THE ROLE OF SOLAR

PART OF A BALANCED ENERGY PLAN

BY JEFFRY E. STERBA

I COMMEND THE AUTHORS OF THE article, "A Grand Solar Plan," for developing a thought-provoking concept regarding the potential of solar energy to address our energy needs, reduce our dependence on foreign oil and reduce our emissions of greenhouse gasses. I, like the authors, believe that solar energy, as well as other renewable energy sources, can and must play a significant role in our energy future. History has proven that without bold ideas, significant advancements will not occur. I also agree with the authors that small, safe incremental steps aren't enough, and that significant subsidies are needed to move supply technologies out of the R&D phase and into demonstration projects and on into deployment.

However, I respectfully disagree with the premise that this is the time to focus in on any one technology as the silver bullet. There isn't one. I don't know anything in the energy business that has a one-size-fits-all solution, and electric generation in a carbon-constrained world is no exception. The history of energy generation in the United States is littered with a number of expensive examples of the country being misled into believing that a single type of generation was the solution to the issue of supply. There was nuclear power, which was going to be too cheap to meter. Then, with such abundant fuel supplies, coal generation was to be the answer. Most recently, natural gas was the fuel of choice. None of these turned out to be the silver bullet. Let's not fall into that trap again.

Photovoltaics have a significant role to play in the future, but I believe a more comprehensive portfolio of solutions is needed. The following outlines some concerns I have about the plan laid out in the article, and then offers what I believe is a more compelling framework for successful CO_2 emissions reductions by the electricity sector.

The feasibility of the authors' grand solar plan rests on many arguable assumptions. Let's look at the specific assumptions in three areas: generation and storage technologies, land use, and high-voltage direct-current transmission-line infrastructure.

TECHNOLOGY AND COST CONCERNS

The emphasis on thin-film technologies is understandable as one of the authors is a well-known thin-film expert previously employed at the National Renewable Energy Laboratory. However, I believe that choosing any one solar technology as the cornerstone of a future supply plan, and making that choice now, is both shortsighted and unnecessarily premature. It's still unclear whether or not thin films will have a meaningful cost advantage, either in the short-term or the long-term, over silicon-based PV cells. For example, one of the world's largest silicon-based PV manufacturers believes it can get the price of its PV modules down to $2 a watt by as early as 2010; if so, what can they accomplish by 2020, when the authors theorize an installed cost of thin-film cells of $1.20 a watt? As for long-term advantages, given the emerging nature of thin-film technologies, their long-term

Solar, nuclear and wind power, along with energy efficiency, are crucial elements of a comprehensive portfolio of options for secure, reliable and low-emitting energy generation.

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durability is not fully understood. Silicon cells, however, have already proven their durability, lasting 20–25 years with limited power degradation.

The total installed system costs for installations of any type of generation facility have been increasing due to the costs of raw materials, such as steel and cement, to build the balance of plants – such as structures, inverters and switchgear. So the total system cost figure of $1.20 a watt by 2020 is most likely understated. Furthermore, these costs don't include the true costs of energy storage. Implementing compressed-air energy storage as a single technology to manage a large network of PV plants is only a partial solution; an additional flywheel/battery storage solution will likely be needed to address grid stability issues.

Finally, the statement that only 10 percent of U.S. energy will come from distributed PV installations –

