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Nevada's Renewable Energy Delusion

Norman Rogers

Executive Summary (450 words):

Nevada has a legal requirement that 50% of electricity must come from renewable sources by 2030. This requirement will be frozen into the constitution if voters approve Proposition 6 in November 2020. The new renewable electricity will come from solar energy. Because we are rapidly developing more solar energy than the electric grid can handle, these new solar energy plants will have to be equipped with expensive batteries to move daytime power to the early evening.

> With the Nevada economy on its knees due to Corona Virus do we have $17 billion to waste on a frivolous project that will accomplish nothing?

Without full federal subsidies, new solar power will cost approximately *9-times* more than electricity from clean natural gas, Nevada's traditional source of electricity. If full federal subsidies for solar are restored and supported, then the new solar electricity will cost *3-times* more.

New solar, with the expensive batteries, will cost about $130 per megawatt hour. If full federal solar subsidies are restored and supported, the cost of the solar electricity will be about $40 per megawatt hour. Generating the power in existing natural gas plants costs $15 per megawatt hour, the cost of the fuel.

Solar cannot displace natural gas. That's because solar does not work at night or on cloudy days. The batteries move power from midday to evening, but if it is cloudy the batteries can't charge during the day and have no energy to release in the evening. Peak demand is on July evenings when Las Vegas air conditioners are running flat out. The full fleet of natural gas plants are needed to meet this demand. Solar can't be counted on. The proper comparison is to compare the full cost of solar against the marginal cost (fuel) of natural gas. The only economic benefit of solar is to reduce fuel consumption in the natural gas plants.

Solar is not an effective method of reducing CO2 emissions to prevent climate change. The most prominent advocates of climate catastrophism know this and denounce the use of wind or solar to prevent climate change. They support CO2-free nuclear.

CO2 emissions in the U.S. have been declining for years. But in Asia the emission are much higher and increasing rapidly. Nevada's renewable mandate will have a completely negligible effect on CO2 emissions.

Solar has worn out is welcome in Washington. Subsidies are likely to end, and many subsidies are already scheduled to be phased out.

The renewable energy mandate will require the electricity consumers and taxpayers to pay for a $17-billion investment over the next 25 years. Huge increases in electric bill are a certainty. Long before the 25-year contracts expire the solar will be seen as obsolete and wasteful.

With the Nevada economy on its knees due to Corona Virus do we have $17 billion to waste on a frivolous project that will accomplish nothing?

Main Article (5500 words):

It's called clean energy or renewable energy. Mostly that means solar energy and wind energy. On a Sierra Club website[1] it is claimed that changing to 100% "clean energy" will provide fantastic benefits:

Healthier and safer.
Affordable, reliable, equitable and just, reflects the public interest rather than the interests of corporate polluters.
Will provide well-paying jobs in a thriving clean energy economy.

These claims concerning clean energy are a fantasy. Utilizing more than 20% wind and solar has formidable problems. 100% is simply impossible.[2] The site Activist Facts[3] describes the Sierra Club:

Once dedicated to conserving wilderness for future human enjoyment, the Sierra Club has become an anti-growth, anti-technology, anti-energy group that puts its utopian environmentalist vision before the well-being of humans.

Renewable energy – mostly solar and wind – is a big business with financial flows of billions of dollars per year. The Sierra Club is on the crackpot end of wind and solar advocacy. But corporate consulting firms such as *Bloomberg New Energy Finance*[4] and

Lazard Asset Management serve corporate developers of wind and solar and advocate for the supposed advantages of wind and solar via respectable seeming[5] analysis.

Wind and solar energy exist on a large scale only because federal and state law provide subsidies and mandates[6]. Without these subsidies and mandates wind and solar would be limited to niche applications such as heating swimming pools or providing electricity for off grid houses. Even though federal subsidies are large, they are not large enough to catalyze the renewable energy industry without state mandates.

The Nevada state mandate requires that 50% of the electricity sold in the state, by 2030, should be from renewable sources. The same mandate will be frozen into the state constitution if Proposition 6 is approved by the voters in November 2020. A press release from the governor's office on April 22, 2019 said the following:

On Earth Day, Governor Steve Sisolak signed Senate Bill 358 into law, committing Nevada to raising its renewable portfolio standard (RPS) to 50% by 2030 and fulfilling a pledge he made in his State of the State address. Senate Bill 358 is sponsored by Sen. Chris Brooks (SD-03) and passed with unanimous bipartisan support out of both chambers of the Nevada Legislature.

