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Increasing renewables on Alberta's power grid

by Sara Hastings-Simon | July 14, 2016

Summary

Since Alberta annouced its intention to increase the mix of renewables supplying the province's electricity needs, opponents have claimed that a range of false scenarios — from rising costs to unreliability — will prevail. This FAQ is meant to dispel such myths with hard facts about the impact of renewables.

Isn't wind and solar expensive?

No. Costs have fallen dramatically, with the cost of electricity produced from solar falling more than 90 per cent since 1983 and wind dropping 65 per cent over the same time.[1]

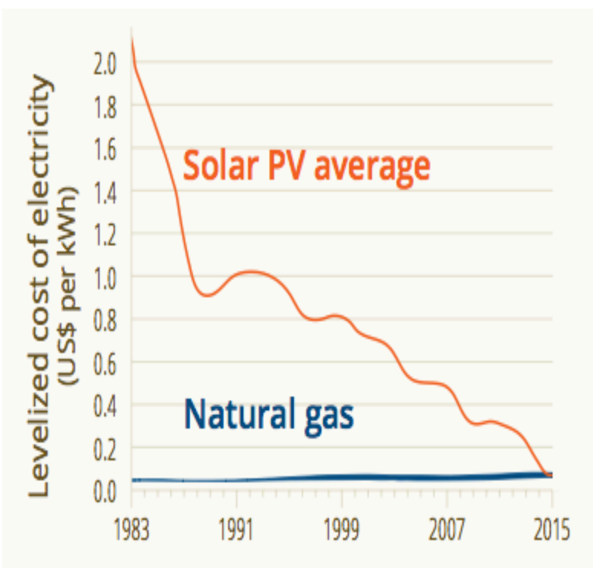


Figure 1: The range of costs from a natural gas combined cycle plant compared to those of solar photovoltaics. The decline in solar costs is expected to level off.

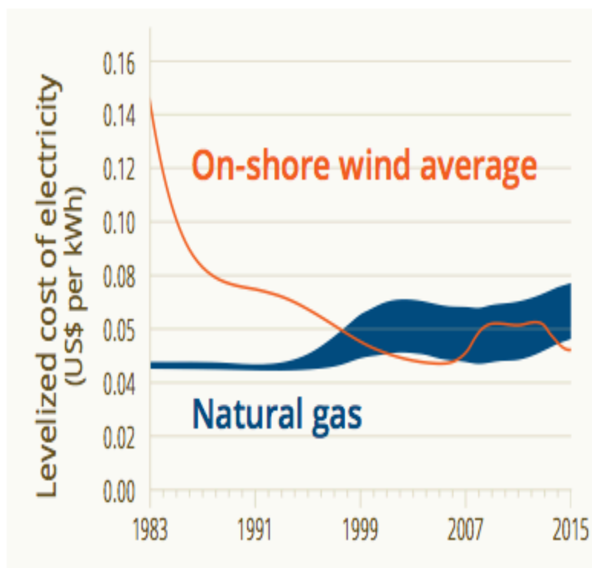


Figure 2: The range of costs from a natural gas combined cycle plant compared to those of on-shore wind. The decline in wind costs is expected to level off.

[1] Sara Hastings-Simon, Barend Dronkers, *The true price of wind and solar electricity generation* (Pembina Institute, 2016). http://www.pembina.org/pub/true-price-of-wind-and-solar

Compared to the next best alternative for new generation (combined cycle natural gas), wind is less expensive on a levelized cost of electricity comparison. This takes into account the capital expenses, fuel and operating expenses over the lifetime of a plant. Solar is also cost competitive in many markets. Moreover, electricity from natural gas generators is subject to fluctuating gas commodity prices that are at all time lows, but could rise in the future. The cost of the fuel is a significant driver of overall cost, whereas the "fuel" for solar and wind generation is free.

Why have costs gone down so much?

The main driver of cost reductions has been "learning by doing." Price declines for wind and solar projects have been driven by the massive increases in wind and solar installations around the world.[2] This phenomenon applies not just to clean technologies but all technologies.[3] It includes both "hard costs" of the technologies as well as the "soft costs" of local installation activities, such as financing.