Autodesk: Leveraging Design to Improve Asset Information

Utility Industry Challenges

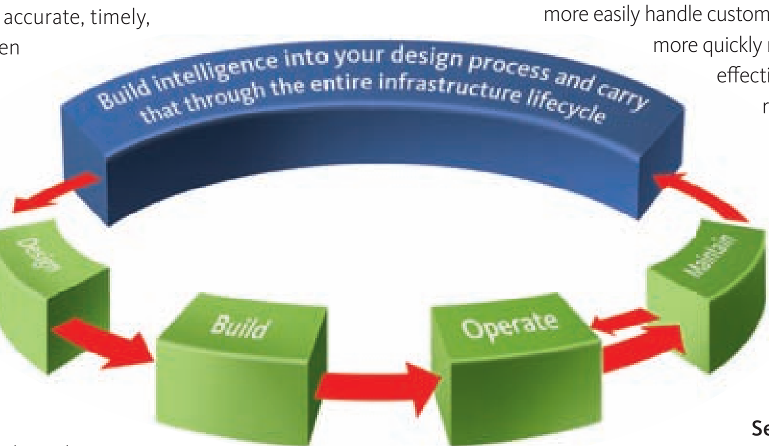
Utilities face relentless pressure to do more with less and maintain high reliability and customer service, all the while coping with aging assets, capital constraints, a rising demand for energy, and addressing sustainability.

Infrastructure: The North American Electric Reliability Corporation predicts that demand for electricity will increase 19 percent nationwide over the next 10 years while transmission capacity will grow by only 6 percent. In addition, surveys indicate that about half of all utility infrastructures in North America are more than 50 years old. This is an issue that is reoccuring across the world, and is estimated to cost $40 trillion over the next 25 years to refurbish infrastructure globally.

Efficiency: There is rising consumer interest and participation in energy efficiency measures and distributed energy resources, which adds to the complexity of grid design and optimization.

Knowledge Transfer: Utilities will have to cope with the retirement of experienced staff over the next decade—workers with valuable knowledge that will be difficult to replace.

However, even under such tough circumstances, utilities still can increase productivity and cost efficiencies by improving asset information. If asset information is accurate, timely, and available to all who need it when they need it, a utility can operate more effectively.



Asset Information Challenges

Unfortunately, for most utilities, it is not easy to access or share asset information across the design, build, operate and maintain infrastructure lifecycle. Often, the information resides in proprietary formats or in data silos throughout the organization. When design information is shared, it is often exchanged via paper format and is manually entered into an as-built system. Making design data available to those managing as-builts, responding to maintenance issues, or answering customer service requests usually requires either manually reconciling the data or converting it to the proprietary formats. Autodesk utility solutions improve business process and data quality by leveraging engineering design information across processes to build, operate and maintain asset lifecycle.

So, what if utilities could get accurate and consistent information quickly enough so they can maximize operational efficiencies, improve responsiveness, and increase quality of service?

The Autodesk Approach

By leveraging the Autodesk design tools utilities likely already have, they can build on that strong foundation. Autodesk solutions for utilities make it easy for all departments to integrate, access and share design and as-built information—in their business processes. This helps to eliminate waiting for reports or pieces of information from different departments and wondering how accurate and up-to-date the information is.

- Key data on every engineered asset – what they are, where they are, and how they are performing – is available instantly, without having to compile the information manually or convert it to another format.
- Every physical asset has a "single point of truth" associated with it.

With Autodesk solutions, utilities can extend the reach and value of infrastructure asset information, so they can more easily handle customer requests; more quickly respond to outages; and more effectively provide information for reporting, planning and analysis.

> **"Autodesk solutions for utilities make it easy for all departments to integrate, access and share design and as-built information--in their business processes."**

Autodesk utility solutions can improve efficiency and data quality by building intelligence into the design process and then leveraging that data across the entire asset lifecycle. With this, utilities:

See the big picture. Manage infrastructure safely and efficiently with greater access to information supporting decision analysis.

Do more with less. Turn out quality work quickly so they can:

- Build standardization into the engineering process
- Eliminate wasteful data re-creation processes
- Remove the silos and to create a single point of truth

Get the right information to the right people at the right time.

With Autodesk, utilities can leverage design to improve business process and data quality.

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rooftop solar panels – by 2050 is a huge assumption. I have no idea what the penetration rate may be, but if the price of solar drops to the levels envisioned by the authors, then grid parity will occur quickly and the increase in the PV installation rate among residential and commercial customers will be dramatic. In addition, available roof space doesn't have any of the land use issues of centralized greenfield PV plants.

