies that will not be functionally available for five to ten years.

Intelligent controls are especially useful to maximize the potential benefits of DG deployment to the grid. Such controls could allocate generation resources across a distribution node to maximize value. Many of these controls are inverter based and would require software and minor hardware additions and modifications, a low cost solution with significant benefits. In addition to technical changes (including modifications of UL 1741), these benefits could be best achieved through a development mechanism of aggregating individual DG sites. There are some fundamental business model improvements that need to be made to integrate DG into the existing utility business model in a way that protects revenues and existing asset base.

Technical Improvements in business model
One of the most important innovations supporting rapid deployment of solar energy has been the technical advance in business models. The solar industry's explosive growth in the last few years has been directly related to the development and use of the solar power purchase agreement (PPA). In 2007 over 50% of the national nonresidential market for solar electric power was developed under PPAs, up from 10% in 2006 ("Solar Power Services: How PPAs are changing the PV Value Chain," Greentech Media, February, 2008). The solar PPA essentially finances the up-front capital cost and offers customers the output from PV systems at or below the cost of fossil fuel generation. The solar PPA developer monetizes the Federal and local tax credits, facilitates utility incentives and renewable energy credit sales, and designs and implements all business processes to minimize and absorb the risk that the customer would

otherwise be forced to assume. These risks include: financial, technology, system performance, construction and regulatory. With discipline and innovation, PPA developers have improved and enhanced the solar photovoltaic transaction across the entire value chain, bringing greater profitability and lower prices to the market place.

It was this customer-centric focus, at a time when customers were reeling from rate increases and pricing volatility that resulted in such an expansion of system installations. The solar PPA using PV technology, offers two financial risk reduction strategies for customers: capital acquisition and future price protection. Under the solar PPA, the developer monetizes all of the incentives and tax credits and through aggregation, secures private sector project financing. Because of the nature of PV technology, especially minimal operations and maintenance requirements once installed, and long term predictable performance output (PV panels have warranties of 25 years), PV can offer firm prices under contract for 20 years. This means an effective 20-year hedge against rising fossil fuel prices for the customer. It is this hedge against rising electric power prices fueled by resources with uncertain and volatile pricing that has made the PV PPAs so successful.

The next generation of solar PPAs, currently entering the market continues this customer-centric focus, but with the addition of utility-centric features. The recent success of solar thermal technologies in the market place (3,000 MW of solar thermal contracts have been initiated with construction expected to be complete in the next three years) highlights the importance of utility-centric features. Solar thermal is a traditional steam turbine electric power generation process, fueled primarily by solar collectors instead of coal, natural gas or nuclear reaction. The familiarity helps many utility executives more readily consider the solar thermal option. But since the approach incorporates a traditional power block, it shares many of the risks and inefficiencies of indirect, multi-stage conversions of energy: large scale, remote location, transmission dependent, multi-year construction, and big impact financing, performance, and operation risks. For these reasons and more, it is not a technology choice and a development approach that can be relied upon to deliver large volume, rapid deployment of solar energy in the first phase. Large scale, strategic, and multi-year development of solar energy in the distributed generation format, especially in the next 10 year period is essential for achieving the goals of Grand Plan for Solar Energy.

Solar energy is a disruptive technology. Disruptive technologies by definition create risk. . But disruptive technologies, like the automobile that replaced the horse and buggy, can offer massive improvements in quality of life and prosperity. What mitigates that risk and transforms it into opportunity is the right technology of doing business, the right business model. Such a model must be both customer-centric and utility-centric. Utility revenue and the remaining life of the massive investment made by investors and rate-payers in conventional generation, power distribution and transmission assets must be protected and maximized as best possible while incorporating solar technologies. But not at the expense of future competitiveness and resiliency.

A major obstacle to massive solar energy deployment, in addition to cost and efficiency, has been conflict. Innovations in the solar PPA, coupled with other innovations in power financing entering the marketplace, are designed to end the current conflict between distributed generation and utility revenue protection while establishing more effective and fair financing for rate-payers. It is in our interest to end the conflict. Much can be gained from strategic deployment of DG: improved system reliability, reduction or elimination of transmission & distribution

expenditures, reduction of local congestion, voltage support, low cost to no cost for non-participants, and reduced subsidies.
Deploying and integrating generators, smart meters and intelligent controls, energy efficiency, virtual net metering, green tariffs and effective storage will permit greater control of load and generation. It is important to note how great the need is for strengthening and hardening our power grid.