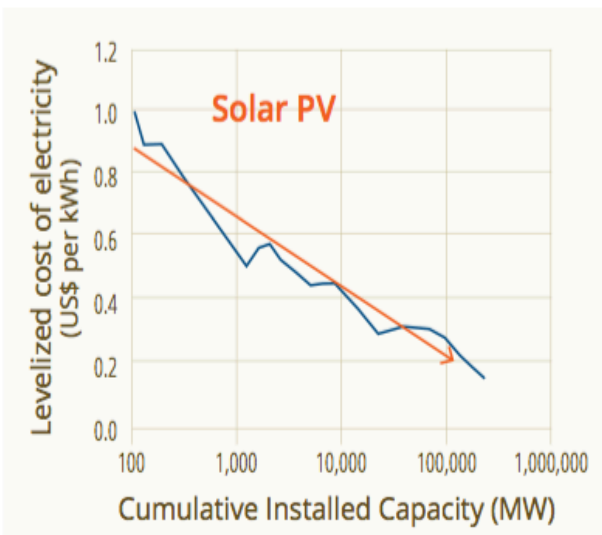


Figure 3: Solar PV costs have decreased as installed capacity has increased. The logarithmic trend line is close to linear and can be explained by the learning curve in manufacture of PV modules and by reduction of soft costs.

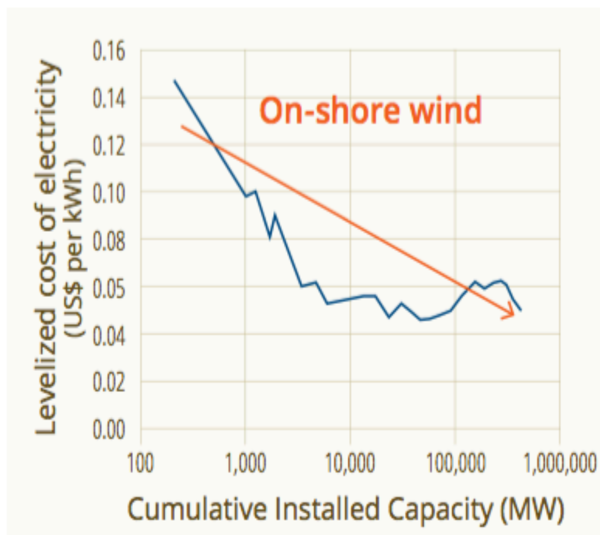


Figure 4: On-shore wind costs have decreased as installed capacity has increased. Cost increases at the end of the last century were from higher site costs and larger turbine designs, but the trend appears to be continuing downward.

[2] Gregory F. Nemet, *How Well Does Learning-by-doing Explain Cost Reductions in a Carbon-free Energy Technology?* (2006), 7. http:// ageconsearch.umn.edu/bitstream/12051/1/wp060143.pdf

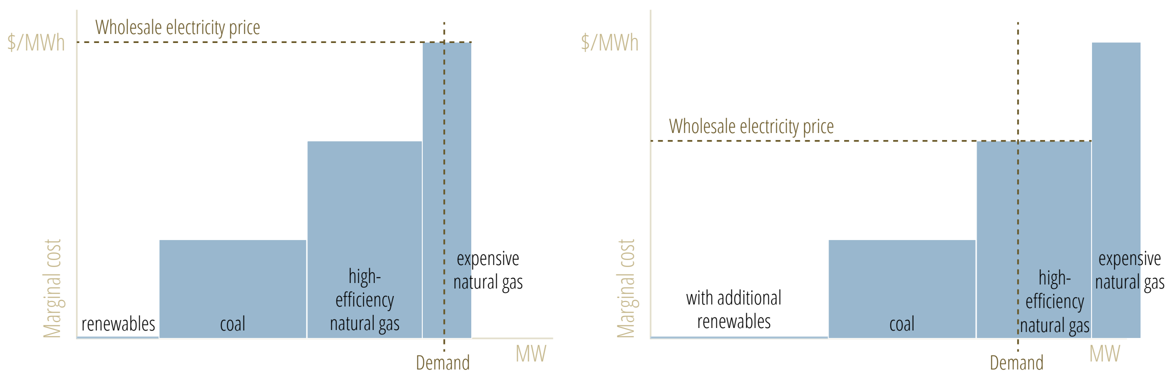
[3] Peter Thompson, "Learning by Doing," in Bronwyn Hall and Nathan Rosenberg (eds.) *Handbook of Economics of Technical Change* (2010), 3-6. Available at http://economics.u.edu/research/working-papers/2008/08-06/08-06.pdf; Lee Quarteman, *Learning & Experience Curves in Manufacturing* (Strategos Consulting, 2014). http://www.strategosinc.com/downloads/learning-curves-dl1.pdf; Boston Consulting Group, "The Experience Curve – Reviewed: Part II: History," *Perspectives* (1973). http://www. andreabiancalani.it/2.pdf

Won’t adding renewables to the grid make prices go up?

