Comments of
Bob Reedy, Director – Solar Energy Division
Florida Solar Energy Center

Before the
Select Committee on
Energy Independence and Global Warming

September 20, 2007

Vision

> "I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait 'til oil and coal run out before we tackle that."
>
> Thomas Edison, 1931.

Early in 2007, Congress began work on significant new legislation to boost our independence from foreign oil, and mitigate the climate effects from consumption of all fossil fuels.

Let's imagine a new vision of the future for the United States – one that is based on renewable energy production. The vision is relatively simple. You live in a highly efficient "zero energy home" that produces more power than it uses and you work in a building that produces more power than it uses. Your home and work place also have the capability of producing advanced renewable energy "carriers" that store energy with the excess power produced by the solar energy systems. You drive a plug-in hybrid vehicle that you can "plug into" multiple points on the electric grid with solar power generation capability (e.g. your parking lot at work). The "utility" company has the ability, through advanced communication and control systems, to identify and control both the energy carrier production and storage system devices and the charging and discharging of your plug-in hybrid. And most important, the utility itself is producing a major portion of its energy requirements from clean renewable resources such as centralized solar plants, wind farms and carbon-neutral biomass plants.

This vision is one of energy independence which salvages our energy security, protects us against terrorist attack and creates economic opportunities and jobs that can not be outsourced to other regions of the world. This vision is the United States leading the world in greenhouse gas reduction, while building a strong economy around developing, installing and servicing efficiency and green technologies rather than sending billions of dollars of hard-earned capital out of our country for the purchase of conventional fuels.

While this vision is already technically possible, some portions may not be economic today. However, we know from history that the economics will change dramatically with improvements in technology, increases in production volume and the catalytic shifts in public policy and perception presently afoot. For example, the President's Vision for the Department of Energy-funded Solar America Initiative is changing the way we power our homes and businesses. The goal of the Solar America Initiative is for photovoltaics to be cost-competitive by 2015. The great strength of this vision lies in the forces behind our discussion here today. We are well on track to see this happen!

Critical Characteristics of Energy Supply

Without regard to type, all energy resources must meet the needs of society. As stewards of these resources, energy companies further evaluate the technologies to meet the long-term needs of their owners (investors, municipal citizens, or cooperative members). Though I today represent the Florida Solar Energy Center, many years of work with electric utilities and energy marketers allows me a unique perspective on these generation expansion decisions. I will discuss solar energy in particular, but emphasize these attributes apply to other renewable technologies as well.

Risk

Ultimately, the generation expansion decision is all about Risk. Utilities are uniquely capital-intensive, with very long payback periods inherent in the model. This gives rise to the regulated monopolies, publicly-owned utilities and membership cooperatives which have served us well for decades. Even with such robust corporate structures, utilities are still at great risk when building new generation. Investors and stockholders seek considerable risk mitigation when lending such huge amounts of capital.

This said, we often wonder how such inherently risky ventures as a large coal-fired steam plant, or a combined-cycle gas turbine can pass the risk criteria. These plants suffer many modes of mechanical failure (technology risk), face high risk of fuel shortage, have large negative environmental impacts (regulatory risk) and present a "technically unhealthy" size to the nation's electric grid (operating risk).

Yet our electric grid is second to none, providing reliable service (in spite of some glitches) and economic (at least in direct costs) service since the turn of the last century. The technologies remain risky, but we have developed a complex set of coping mechanisms to mitigate those risks – from the basic monopolistic structures to a strong transmission grid, to a strong regulatory infrastructure.

Change to this complex set of mechanisms can itself be seen as a great risk. The old adage "don't fix what isn't broken" is often cited in the debate. However, our changing climate and our energy dependence are telling us in no uncertain terms: we must change. The good news is the shift to renewable energy technologies by our utilities will surely *lower* their risk profile, even when evaluated on utility terms. Let's examine some key elements of the overall risk profile.

Economic Feasibility

Instead of trying to generate our new electric energy requirements, consider the implementation of a very aggressive energy-efficiency program saving 30 to 50 percent of the energy used in buildings. This program would reduce the need for new generation by 25 percent while developing new industry and jobs. These savings require thought and effort, but the results have been proven. Studies conducted by the Florida Solar Energy Center using measured data from side-by-side homes show that a well-designed, energy-efficient home can save 60 percent of the energy it uses, and, by adding a 2- to 4-kilowatt PV system, the home can approach 90 percent savings. And these savings were achieved with an amortized cost of about $0.06 per kWh – about half the current average retail electric rate in Florida.

What about renewable energy production? Let's only look at photovoltaics for electric power generation, and solar water heating for direct displacement of electric generation needs. Recent calculations have shown the life cycle cost of photovoltaic applications in Florida is $0.28 per kWh. U.S. Department of Energy cost projections show the cost of a PV system without financial incentives decreasing from a present U. S. national average value of $0.32 per kWh to a future of $0.09 per kWh by 2020. Solar water heating technology is fairly mature, leading to the conclusion that today's life cycle cost of energy production will remain essentially flat at something less than $0.08 per kWh.

Floridians now pay the utility about $0.12 per kWh. If one assumes that the cost of electricity from Florida utilities goes up by only 3 percent per year, in 2010 we will pay $0.135 per kWh and by 2020, we will pay $0.18 per kWh. So with no incentives or subsidies, in 2020 the energy generation systems on your roof, *and* the energy efficiencies built into your home will cost half the utility rate!

This is the customer perspective—the utility view is proportionate, as it must be in a regulated monopoly. In other words, the utility can only charge a small percentage above delivered cost as a fair rate of return. Nothing about solar energy on a residential rooftop precludes the utility from owning and operating the system under an easement agreement. Surveys have consistently shown many homeowners would not object, and even prefer an energy company take responsibility for installing, operating and maintaining a solar system. Consider the popularity of lawn maintenance and home maintenance services. Certainly the multi-family and rental properties are prime for this plan, so long as the owner benefits from the easement.