> "…the United States has three times as many power outages of the United Kingdom and over 30 times as many power outages of Japan.[i] Both Japan and the United Kingdom have achieved this reliability in part by investing in 21st century distributed generation technologies—distributed solar, combined heat and power, fuel cells, energy efficiency measures, and other customer-centric market solutions. (as quoted in "The Materiality of Distributed Solar, "Jigar Shah, Apt, Jay & Lave, Lester & Morgan, M Granger. (2006). Power Play: A More Reliable U.S. Electric System. *Issues in Science & Technology.* http://findarticles.com/p/articles/mi_qa3622/is_200607/ai_n17174065)

Finally, just as "simple, easy" is a useful guiding principle for technologies and technology systems, it is a good design principle for business models as well. "Solar PPA 2.0" can reduce and eliminate the need for complex and copious regulations, mandates and other policy requirements.

Critical factors #3 – Effectively structuring the multi-billion dollar investment that will be made by ratepayers, investors and the government.

The solar energy investment envisioned by the Grand Solar Plan is significant and such an investment should be fair to all investors and maximize both direct and indirect benefits. Because solar energy financing consists of several mechanisms: tax advantages, utility sector incentives payments, and private capital different investor groups are coordinated in the transaction.
Fairness would recommend that all investors receive benefits that justify the investment made. The Federal investment for solar is no different than investments made over the last 100 years for general public access to energy and electric power. From 1943 to 1999 $151 billion was spent by the Federal government for support to nuclear power, $145.4 billion; solar energy, $4.4 billion; and wind, $1.3 billion. ("Federal Energy Subsidies: Not All Technologies are Created Equal," Marshall Goldberg, Renewable Energy Policy Project, Research Report July 2000, No. 11). Clearly, for solar energy to become more broadly available, restructuring of the Federal energy investment must be made.

The ratepayer contribution is the area of greatest concern for assuring fairness. At the current level of financing for a residential ratepayer, usually less than $50 per year, when some ratepayers benefit more than others, although contributing benefits for all, there is less need for concern. But for the kind of investment that the Grand Solar Plan would entail, spreading the benefits across all ratepayer classes and all communities is crucial. The DG development approach can distribute the benefits across a broader range of ratepayers and communities.

But the fairness issue still remains. Not all ratepayers are in a position to invest in solar energy systems even with the tax credits and utility incentives available. The new funding mechanisms must be designed so that those who can directly benefit, contribute greater investment. Recent developments in PPAs for the DG market can increase the fairness, if the directive to support utility scale coordinated DG development is made.

2. The current marketplace for solar energy and expected evolution.

The current solar energy market has been dominated by DG deployment of PV, although 3,000 MW of solar thermal projects are expected to be built in the next few years. PV deployment over the next five years is conservatively projected to increase 35% annually. Worldwide 2007 deployment was just under 3 GW and is expected to increase to 11 GW by 2012. US deployments of approximately 300 MW (SEIA as reported by the Wall Street Journal 1/18/08) are conservatively expected to grow in excess of 35% annually (internal proprietary analysis). The US market is commonly considered to be the next high growth solar market, anticipating greater consolidation of political will and the necessary regulatory framework at the US Federal level.

PV is on track for delivering promised cost reductions. Incremental improvements in silicon pricing, silicon utilization and overall system costs are expected to decrease annually at a consistent, but modest level. This is independent of any major game changing technology or manufacturing process coming on line. There are cost, performance and manufacturing processing improvements in the pipeline, but it is uncertain when, and at what scale they will enter the marketplace. Commercialization is a highly uncertain process and although it is clear that more attention and investment has been directed toward PV improvements across the entire value chain, it is unclear how soon those improvements will be translated into value.

The Grand Plan calls out thin film and expected cost reductions. In general, I am in agreement, though my colleagues at University of Arizona have pointed out some of the fundamental resource issues from both a supply and a toxicity perspective, with the cadmium telluride cells. They and others are working on next generation materials with great promise that avoid supply and toxicity concerns, but again, there are uncertainties concerning time to market.

The greatest concern in the next three to five years may be financing. Solar energy financing comes from multiple sources (Federal, utility rate payers and private capital). Difficulties in any of the sectors will constrain the total financing. In particular, without new approaches to utility contributions, in the current near-recessionary (recessionary) environment, there will be limits to how much of a cost burden can be placed on the ratepayer.

PV and HCPV technologies should and will dominate development in the next ten years, especially in a DG format. With all the talk of large-scale projects and exporting to the rest of the country, it would make sense to take care of the domestic needs of potential power exporters first and then use the fixed cost clean power to build generation for export.

The Grand Solar Plan suggests equal development on a GW basis for each technology for the next ten years. On that basis alone, with 3,000 MW of solar thermal in process, the focus for the next 5 to 10 years should be on PV deployment, especially in the DG development model (PV because it is scalable, modular and flexible can be developed in a central station format or distributed format)

Another way to think about it is to emphasize the technology that offers the “two-fers” or perhaps more elegantly “positive externalities.” These are other positive benefits that come from the technologies, independent of clean, cost-effective energy generation. Economic development and job creation is essentially the same for each technology, more maintenance jobs for solar thermal, more flexible job experience for PV. Solar thermal is not less expensive than PV, and there is evidence that it is more expensive when comparing scale to scale. Other features and comparisons will be discussed later.

