PEMBINA institute

Fact sheet: The true price of wind and solar electricity generation

In this fact sheet we examine the historic trend of producing electricity using wind and solar. The goal is to give Albertans a better idea of the actual impact of greening the grid.

The cost of solar technology has been falling dramatically for decades. The cost of electricity produced from solar technology has come down more than 90 per cent from 1983 to 2015. Wind has dropped 65 per cent over the same time. Cost decreases have largely been driven by increases in deployment of the technologies.

In contrast, natural gas power plants have not seen the same trend. Recent modest cost reductions can be attributed to the falling price of natural gas — a trend that is likely to reverse as global demand for natural gas increases. The only certainty in projecting the cost of electricity from gas is that it is tied to a traded commodity that is inherently volatile.

Summing up the cost of capital, fuel, operating expenses such as maintenance and taxes, and decommissioning equipment at the end of life determines the cost of generating electricity from a power plant over its lifetime. Solar and wind "plants" have no fuel costs — the sun and wind are free — and the operating costs are also low. This sum of costs is called the levelized cost of electricity (LCOE) and it has fallen tremendously since the world started installing wind and solar power generating technologies.

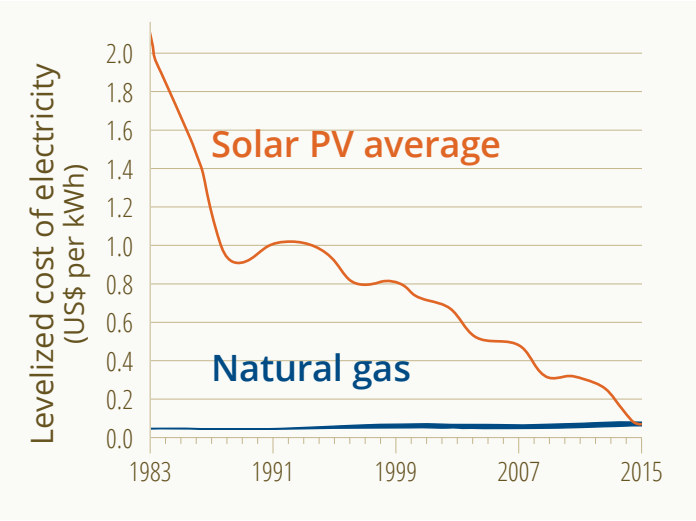

Figure 1: The range of costs from a natural gas combined cycle plant compared to those of solar photovoltaics. The decline in solar costs is expected to level off.

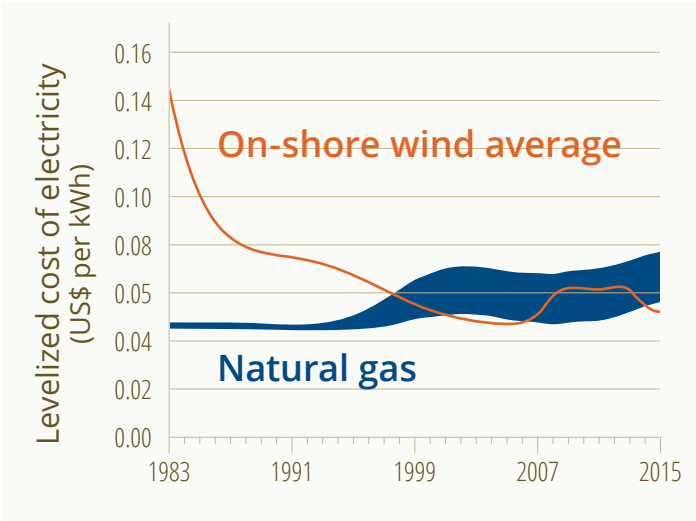

Figure 2: The range of costs from a natural gas combined cycle plant compared to those of on-shore wind. The decline in wind costs is expected to level off.

Whereas the LCOE gives an indication of cost, and is an invaluable tool to help decide investments in power plants, an even better indication of market price is the value of signed Power Purchase Agreements (PPAs) between project developers and utility buyers. The Berkley National Lab (U.S.) finds that PPAs signed today have substantially lower value than those from the mid-1990s. Wind projects continue to decline from $40-$60 to $20-$40 per MWh.[1] Solar projects have seen a more dramatic drop from $100-$200 to $50 per MWh.[2] Most recently, record-low solar and wind PPAs were signed for $36 and $30 per MWh respectively.[3]

How have we gotten here?