*"Renewable energy is a major cornerstone of my economic development plan, and this bill will put Nevada back on the path toward renewable energy leadership on a nationwide level and continue to bring well-paying jobs to our communities," **Governor Sisolak said.** "Today, Nevada sent a message to the country and world that the Silver State is open for business as a renewable leader, and our commitment to growing our clean energy economy transcends party lines."*

In his state of the state address the governor said:

...I strongly support the goal of achieving a minimum of 50% in renewable energy by 2030. And I know we can meet these standards without raising the cost of electricity for the ratepayers of our state.

This claim is bizarre given that renewable energy costs around *9-times* more than traditional energy from natural gas. Even with full federal subsidies, it is around *3-times* more expensive.

This is not a partisan problem. The governor is a Democrat. All the Republicans in the legislature joined their Democrat colleagues and voted for SB358. Both sides seem eager to waste money on pointless renewable energy.

I think that most of the citizens of Nevada are suffering from the same delusions as the Governor and the legislators. Relentless propaganda from the industry abetted by lack of independent analysis by the media have convinced most Nevadans that renewable energy is some sort of Nirvana. There are good sources of technical information on renewable energy, such as the National Renewable Energy Laboratory, the Lawrence Berkeley Lab and the Institute for Energy Research. On the other hand, there are dozens of organizations cheer leading renewable energy and a supposed transition to a green economy. These cheer leaders are convinced that they are leading a righteous movement, but they notably lack an acquaintance with the facts.[7]

Why did the legislature unanimously adopt SB358? I suspect that ignorance of the true facts is the primary reason, but campaign contributions from the solar industry may also have been a factor. The renewable energy plants that will be built during the next 10-years will be mostly solar. The "well-paying jobs" come from mortgaging the future to build these gigantic projects. After construction is complete there is very little employment associated with solar. The only message that Nevada will be sending to the country is that Nevada is happy to burden its residents, and federal taxpayers, with electricity that costs 9-times more than traditional fossil fuel electricity.

Nevada is sunshine rich. The wind resource is poor, and in the past political opposition to wind has been strong. Most new renewable energy will be solar energy. A third source of renewable energy is geothermal energy that exploits underground heat of volcanic origin. Nevada has significant geothermal resources, but due to the need to discover and evaluate resources, high cost, and environmental red tape, it is doubtful that geothermal energy can be a significant contributor to meeting the 2030 goal. Some federal subsidies for geothermal energy are being phased out.

The analysis given here is simplified in the following ways. I assume that the 50% mandate will be met by building new solar installations equipped with auxiliary batteries. Auxiliary batteries make solar electricity much more expensive and become necessary as the percentage of solar energy on the electrical grid passes a threshold.[8] I assume there are no federal subsidies. Although some federal subsidies are scheduled to be phased out, there are other subsidies that have not yet been reduced, such as special tax depreciation rules that enable diverting money from the U.S. treasury into the pockets of solar developers. The solar industry has worn out its welcome in Washington. The Congress refused to halt the phase out of subsidies in the most recent session, in spite of requests from industry lobbyists. Some readers may think that federal subsidies for exorbitantly priced renewable electricity excuse the state of Nevada from responsibility for wasting billions of taxpayer and ratepayer dollars. I disagree.

Nevada public policy, as it now stands, will result in adding a vast amount of solar electricity. By 2030 new solar installations will have to provide about 15 million[9] megawatt hours of electricity per year. The construction cost of these installations will be approximately $17 billion.[10] This amount is greater than the total annual state and local spending in Nevada. The people of Nevada, through their electric bills, and their federal taxes, will indirectly undertake the financing of this $17 billion.

The solar installations will be built by private developers with invested and borrowed money guaranteed by 25-year electricity purchase agreements with NV Energy, Nevada's electric utility. This solar financing paradigm is well established in Nevada. Although NV Energy can go bankrupt, it cannot go out of business. The state government has to do whatever it takes to keep the lights on. NV Energy is about to undertake the financing of $17 billion worth of solar energy installations by promising to purchase the electricity generated by these installations for 25 years. By 2030, assuming no federal subsidies, the annual payment for solar electricity will be about $2 billion, or about $1500 annually[11] per Nevada household. If we were to just continue with natural gas to handle expected 1.5% per year population growth, the annual additional cost in 2030 would be about $200 million, or about 10 times less than the cost increase under the renewable energy mandate. That annual cost could be covered by the normal electric bills of the new households.

Why does NV Energy enter into 25-year long contracts for solar energy? Why not 10-years or 5-years? This goes back to the renewable energy mandate. NV Energy is required to find sources of renewable energy and pay whatever it takes. Solar developers are not going to invest and borrow billions unless their risk is small. Having a guaranteed market for overpriced electricity for 25-years seems to be the sweet spot. Another advantage is that it postpones any reckoning into the future.

