CHAIR'S CORNER

The Future is Renewable Energy

The days of cheap oil are numbered,
but RE is growing fast enough to fill the breach.

This column was spurred by my frustration in how reporter Richard A. Kerr dismissed renewable energy's future in the Nov. 18, 2005, issue of *Science* magazine. As I'll prove, because of the exponential growth and aggressive "learning curve" for just one RE technology — solar photovoltaics (PV) — Kerr is plain wrong. We still have time for renewable energy to be a central solution to the looming crisis of global peak oil, *SOLAR TODAY's* theme topic this issue.

The following is my best one-page, one-technology shot at establishing that renewables can fill the gap. Let's consider three potential scenarios for ramping up PV production and the associated cost reductions. Consider the semi-logarithmic chart, right. For any values that increase exponentially with time, semi-log charts can be used to determine doubling times.

Scenario A: Two-Year Doubling Time. In the normalized growth scenario figure below, curve A assumes a two-year doubling of installed PV (corresponding to 35 percent continuous compounding, or 41 percent annual compounding). In fact, for the past five years, the worldwide *grid-connected* PV market has doubled appreciably faster than every two years, according to the Worldwatch Institute *(www.worldwatch.org/brain/media/pdf/pubs/ren21/ren21-2.pdf)*.

If a two-year doubling could be maintained (an unrealistic expectation), installed PV would grow by a factor of 2^10 = 1,024 in just 20 years, as shown in the top curve below. The second data row illustrates projected Scenario A costs — calculated by multiplying the quantity curve by a per-unit cost for each future year. Surprisingly, this line also is straight in semi-log plots, as the industry has, for many past doublings of cumulative production, reduced costs by 20 percent *(see www.nrel.gov/ncpv/thin_film/docs/margolis2003_experience_curves.ppt)*. Since 0.8^10 = 0.1076, we find that *cost* growth is projected to be only 2 orders of magnitude (OOMs) as *quantities* increase by 3 OOMs.

Scenario B: Longer Doubling Times. To strive for realism, Scenario B assumes that the continuous compound growth rate drops by 6 percent per decade, a change designed to reach 10 percent growth in 2045. In this scenario, by 2025, the cumulative production has only grown by 2 OOMs and costs by less than 1.5 OOMs. The fourth curve down, 2025 costs, with per-unit costs dropping by more than a factor of four ($2 per watt rather than $8), are possibly as low as any energy source (especially as this "total" cost can be realized by the end-user). This scenario projects overall cost savings even before 2025 — not added expense.


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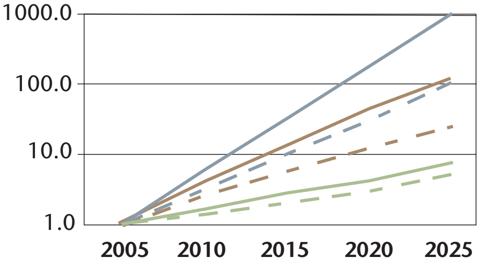
Scenario C: Seven-Year Doubling. This third scenario, which assumes annual growth of approximately 10 percent, or a seven-year doubling time, is far below realistic projections given the past 20 years' growth history and experts' near-term growth projections *(see the websites of Paul Maycock, www.pvenergy.com, and Michael Rogol, http://esd.mit.edu/esd_reports/summer2005/solar_power.html)*. Low-annual-growth proponents, like ExxonMobil, have more invested in justifying its use than we who propose to start with present trends and see a seven-year doubling only after about 40 years.

PV Industry Scenarios A, B, C

Quantity or Cost Scenarios Normalized to 2005 Values



	2005	2010	2015	2020	2025
A Quantity	1.0	5.7	32.0	181.0	1024.0
A Cost	1.0	3.2	10.5	34.0	110.0
B Quantity	1.0	3.9	13.4	40.8	110.5
B Cost	1.0	2.5	5.8	12.4	24.3
C Quantity	1.0	1.6	2.7	4.5	7.4
C Cost	1.0	1.5	2.2	3.2	4.6

Numerous analysts now evaluate the changing energy supply mix in terms of "wedges," that is, the same addition to supply each year — a straight line on a linear, rather than semi-log, graph. Such linear growth would be possible only with an unrealistic jump in PV factory output in 2006 and no change thereafter (although some cost *decline* could be anticipated). Scenario B has a 20-year quantity ratio closer to 100:1. Fortunately, this huge growth disparity is consistent with the use of energy-efficiency (EE) measures — which realistically must decline over time — the lowest-hanging fruit being "picked" first. When RE combines with EE, we can live with this simplified "wedge" concept of zero production growth.

As other countries increase PV installations, they will force price reductions, to our great benefit. Do not make the mistake of estimating future PV costs based on learning curve progress along a U.S.-only path. In 2025, Scenario B (should we get back to buying 25 percent of the world's PV energy) would have a U.S. *per-capita weekly* PV area of a few watts — an addition the size of a postcard. That's not difficult to imagine our producing and purchasing! The main assumption is low-cost energy storage — which is promising based on recent advances in electric cars and plug-in hybrids.

Is the Scenario B future realistic? If not — why not, and what is realistic? We need these answers and agreement on them soon. It's high time for us to make the incredible promise of PV a reality in the eyes of skeptics. Next issue I'll touch on the great capability of other RE technologies to mitigate climate change (*SOLAR TODAY's* next theme topic). Then join us in Denver, where we'll continue this "solar limits" dialog at the SOLAR 2006 conference July 8-13.

In mid-January, I joined about 30 ASES volunteers in selecting final papers and forums for SOLAR 2006. Groups of us sweated for dozens of hours over how to decline a third of the (anonymously authored) abstracts and half of the forums. We had to turn down some very good ones. But quantification of RE's future is a theme of many of the accepted papers — whose quality is excellent. I hope to meet hundreds of you, especially first-timers, at SOLAR 2006 to further discuss how to best make our case for realistic RE growth. ●

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