No. Since renewables are cost competitive with other new generation technologies, adding renewables to the grid as opposed to adding more natural gas can actually lower the pool price for power. In the deregulated market, the system operator dispatches calls for generation from the lowest bidders and works its way up to more expensive bidders until demand is met. The price is set by the cost of the marginal producer (the most expensive generator that gets dispatched) — everyone who is dispatched gets that price.

Because renewables have no fuel costs to produce energy, they bid close to $0/MWh. Additional renewables can fill more demand at this low price, meaning the price gets set by a lower-cost marginal producer (see figure below).

When additional renewables are added, prices will be set by lower-cost generation



What about the experience from other jurisdictions?

In the U.S., states that have increased the deployment of renewables have reduced their costs by as much as 10 per cent[4]. Many of these states have electricity markets and renewable energy programs similar to Alberta.

What about when the wind isn’t blowing and the sun isn’t shining? If you need backup, doesn’t that add to the cost?

The electricity system is a sophisticated grid network where all types of power generation work together to cover planned and unplanned outages of all generation types, along with unpredictable fluctuating demand, ensuring near-constant electricity supply. While the cost of energy for a given plant is easy to understand, the costs of changing generation mix and fuel

[4] A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standardshttp://www.nrel.gov/docs/fy16osti/65005.pd

prices to the system as a whole can only be understood by looking at the system as a whole. Our intuition breaks down for such a complex system and we must look at models that can capture these dynamics.

A recent study[5] looked at the incremental benefits and costs of non-dispatchable renewables, wind and solar, taking into account the need for reserves for an isolated electricity region with many similarities to Alberta. The results are quite striking. Going from 15 per cent renewables generation to 20 per cent reduces operating costs by $30.5/MWhr while the cost of the reserves is only $0.5/MWhr, for a net benefit of $30/MWhr. Results are similar for higher levels of renewables up to 35 per cent.

This result can feel counterintuitive but there are some facts that can help us understand how this can be true:

- Because no generation type, including fossil plants, can operate all of the time, there is already redundancy in any electricity grid, even one that has only fossil plants. The incremental additional generation required with more renewables is therefore not as large as one might imagine. And much of that generation may already be in the system with fossil plants that are currently operating below their maximum capacity, so even less new capacity needs to be built.
- Secondly, the operating cost dynamics are very different for fossil plants and renewables. In the case of renewables, the upfront cost for the plants are very high and the incremental cost of each MWhr of electricity produced is low. For fossil plants (particularly the most responsive plants) the situation is reversed: compared to renewables they are much less expensive to build, but cost much more to operate because of the fuel burned. Overall, it is more cost effective to have renewables provide all of the power they can and use the fossil plants to top that power up.

All generation types require some degree of system backup. Renewables do not need 100% additional backup, and the additional costs of renewables must be compared to the savings from reducing the amount of fuel needed.

In addition to using fossil generators as reserves, extra capacity can also be supplied by demand response and energy efficiency. Finally, as more renewables come online, increased interconnection and new developments in storage may also be able to provide backup.

Renewables also offer other advantages to the grid and consumers that fossil generators don't. Changes in wind or solar energy can be easier for grid operators to manage as they can be

[5] National Renewable Energy Laboratory, *Fundamental Drivers of the Cost and Price of Operating Reserves* (2013). http://energy.gov/eere/analysis/downloads/fundamental-drivers-cost-and-price-operating-reserves

predicted in advance quite accurately through weather forecasting.[6] Wind turbines are relatively simple machines and a wind facility continues to generate power even when a few turbines are offline for repairs, whereas fossil-fueled power plant outages happen without warning and typically involve fast, large reductions in power as a whole unit goes offline at once.

For some sources, individual generators are smaller and more geographically diverse, naturally providing a distributed network that is more robust against breakdowns. This also compensates for variability as weather varies across the grid. And some renewables can be turned on as demand requires. In addition, fine-tuned generation changes can be made very quickly with renewables like wind, whereas only specalized fossil generators have the ability to make the quick adjustments if needed.[7] Finally the zero-cost fuel provides a cushion against future commodity prices as a spike in commodity prices such as natural gas would translate directly into spiking electricity prices. Electricity from renewables will soften the blow of that increase.