The nature and cost of solar energy is obfuscated by industry propaganda. It is often claimed that solar energy is close to "grid parity." By this it is meant that solar energy will soon be less expensive than traditional natural gas energy. Conveniently, the industry press agents don't mention the federal subsidies that pay for most of the cost of solar energy. They don't mention that solar energy cannot replace Nevada's natural gas generating plants because solar output depends on the time of day and the weather. Solar, unless supplemented by expensive batteries, does not provide electricity after the sun sets on peak demand Las Vegas July evenings, when every air conditioner is running full blast. Even when batteries are present, battery-backed solar can't provide evening electricity if the sky is cloudy during the day and the batteries are flat by the evening.

The solar industry often makes the claim that the cost of solar is declining rapidly and that if subsidies are continued the industry will soon be strong enough to survive on its own. The National Renewable Energy Laboratory projects that the real cost of solar plants will decline by 20% during the next 10 years[12]. That estimate does not take into account the shift to battery assisted solar that dramatically increases plant cost. Conversely, the cost and efficiency of natural gas generating plants has improved in past years and that trend may continue in the future.

The price of natural gas, thanks to fracking, has declined precipitously. In 2008 the cost per million Btu peaked at nearly $15.59. Now it is less than $2. Not long ago the U.S. was importing natural gas from Canada. Now we export natural gas to the world. Natural gas is a fuel known for burning clean. It creates little air pollution. One reason Nevada electric rates have held steady is that the declining price of natural gas has masked the increasing waste of money on renewable energy.

The most important characteristic of the electric grid is reliability, not cost. The reason is that a blackout costs the economy millions every hour. Prevention of blackouts always has to be the first priority. If your house is on fire you don't care how much fire extinguishers cost. In order to avoid blackouts, grid operators strive to have extra generating capacity available for stressful situations. A generating plant may fail within seconds if something breaks. Online "spinning reserve" is expected to take up the slack in seconds. Most solar installations, including residential rooftop solar installations, cannot operate independently if there is a grid blackout.

Btu stands for British Thermal Unit, a measure of heat energy. A megawatt hour (Mwh)is a million watts of electricity delivered for one hour. This is a standard measure of the quantity of electricity. Residential bills usually charge by the kilowatt hour (Kwh), a unit 1000 times smaller.

Solar energy is not reliable. In grid jargon it is not "dispatchable." It doesn't work at night and it doesn't work if it is cloudy. For that reason, solar electricity generating plants cannot be substituted for the reliable natural gas generating plants that are the core of Nevada's electric grid. The only economic benefit of solar energy is to reduce fuel consumption in the natural gas plants when the natural gas plants are throttled back while the solar plants are pumping electricity into the grid.

The unreliable nature of solar is a crippling fault. Because it always has to be backed up by reliable fossil fuel plants its economic value is only the cost of the fuel saved in the Nevada natural gas plants.

If we analyze the cost per megawatt hour of electricity from a solar generating plant, the cost is almost entirely based on the initial capital cost amortized over the life of the plant along with smaller incidental costs. For a natural gas plant, the cost is a combination of the capital cost, the cost of fuel and additional incidental costs.

The annual capital cost, assuming a 25-year plant life, is the same as the payment on a 25-year 100% mortgage. The size of the payment depends on the interest rate and the initial cost. For a solar plant, using a recent Nevada plant[13] as a benchmark, the cost of the electricity is about $130 per megawatt hour. For a natural gas plant, the cost of electricity is about $41 per megawatt hour.[14] Included is the cost of the fuel at $15 per megawatt hour. It is assumed that the natural gas plants have 50% utilization or *capacity factor*, near the national average.

No matter how much solar is added, the full portfolio of natural gas plants able to fully serve the electric grid must be retained. That is because solar is absent at night or when it is cloudy. As a consequence, the alternative always exists to generate needed power in a gas plant for the cost of the fuel, $15 per megawatt hour. Solar is not competitive unless it costs less than $15 per megawatt hour. New, unsubsidized, solar electricity actually costs $130.

The cost of unsubsidized solar electricity is about 3 times as much as for natural gas electricity per megawatt hour, $130 for solar compared to $41 for gas. But this is the wrong comparison. The correct comparison is to compare the cost of the solar electricity to the marginal cost of the natural gas electricity – the cost of the fuel or $15. *This is the most important often ignored fact when comparing solar to natural gas*.