LAND CONCERNS

The article may understate the magnitude of land issues. For instance, 46,000 square miles of arrays by 2050 is an astonishing number, and it's unclear if the cost to purchase such land is included in the authors' costs. Even if only half of the land needs to be purchased, at a reasonable price of $5,000 an acre, the cost of purchasing this land is more than $73 billion.

Keep in mind that although the authors may not put much intrinsic value in this land, other people do. Desert land has extraordinary meaning and value to the people who make it their home, not to mention its environmental value for species diversity and its stunning scenic vistas. In addition, even though the authors believe that environmental concerns would be minimized since solar power is benign, the energy industry's experience with other seemingly benign types of generation raises substantive questions. While solar is more benign than fossil fuels, nothing is truly benign. Concerns about the effect of wind farms on bird populations and visual vistas is a case in point. The environmental impact of covering approximately one out of five of the suitable 250,000 square miles of Southwest land with photovoltaic arrays is, in point of fact, unknown.

TRANSMISSION CONCERNS

Concentrating large, centralized, energy-generation facilities in a single area of the country risks reduced grid reliability and likely heightens the concerns around energy and grid security. Furthermore, generation and transmission of close to 70 percent of U.S. electricity from the Southwest to major load centers over an entirely new HVDC transmission system defies certain basic operating rules about grid efficiency, stability, reliability, and options for contingencies when a major element of the grid ceases to function. AC-DC-AC terminals cost about $45 million to $60 million each, and it's unclear whether these costs are included in the authors' estimates. It is also not clear whether the necessary redundant generation and transmission resources necessary for contingency planning on the HVDC backbone are included in the authors' plan. Finally, let's not underestimate the political issues inherent in the idea of one area of the country supplying power to another. Just as Arizona did not want to act as an extension cord for California so that it could have clean affordable energy, the Southwest might negatively perceive the idea of paving over its land with solar panels for the benefit of other areas of the country.

A PORTFOLIO OF OPTIONS

Clearly there are some fundamental engineering and financial challenges as well as practical realities that are of concern. But let's assume this grand solar plan can actually be done. Should it be done? I don't think so. It would be imprudent, as well as costly and inefficient, to put most or all of our energy eggs in one basket.

The optimal grand plan that speaks to both emissions and dependence on foreign oil involves a portfolio of options, starting and ending with energy efficiency and involving renewable energy, distributed resources, nuclear and advanced coal generation, carbon capture and sequestration, and plug-in hybrid electric vehicles. Location and timing are crucial to effective, on-demand power delivery, and a mix of technologies and generation locations has a greater chance of providing the lowest-cost and most-secure electric system.

The Electric Power Research Institute has been intensely studying this very issue. Its recent work on the electricity sector's potential for reducing CO_2 emissions and the economic value of deploying the associated technology is enlightening. Its PRISM and MERGE analyses show the clear benefits of deploying a diverse set of new and existing technologies, both from an economic and an emissions standpoint. This deployment would not require large distortions of the generation-and-transmission systems, and its technological and economic assumptions are relatively conservative and straightforward. Importantly, a portfolio approach hedges against the real potential for delays in technology development.

Solar power will play a necessary and important role in the future of electric generation, as research and technology advances solve the intermittency concerns and the issues around integrating renewable energy into the grid. PV has a significant benefit in that it does not require water and is inherently modular, which allows for rapid deployment. PV systems have excellent potential to offset summer air conditioning loads and provide significant distributed generation inside our cities. I also believe that solar thermal technology along with integrated thermal storage will very likely play at least as large a role in the solar solution as photovoltaics. With the development of adequate and cost-effective storage, solar can move from providing peaking and intermediate capacity to serving our baseload energy needs.

The authors are spot-on when they write that without subsidies, solar power will not reach its full potential. However, I believe the future of an electricity system that is secure, reliable and as free of emissions as possible lies in a comprehensive portfolio of robust generation options, and the collective will of citizens, scientists, engineers, policy makers and industry leaders to make it so.

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