While R&D continues — and gets a lot of attention in this high-tech space — the main driver of these impressive cost reductions is not laboratory research, but simple "learning by doing." The phenomenon applies not just clean technologies, but all technology innovation. Literature attributes the cost decline through cumulative production to effects like labour efficiency, organizational learning, technology improvements and economies of scale.[4]

Economic thinker Theodore P. Wright observed in 1936 the relationship between cost and cumulative production by studying the manufacture of aircraft and shipbuilding. He argued that declining aircraft and ship costs coincided with cumulative production and associated the phenomenon with an "experience curve." The exponential relationship goes by various names, including progress and learning curve. In fact, the Boston Consulting Group through the 1960s and 1970s perfected the use of a learning-by-doing argument to explain cost declines in technology manufacturing including televisions, appliances and semiconductors. Now, the most common application of learning-by-doing is in the clean technology sector. Swanson's Law — a derivative of Wright's — specifically targets the declining cost of solar as a direct consequence of cumulative installed solar capacity.[5]

Price declines for solar and wind projects have been driven by massive increases in wind and solar installations around the world — nicely following exponential learning curves. Cost reduction comes from both "hard" costs of technology components and "soft costs" of siting, acquiring energy buyers, financing and construction. Solar and wind costs plotted on a logarithmic scale show near straight-line declines. Decline in solar prices is a near-perfect example. Wind energy, likewise, shows a good correlation from industry infancy in the 1980s through the end of the century. By the turn of the century, some of the best wind resource sites were exhausted — adding an increase in commodity prices and a shift to new, larger turbine designs coinciding with a brief reversal of the learning curve. Since then, prices continue to fall according to Wright's theory.

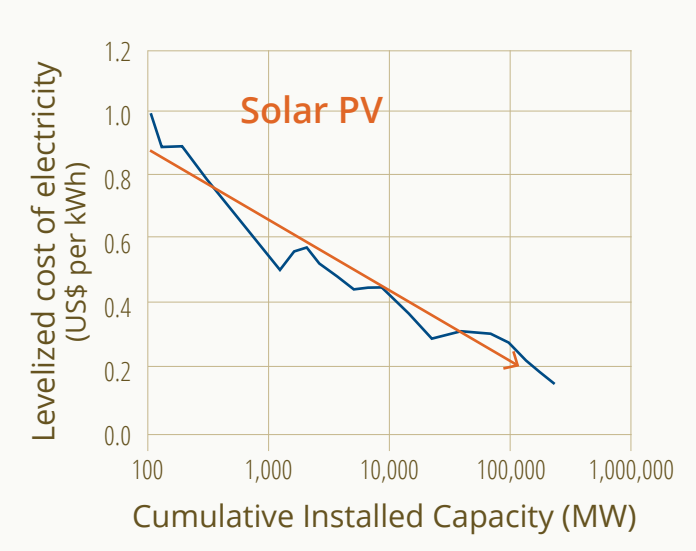

Figure 3: Solar PV costs have decreased as installed capacity has increased. The logarithmic trend line is close to linear and can be explained by the learning curve in manufacture of PV modules and by reduction of soft costs.

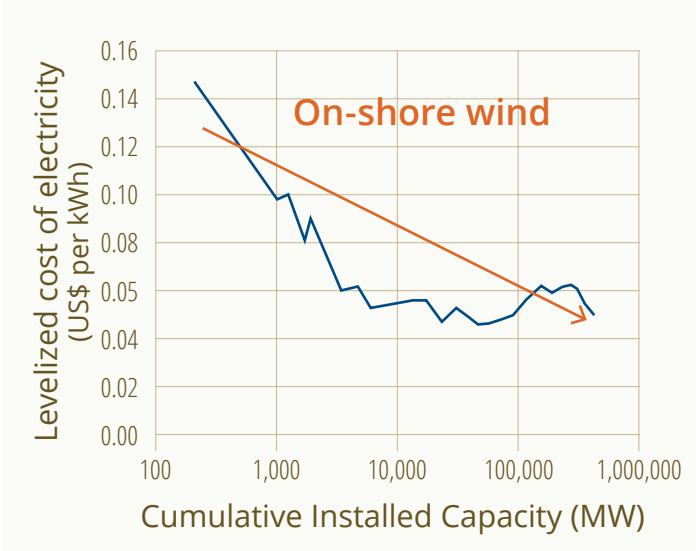

Figure 4: On-shore wind costs have decreased as installed capacity has increased. Cost increases at the end of the last century were from higher site costs and larger turbine designs, but the trend appears to be continuing downward.

Where do we go from here?

We can, with reasonable certainty, predict a declining cost trend for solar and wind energy. Even the most aggressive of recent solar cost decline predictions — McKinsey & Company — fell short of actual reductions. "We expected costs to fall to $2.40 per watt by 2030 but weren't bullish enough; in fact, they are on course to hit $1.60 per watt by 2020."[6] The same learning-by-doing forces that have reduced costs in the past continue to work for the immediate future.