Introducing solar power cannot replace any natural gas plants. There must be sufficient natural gas plants to carry the full load and provide a safety margin, because solar does not work at night or on cloudy days. Even after all the solar is added to the grid, all the natural gas plants are still there. For the natural gas plants, capital cost and other costs independent of fuel continue. The economic contribution of solar is $15 per megawatt hour,[15] the value of the fuel saved for each megawatt hour of solar electricity produced. So, $130 solar electricity costs 9 times as much as using the existing natural gas plants to generate electricity for $15 per megawatt hour. If there is substantial solar electricity the utilization of the gas plants declines, resulting in increased capital cost per megawatt hour of gas electricity. Not only is the solar electricity wildly expensive, but it makes the gas electricity still generated more expensive too.

Many of the solar electricity power purchase agreements executed in the past by NV Energy are for a cost per megawatt hour higher than $100. In 2018 NV Energy purchased $15 million worth of electricity from Nevada Solar One at $197.79 per megawatt hour. It

purchased $16 million worth from Silver State Solar at $139.54. It purchased $108 million worth from 13 solar projects at an average of $88.84 per megawatt hour. These plants, built in previous years, benefited from subsidies. In each case the same electricity could have been generated in existing natural gas plants for $15 per megawatt hour.

Out of necessity, most new solar plants will have to have expensive batteries. Solar electricity peaks in the middle of the day and drops rapidly as the sun falls lower in the sky. But peak electric demand takes place in the late afternoon and early evening due to peaking temperatures and a heavy air conditioning load. The batteries store solar power in the middle of the day and release the stored electricity when peak demand occurs later in the day. Without the batteries there would be more solar electricity than the grid can accept in the middle of the day, requiring the solar electricity to be curtailed and wasted. The need for batteries starts when solar is more than about 20% of the total megawatt hours of electricity. Because the batteries are very expensive and have to be replaced about every 5-years, electricity from a solar plant with auxiliary batteries costs approximately $130 per megawatt hour. This assumes that the batteries store 3/8th the daily output and release that energy over a 4-hour period in the late afternoon or early evening. Solar energy under these conditions will cost about 9-times more than generating the same electricity in existing natural gas plants. The batteries do not reduce the need for backup natural gas plants. One cloudy day and the battery will be flat when the sun sets. It is not feasible to have batteries large enough to eliminate the need for backup natural gas plants. The cost would be astronomical.

NV Energy is planning to contract with private developers for electricity from three new solar plants with battery storage: Moapa, Southern Bighorn and Gemini. Together these plants will supply approximately 2.5 million megawatt hours annually. Presumably construction will start soon enough to avoid the currently scheduled phase out of certain federal subsidies. If it weren't for the federal subsidies and the state renewable energy mandate, the electricity would cost about $130 per megawatt hour. Due to the subsidies the purchase contracts average about $40 per megawatt hour, still about three times as much as it would cost to generate the electricity in existing natural gas plants.

The proposed Gemini plant, north of Las Vegas, will have a huge lithium ion battery capable of storing 1400 megawatt hours of electricity. The battery and support equipment will cost about $500 million. About every 5-years the battery wears out and must be replaced at a cost of about $300 million. There have been many fires involving large lithium battery installations. The Gemini battery stores as much energy as 5-million sticks of dynamite. Although an explosion is not expected, a very big fire is a possibility. The battery must be air conditioned to prevent damage from high desert temperatures.

The recent history of solar power does not create confidence. The Crescent Dunes project in central Nevada, built with huge government subsidies is now in default because it could never be made to work reliably. The Ivanpah project in California, near the Nevada border, could not be made to work according to expectations. The developers asked for and received an increase in the price of the electricity beyond the contract value of about $150 per megawatt hour. Although these installations are thermal solar, a less successful technology, the squandering of billions shows a lack critical analysis.

For any of these projects the developer can be in a strong bargaining position if he decides to ask for more money. If the developer is losing money his obvious solution may be to declare bankruptcy of the shell company that owns the plant, rather than to keep making up the losses. With the right legal structure, the developer may have already taken out much of his profit. It his situation NV Energy and the Public Utility Commission will pay more to prevent losing the renewable energy credits that they are mandated by law to have.