PV is scalable and flexible and it can be developed across a whole range of sizes from a few kilowatts to 50+MW on rooftops and ground mounted, using land that may not have any other productive use. Developed near to the customer demand, transmission costs can be saved. Larger numbers but smaller installations spread across more communities could be deployed, permitting more people and more communities to participate in the economic benefits of a large infrastructure development campaign. Large scale DG deployment also offers additional reliability as has been noted above.

Scale development of any solar technology has the potential to bring cost down, from component manufacturing to installation practices to financing and other transaction costs. Utility scale solar thermal provides component scale benefit solely to utility scale solar thermal. Because the same components are used in PV small scale to utility scale, any wins in the PV area have benefits across the whole range from utility scale down to the small systems on homes or for remote emergency applications.

For the next 3 to 5 years it is critical that we allocate solar energy investment to the highest benefit lowest risk installations. That would suggest a predominant role for DG, where the rate-payer investment can be more effectively stretched with private capital, and where the investment has the biggest return to rate-payers: near the load, dispersed throughout communities, benefiting more communities. Larger investments, with longer construction periods, greater cost of construction exposure, higher technology and performance risks, are less beneficial under the current constrained conditions. Since PV can go to scale in a DG format (5 to 20MWs) and at the higher MW level, deliver price breaks equal to or below the current cost of large scale solar power, it is prudent to focus on PV technology and DG scale.

As presented in the technology obstacles above, DG presents difficulties for utilities concerning revenue loss. With the entry into the market place of means to address those concerns, large volume strategically developed and integrated DG projects utilizing PV technologies will dominate in the next 5 years. In the second five, CPV and HCPV advances in scalability will support additional DG and more cost effective central station from regions like Arizona that have good solar resource and available land.

3. Current regulatory environment and incentive structure & large-scale solar development.

Key to large scale development in the near term is the extension of the Federal Investment Tax Credit, standard interconnection and net metering at the Federal level, support for solar energy on Federal lands and protection for the key solar energy financing mechanism to date, the Power Purchase Agreement ("PPA").

The rationale for the first two issues have been offered and discussed above. Support for solar energy development on Federal lands could be in terms of multipliers for requirements for Federal agencies to deploy solar energy on-site and other Federal lands as was done in EPACT 2005 (energy production is doubled for accounting purposes), and in reducing the administrative burden for long term leases, etc. The fourth issue, protection for the PPA, like standard interconnection and net metering has been addressed in many states, but not all. This requirement concerns the ability of PPAs to be offered by solar energy developers without the burden of excessive and unnecessary regulatory requirements and approval. Federally pre-empting state attempts to prohibit or restrict on-site generation could consist of the following:

"Provision of electricity from equipment which uses solar energy to generate electricity shall not be considered a sale of electricity for the purposes of any federal, state, or local regulation governing sales of electricity or regulating utility service, provided the sale is to serve load on the premises where the system is located, or on contiguous property."

4. Distributed photovoltaics, concentrating photovoltaics, solar thermal technology comparisons, R&D funding & Congressional actions.

Solar energy consists of two kinds of approaches: capturing the sun's photons (solar electric, photovoltaics, "PV") and capturing the sun's heat (solar thermal). These approaches can be developed in two formats: central station and distributed generation ("DG"). Central Station consists of large scale (20MW to GW, multiple square miles), remotely located, and connected to the grid via transmission lines and infrastructure for distances up to hundreds of miles. Distributed generation ("DG") consists of micro generators of hundreds of watts up to 20MW and can be located near the consumer demand. DG does not require transmission infrastructure, and is delivered to the end user directly through the service panel or in larger systems of multiple megawatts by means of distribution lines and equipment.

Capturing the sun's heat requires components and equipment that is different depending on whether the developed in central station or DG format. Capturing the sun's photons, depends on similar components regardless of small scale or large-scale development. (This is particularly true for PV. For concentrating and high concentrating PV, smaller scale may not be effective).

Utility scale solar thermal approaches include parabolic troughs, power towers, and other systems. Most systems concentrate the sun's heat and focus that heat on production of steam to turn electric generators that then produce electricity.

