The Arithmetic of Solar Royalty Trusts

In many ways, owning a PV system should be a dream investment. It promises dependable cash flow for an indefinitely long period of time, even a century, with little underlying market risk. It could be as good a definition of 'risk free' return as government bonds. Government bonds still face the challenges of national default; and PV, the challenge of a price drop in electricity. Maybe the PV is more dependable?

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The basis for this is the two almost unique aspects of PV systems that are hardly ever fully exploited or even understood:

1. It uses no fuel, needs no on-site labor, and may have no moving parts (and thus has negligible operating costs)
2. The basic parts either last indefinitely (the PV module that converts sunlight to electricity) or can be replaced with nominal maintenance costs (the inverter that takes DC electricity and makes it ready for the AC grid).

An open question is how long PV modules will actually last. Modules and systems are warrantied for 30 years now, and there is discussion of 40 years. Few ask for longer, because they can't imagine anything being used longer; but it isn't because they believe it can't be done. Old systems exist with modules that are almost 40 years old, and most are not dead. Most make electricity almost as well as they did originally, although this needs further verification. We can speculate that if people cared enough, PV systems could be designed to last a century.

How many investments last a century and produce a valuable commodity (electricity) at a tiny operating cost (let's say 1 c/kWh), without inflation risk?

Why haven't we been able to invest in PV systems? Because until recently, they have been too expensive (without complex tax credits) to make a suitable return. We could have bought such a system, but we would have been stuck making 1%-2% return on our capital. That's why until now, you have never heard of this possibility.

But all that is changing. PV prices dropped about 40% in the last two years.

This article is the arithmetic of making money from an investment in some ways as risk free as the US government – or maybe, as risk free as Johnson and Johnson, because I hear their paper is now more expensive than the USA's.

So let's understand the problem. We buy a share of a PV system. Then the system turns on and produces electricity. Every year, it produces about the same amount of electricity (within 3% or so) and costs a tiny amount of money to maintain, even including washing the modules once in awhile. Probably the price of electricity won't tank (unless everything in the world does), and more likely it will rise and we will get paid more. The PV modules will very slowly and very slightly lose power, maybe 0.5% per year, but the price of electricity is likely to rise faster – or we can add that many more modules each year to keep output steady. And this will go on indefinitely, at least 40 years, and maybe 100.

Today, large PV systems can be built for about $3/W. (I want to thank Maja Wessels, VP at First Solar, for yesterday confirming at our 2nd annual solar symposium, that this is a sensible price for today's large systems.) This means, if they are 10 million watts in size (10 MW), they would cost $30M. If you got a 5%

return (30 year US bonds are about 5%), you would need to get $1.5M back each year. Let's see whether you would get this money from a PV system.

Elsewhere, I have explained how you can figure out how much electricity a PV systems puts out per year. You will try to build your solar system where you get the best return, which means the right combination of sunlight, local price of electricity, access to the grid, system siting costs, and incentives. But in my example, I will ignore some complexity and calculate based on sunlight, system cost, O&M, annual degradation, revenue, and the 30% Federal investment tax grant.

A simple, low-maintenance non-tracking array in the Southwest can produce about 1.8 kWh per installed DC watt every year. So a 10 MW system, for example, might produce about 18 million kWh a year. Are we close? 18 million kWh at 10 c/kWh is about $1.8 million. That's higher than the $1.5M we need to make 5%, so we are in the ballpark.

Let's be a little more precise and practical, because we don't want to faked out. After all, there are losses, and the losses hurt returns. It turns out, we are on the hairy edge, but that shouldn't be a surprise. That's why this is new.

Let's do this all "per watt" so we can see it very clearly. So we get 1.8 kWh/W each year from our PV system. It costs us $3/W to own the system. Our annual O&M is about 1 c/kWh. We might have a transmission cost. Probably the lucky owners of the first systems will find a way to get near their load and avoid this, but let's not assume this. Let's assess a 1 c/kWh transmission transmission cost so we are safe.

So on a system cost per watt basis, we get the following:

Rate of Return (including capital, O&M, sunlight, transmission; but without rebates, degradation, or siting or grid connection costs or delays)

	$3.5/W	$3/W	$2.5/W	$2/W
6 c/kWh	2.1%	2.4%	2.9%	3.6%
8 c/kWh	3.1%	3.6%	4.3%	5.4%
10 c/kWh	4.1%	4.8%	5.8%	7.2%
12 c/kWh	5.1%	6%	7.2%	9%

The systems in the bottom right, low cost and high electricity price, make the 5% rate easily.

How do we estimate the impact of degradation and costs and delays of siting and grid interconnection? Current PV systems are warranteed at under 1% loss per year, but good ones are in the 0.2%-0.5% loss range. Let's assume we replace the equivalent of 0.5% of our system output per year by buying and installing that much new PV – so the output is unchanged. That would add 0.5% of our capital cost per watt to our annual cost. How much is this per kWh? For today's best $3/W system, this would be 1.5 c/W annual additional cost to replace 0.5% of the output. We get 1.8 kWh/yr from each watt, so this is 1.5 c/1.8 kWh, or about another penny a kWh of lost revenue. Not huge, but not insignificant. (Note that this will get smaller as system prices continue to decline.) So let's re-do Table 1 with degradation included. It makes about a 10% difference in rate of return, which is unpleasantly significant. Stability counts.

Rate of Return with capital, O&M, sunlight, transmission and replacements for 0.5% degradation (no rebates, or siting or grid connection costs or delays)

	$3.5/W	$3/W	$2.5/W	$2/W
6 c/kWh	1.8%	2.1%	2.6%	3.3%
8 c/kWh	2.8%	3.3%	4.0%	5.1%
10 c/kWh	3.8%	4.5%	5.5%	6.9%
12 c/kWh	4.9%	5.7%	6.9%	8.7%

The 5% barrier is surpassed in the case of the highest price for electricity and for the lower price systems. But even 10 c/kWh electricity and $3/W systems; and 12 c/kWh and $3.5/W systems are close. Remember, these systems include the replacement of all lost power every year with new modules sufficient to produce that power, and at today's prices. Those prices will drop (not accounted for), nor will they be as high with all the other preparations already in place.

The other factors are still significant. Due to the immaturity of the US market and the multiplicity of states and regulations involved, there are siting and grid connection delays. However, there are also compensating rebates and tax credits.

Perhaps the simplest way to conclude is to say, the tax credits and rebates can change a $3/W system to a $2/W system (30% tax credit is 90 c/W less); and the siting and grid connection can cost some of that advantage. But at reasonable prices for daytime electricity (around 10 c/kWh), the implied approximately $2.5/W system (after rebates but with siting costs) would meet the 5% rate of return we are seeking, with a little leeway for bumps along the way. And this completely ignores likely future increases in electricity prices and thus in PV system revenues.

Finally, how does this revenue get to the investor? If this were set up as a private partnership, like an S partnership, the income would come to owners, who would pay taxes on it. That would be great, but how many individual taxpayers can be part of complicated S corporations? If it were through a regular corporation, like those listed on the stock exchange, the corporation would have to pay taxes on the income (somewhat offset by depreciation) and then the resulting dividend would be taxed again. Individual investors would not see an adequate return and would not invest.

But protected investments like REITs, annuities, and royalty trusts pass through their income without taxation, and the owner – us, the individual investors – gets the untaxed income. If our lawmakers can make a few tweaks in the existing laws (e.g., making revenue from PV like rent, and making the investment tax credit into a rebate for this purpose), then we can get going. We can have one of the best engines of growth possible for our collective future.

Your kids will thank you if you give them one for Christmas.

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