Such distributed generation should absolutely qualify as necessary generation and distribution facilities in determination of rate base facilities. Go Green and earn a guaranteed return!

One major frustration to the solar industry is our persistent habit of comparing the "base load" average generation costs of conventional generation to the peak period production costs of solar energy. (Even I have done this in the paragraphs above) In fact, the utility generation costs during the daily summer peak (when PV production is highest) are about three times the annual average generation cost.

In a recent analysis of Florida generation costs, FSEC found the total amortized 30 year life-cycle cost of a new simple-cycle gas turbine peaking unit to be around $180 per megawatthour, while an equivalent utility-scale PV investment would cost less than $110 per megawatthour on the same terms and assumptions.

Reliability

Solar systems are far and away the most reliable generation technologies available. The solid-state PV panels will operate for 20 or even 40 years without significant degradation, and even the circulating pump of an active solar water heater is built with 20 years as the standard.

Compared to utility generators with fuel systems, turbines and all the controls between, these solar systems are "like a rock". Another impressive reliability gain comes from the incremental nature of an aggregate of small solar systems. The utility often loses a complete block of several hundred megawatts when a generating unit suddenly trips offline (or thousands of megawatts with loss on an entire plant). An equivalent event with PV generation would require the coincident failure of thousands of rooftop systems.

Solar systems are technically "intermittent" because the sun sets every day, and dense storm clouds can reduce output. But utilities highly value the predictability of solar system production. Given their already extensive weather modeling capabilities, utilities can accurately estimate production next hour, next day and even into the annual realm.

Availability

Obviously, there is no lack of solar energy. Even in the far north or in cloudy regions, we have ample solar resource. Conversion of the available energy is the challenge, with the necessary infrastructure for mounting collectors as the particular problem. Desert regions with large "solar farms" come to the public mind, but a tremendous amount of otherwise unused space is available everywhere. In fact the solar farm is actually disadvantaged over distributed rooftop systems because it is really a central-station power plant, with the resulting requirements, losses and problems of electric transmission and distribution. Consider some of the opportunities:

- Joint usage of suitable roof space in cooperation with, and to the economic advantage of the building owner. This allows for 25kW to be installed where a homeowner may only need and want 5kW.
- Linear arrays along the median of divided highways, coincident with existing crash barriers, and along the edges of the right of way outside any safety zone, and integrated into sound barrier structures.
- Ground mounted arrays in the perimeter zones of airports
- Linear arrays along the edges of suitable stretches of transmission line rights of way

Such new configurations are not necessary for a significant contribution by solar energy. FSEC has recently estimated sufficient roof space to provide 2% of Florida's electric energy needs with PV generation, and 2% electric generation offsets from solar thermal generation (hot water). And this is achievable with very reasonable changes in practice and policy, all at a net savings (monthly cost of energy plus mortgage) to the homeowner. The newer deployment techniques described above would bring at least 10% of our electric energy needs while remaining economic (less than 1% increase in total generation costs).

Certainly, the roofs of every school building in America should be covered with solar panels!

Air conditioning is a huge electric system demand throughout the Sunbelt. One of the most promising opportunities for solar energy lies with solar-driven absorption chilling. The basic technology is decades old, but has relied on fossil-fired boilers with resulting high fuel costs, maintenance problems, and environmental impacts. New computer-controlled solar-assisted absorption chillers could mitigate or eliminate these problems.

Economic Impact of Creating New Industries and Jobs

We often discuss the obvious economic advantages of renewable energy supply: keep our dollars at home, control risk and the shifts from speculation and shortages, and prevent costly spills and accidents. We have even begun to understand and quantify the fossil-fueled externalities of environmental costs, health care and social dislocation. But the newest excitement of the Green Economy is about jobs and investment opportunity.

The U.S. PV industry has been growing at a rate of 40% per year (increasing from 108 Megawatts in 2005 to 141 Megawatts in 2006 and to 259 in 2007). The 2007 increase is projected to be 83% because the U. S. market is expected to dominate the world PV market over the next four years. The states with major PV market are California, New Jersey, New York, Arizona and Texas. (Florida has a better solar resource than any of these states except Arizona and has double the solar resource of the world's largest PV market – Germany). The industry surveys and U. S. Department of Energy data indicate that this double-digit growth is expected to continue in the upcoming years.

The Opportunity

Sunlight provides by far the largest of all carbon-neutral energy sources. More energy from sunlight strikes the Earth in one hour than all the energy consumed on the planet in a year. The most successful renewable technologies taking advantage of this resource are the direct conversion systems of photovoltaics (PV) and solar thermal energy (particularly domestic water heating). The earliest engines of the industrial revolution driven by wind and hydroelectric turbines and biomass boilers – are actually indirect solar energy conversion systems.

Yet, in spite of the vast potential, photovoltaics currently provides only about one-millionth of world total electricity supply. The huge gap between our present use of PV and its enormous undeveloped potential presents a grand challenge in public policy. As Edison suggested in 1931, sunlight is a compelling solution to our need for clean, abundant sources of energy. It is readily available, secure from geopolitical tension, and its use poses no threat to the environment or climate through pollution or emission of greenhouse gases.

Worldwide demand for energy is outpacing supply. A large number of energy experts claim that we have reached the world's oil peak – the peak of the annual production of the crude oil. During the "energy crisis" of 1973, our country imported less than half of its oil consumption. Today we import 60 percent. These and other factors underlie our vulnerability to energy supply.

It is time for the nation to act.