PV, concentrating PV ("CPV" to 100 equivalent suns) and high concentrating PV ("HCPV" in excess of 100 suns) all use semi-conductor material that when exposed to the photons of the sun, directly produce electric current. The concentrating technologies, by means of special lens, dishes and reflective surfaces, effectively multiply the potential electric current from the photon energy of the sun (some proposed CPV systems are hybrids and use heat for energy production, but they are exceptions). Such systems require tracking and sophisticated thermal management. The complexity is offset by the potential to substantially increase the 10% efficiency of PV to 20 to 40%. As sophisticated tracking and thermal management technologies from other industries, especially the defense industry, migrate to the CPV and HCPV arena, these complexities could be profitably managed. As experience increases the certainty regarding performance, CPV and HCPV can become more viable, especially those that lend themselves to a scalable, modular and flexible development profile. *(Please see pictures of systems following the text).*

A key consideration for assessing the functionality and finance-ablity of a technology, is how quickly and efficiently it can be deployed. Finance-ability requires long term dependable production, either low cost or reasonably predictable operation and maintenance costs, and other minimized risk factors. The following table summarizes risk factors for PV and solar thermal. Due to the limited deployment of CPV and HCPV technologies, the risk analysis was not meaningful.

Risk Factor Reduction	**PV**	**Solar Thermal**

Fast, simple installation	Yes	No
Modular, scalable, incremental installation	Yes	No
Flexible installation (central station, DG, combination)	Yes	No
Low Operations & Maintenance cost	Yes	No
Faster, less production impacts from O&M	Yes	No
Greater cost reduction 2009 to 2015	Yes	No
Storage can be added at any time	Yes	No
Not dependent on fossil fuel support	Yes	No
Little water needed	Yes	No
Economic Development	Yes	Yes
Dispatch-ability (with storage addition)	Yes	Yes
Cost effective at smaller project size & lower capital requirements	Yes	No

There is a feature of solar thermal that may make it more advantageous and that is storage. Adequate storage increases the dispatch-ability and value of solar energy generation. Large-scale storage for solar thermal, supported by fossil fuel generation, is purported to be farther along in the development and reliability cycle than large-scale storage options for PV. Several proposed projects with storage features are expected to be completed in the next three years and will clarify.

Development Format: Central Station and Distributed Generation

PV (and CPV and HCPV) can be developed in a DG or central station format, though nearly all developments to date have been in a DG format. Utility scale solar thermal requires a central station format. As has been discussed, there are many advantages to DG, as summarized below:

Benefits Central Station & Distributed Generation	**DG**	**Central Station**
Direct customer hedge value	Yes	No
Direct customer access to benefits, more customers benefit	Yes	No
Benefits Central Station & Distributed Generation *cont.*	**DG**	**Central Station**
More communities have access to economic development	Yes	No

Strengthens Grid Reliability	Yes	No
Increases Energy Security	Yes	No
Allocates Costs more directly	Yes	No
Reduces transmission costs	Yes	No
Reduces need for transmission investment	Yes	No
Relieves Distribution Congestion	Yes	No
Reduces need for distribution investment	Yes	No
Multiple financing opportunities (asset based, tariff based etc.)	Yes	No

Other Regulatory & Incentive Mechanisms

Pricing Carbon Emissions

Currently, pricing carbon emissions has been done indirectly, through an assumed green value attributed to generation from renewable sources. How these attributes are valued and bought and sold is dependent upon the regulatory framework adopted by the state where the project is located. Establishing market based pricing mechanisms at the national level, by means of carbon taxes and/ or carbon trading would be very productive and supportive of rapid and efficient deployment of solar energy. Among other positive results would be a reduction in transaction costs.

Setting Standards & Mandates

Although market driven strategies are always to be preferred on core resource issues, standards and mandates are often prudent and necessary to achieve certain objectives. The electric power industry is a regulated monopoly and does not operate in an environment where competitive alternatives can be easily presented and adopted. This is especially true in a market where many of the negative costs have not been systematically included, as is true for electric power. A national requirement or standard for renewable energy deployment could be helpful.

Summary of Federal Research & Development Support and Regulations

Research & Development

1. Storage *Large scale and small scale: batteries, inverter based, flywheels, compressed air storage.*
2. Intelligent Controls for Grid Integration
3. Value and Integration of Distributed Generation
4. Photovoltaic Materials, *including CPV and HCPV*

Regulations

1. Extension of Federal Investment Tax Credit
2. Federalizing Standard Interconnection, Net Metering, and PPA protection.
3. Access to Federal lands for solar energy deployment.
4. Pricing Carbon Emissions
5. Setting Renewable Energy Requirements

In conclusion, we are walking a tightrope of opportunity in the decisions we will make on cleaning and greening our electric power system. And the consequences of making a large, monolithic bad choice are no longer minor. At the end of the day, it all comes down to limiting our risk. Our choices must reflect a hard-nosed look at the risk, no matter how brutal the facts are.

Thank you Madame Chairman and the Members of the Committee for the opportunity to share these observations and opinions with you.