Meanwhile, the cost of electricity from gas plants — a comparatively mature technology — is unlikely to decline. Learning by doing will not result in substantive lower cost. On the contrary, these prices are more likely to go up due to rising cost of natural gas. Recent price trends, having shot up to $8/MMBtu leading up to 2008 then collapsing under the weight of a shale gas boom, are now creeping upwards.[7] Rather than declining, the cost of electricity from natural gas will likely stay flat or increase and experience volatility linked to the price of a traded commodity. A diverse grid with solar and wind provides a hedge against the future cost of natural gas, while complete reliance on natural gas and other fossil fuel generators leaves consumers exposed to potential price spikes.

So, how low can things go?

Bloomberg's New Energy Finance predicts solar and wind costs will continue to fall.[8] For Alberta, we will benefit from the cost reductions in the hard costs that have been realized around the world. But we will only see the added soft cost reductions when we start installations here at scale.

Investments speak louder than prices

It's fun to talk about cost projections as an argument for more solar and wind. But solar and wind cost declines are only interesting when matched with new investments in new generation capacity — lower cost translates into greater investment. Since 2011–2012, the International Energy Agency (IEA), the U.S. Department of Energy's Energy Information Administration (EIA) and Bloomberg have been predicting 2015's cumulative installed capacity of wind and solar. We can now safely say they were all wrong.[9] While some are better than others at reading the crystal ball, all under-estimated the power of learning by doing. That is, today's market is supporting a greater demand for solar and wind than yesterday's experts could predict. And solar and wind are poised to increasingly dominate new investment in electricity generating capacity. Bloomberg New Energy Finance estimates renewable energy, including solar and wind, will capture two-thirds of new investments by 2030.[10]

Can we predict that these predictions will be surpassed with more solar and wind investment? Given what has been witnessed so far, the answer is likely a resounding yes.

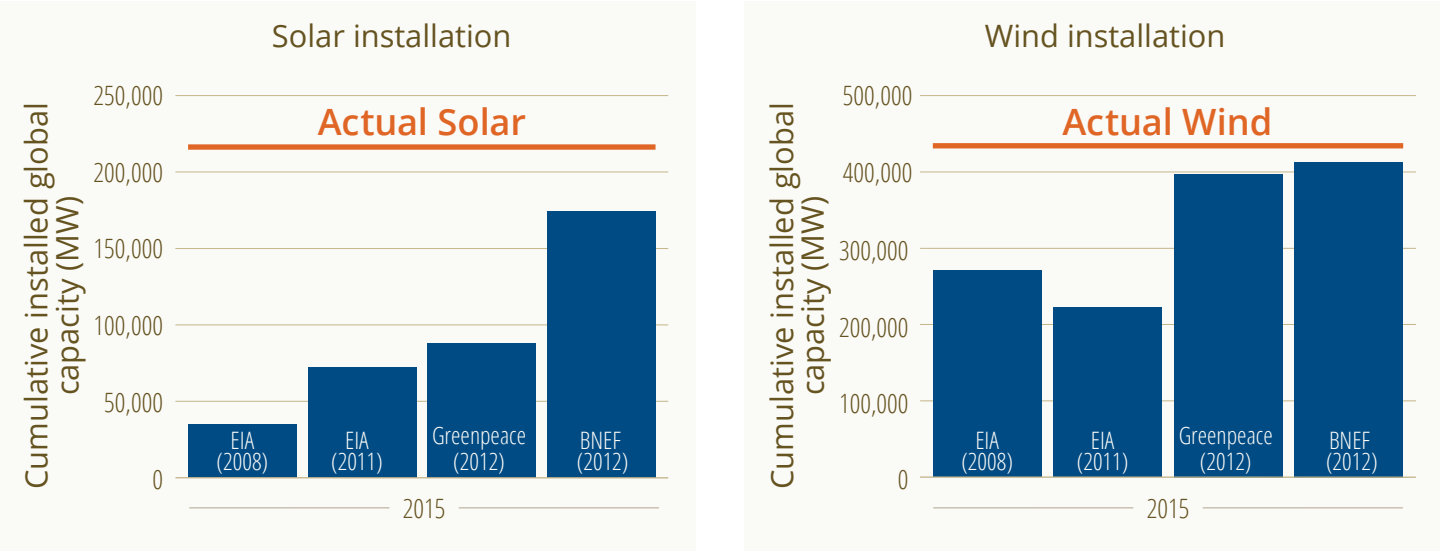

Figure 5: Global cumulative installed solar and wind as of 2015 compared to projections by Energy Information Administration (EIA), Greenpeace and Bloomberg New Energy Finance (BNEF).

Endnotes

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