What about the cost of transmission?

The Alberta Electric System Operator has repeatedly stated[8] that it is possible to integrate a significant amount of new renewables in the current system without the need for additional transmission line construction beyond what is already built, contracted or approved. This is due to the extensive transmission system build out that has taken place over the recent years to meet demands of fossil generation.

In future decades changes to the transmission system could be a net cost or net savings as the ability to build renewables close to where they are needed can reduce costs for the system. Other jurisdictions are realizing this benefit. New York is building new renewable generation along with investments in distributed generation, energy efficiency and demand response to deliver savings to the grid.[9]

[6] Silvio Marcacci, "Breakthrough Renewable Energy Forecasting Coming To US Grid By 2015," *Clean Technica*, May 10, 2013. http://cleantechnica.com/2013/05/10/breakthrough-renewable-energy-forecasting-coming-to-us-grid-by-2015/

[7] National Renewable Energy Laboratory, A*ctive Power Controls from Wind Power: Bridging the Gaps* (2014). http://www.nrel.gov/docs/fy14osti/60574.pdf

[8] Alberta Electric System Operator, "Renewable energy to play key role in Alberta's electricity future," media release, March 3, 2016. http://www.aeso.ca/downloads/Renewable_energy_to_play_key_role_in_Albertas_electricity_future.pdf

[9] William Opalka, "NY REV Order Revamps Utility Business Model," *RTO Insider,* May 23, 2016. http://www.rtoinsider.com/ny-rev-track-2-order-26813/

If it's so cheap, why do we need targeted policies to advance renewable energy deployment?

There are three main reasons to actively support renewables in the near term.

First, without support, investors in the wholesale electricity market will prefer natural gas over renewables as the risk of rising natural gas prices is hedged. If gas prices rise, the cost of generating power for a natural gas generator rises — but so does the price received, as gas is more and more the price setter in the wholesale market. If the price of gas falls, so does the cost of natural gas generation. In contrast, the renewable generators are price takers; they provide a hedge to consumers against rising gas prices, but do not benefit from an internal hedge that makes them attractive to investors. As a result, the renewables projects are not as attractive to investors, who may not be as well-versed in the potential for renewables that are newer to the province, such as solar. Without targeted policies to support renewable generation, the market's signals to investors to build natural gas will result in an over-reliance on natural gas prices, whose uncertain fuel cost trends are a risk to consumers, and a failure to secure the price-hedging benefits of renewables.

Secondly, learning by doing has decreased both the hard costs (e.g., equipment) and soft costs (e.g., installation, sales). While Alberta will benefit from the reduced hard costs, local markets will need some additional learning by doing for soft costs. Ramping up renewable installations in a controlled way will allow these soft costs to come down over the course of deployment, and ensure that Alberta gets renewables at the lowest price.

Finally, one of the key levers to reduce the cost of renewables is the cost of capital (financing). Because renewables have very low operating costs compared to fossil plants (the sun and wind are free and operations and maintenance are limited), the bulk of the costs for renewables is borne upfront. As a result, the projects are sensitive to the financing rate and cost of capital. Policies that reduce the cost of capital can make renewables even cheaper for Albertans[10].

But is solar really useful so far north in Alberta?

Alberta has an excellent solar resource, one of the best in Canada, and comparable to sunny regions south of the border. Alberta sees annual average solar radiation levels in places like Medicine Hat of 6.3 $kWh/m^2/day$ for a single axis tracking system. This is similar to the sunniest parts of the U.S. (e.g., Austin, Texas at 6.4), and more than other places in Canada (e.g., Toronto at 4.8).[11].

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[10] TransAlta Corporation, *Submission to Alberta's Climate Change Advisory Panel* (2015). http://www.transalta.com/about-us/coal-transition/transaltas-submission-alberta-climate-change-advisory-panel

[11] National Renewable Energy Laboratory, PV Watts calculator. http://pvwatts.nrel.gov

And as increased air conditioning use drives up the summer load in Alberta, solar power — which is more productive on sunny summer days — is increasingly a good match for the demands on the grid.[12]

[12] Benjamin Thibault, Sara Hastings-Simon, “Solar is right where and when you need it,” *Pembina Institute*, June 16, 2016. http://www.pembina.org/blog/solar-right-where-and-when-you-need-it