Rooftop Solar

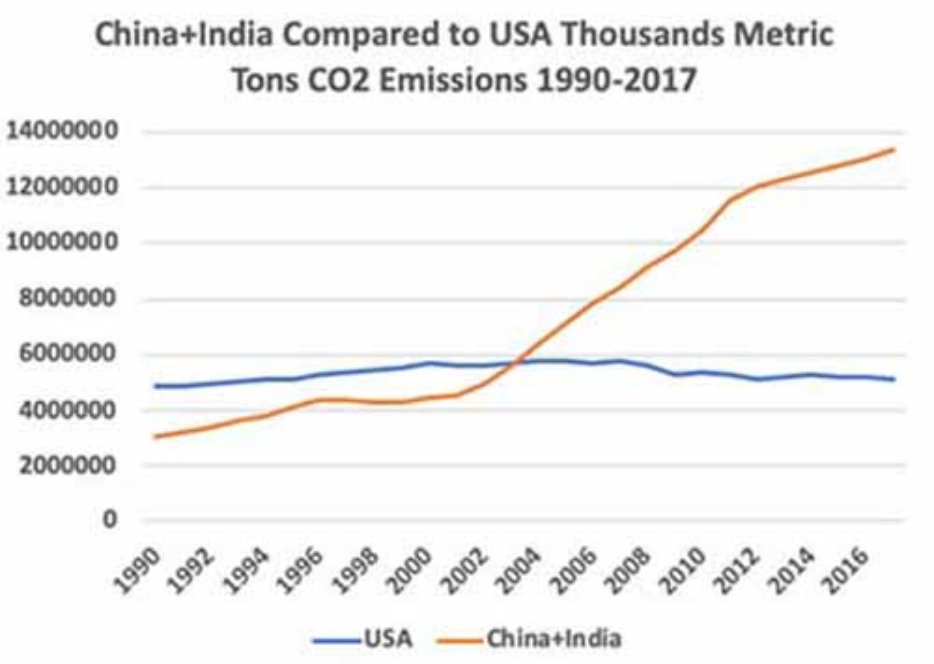
Rooftop solar is promoted by an industry that has sprung up to place solar panels on house roofs and substitute solar power for power from NV Energy. The home solar industry discovered a structural loophole in the way homeowners pay for electricity. By exploiting the loophole and even lobbying for changes that made the loophole bigger, a large number of homeowners became convinced that they had discovered a cheaper source of electricity. The loophole is actually a scheme to make everyone else pay for the electricity of the home solar users. Further, home solar is subsidized by the federal government until 2022.

Because Nevada electricity is still cheap, especially compared to California, it is doubtful that the home solar is a good investment for the homeowner. The cost to NV Energy of a home connection before any electricity is sold is around $100 per month for power lines and generating capacity, but the monthly fixed service charge is only $12.50. Every kilowatt hour of sales lost to home solar cost the company more than 9-cents in gross profit. Home solar installations, lacking scale, cost around 3 times more per kilowatt hour generated compared to utility scale solar without batteries. A scheme called net metering allows excess home solar electricity fed back to the grid to be “banked” for later use. But the banking is a fiction because there is no way to store the electricity. It is used immediately by other customers. Every banked kilowatt hour costs the company another 9 cents.

The Global Warming Argument

Even if one uncritically accepts the most extreme claims of the advocates of a looming climate disaster driven by CO2 emissions, it is very clear that the solution does not lie in solar electricity. The technically qualified believers in the climate catastrophe agree that solar and wind are not a solution. James Hansen, the government scientist that is virtually the father of global warming catastrophism calls intermittent sources of electricity (wind and solar) a "fantasy" and a "grotesque idea." He advocates nuclear energy as the only practical method of reducing CO2 emissions. Other climate scientists and other promoters of global warming catastrophism such as Michael Shellenberger and Stewart Brand agree. The reasons are obvious to anyone who looks into the details. Getting an electrical grid to 20% solar energy is expensive, going to 50% is much more expensive because batteries must be used to avoid excessive midday solar. Getting to 100% is impossible in any practical way. The cost of reducing natural gas CO2 emissions by one metric ton by using solar is about $140. There are much cheaper ways. Nuclear is one and nuclear is practical and proven. Nuclear is CO2-free. Nuclear has a great potential future[16] but has been handicapped by hysterical opposition[17] from the likes of the Sierra Club.

U.S. emissions of CO2 have been declining while emissions from Asia are skyrocketing.



U.S. emissions are declining due to energy conservation and the substitution of natural gas for coal. Only about 10% of U.S. emissions come from burning natural gas to make electricity. Natural gas is a carbon light fuel. Natural gas emits about half the CO2 of coal

when burned and for technical reasons natural gas generating plants are 50% more efficient than coal in converting the heat energy to electricity. This results in about 1/3 the emissions for natural gas over coal. Conversion from coal to natural gas is taking place primarily for plant cost reasons and because the Sierra Club is running a political campaign against coal. (They also hate natural gas.) This is a risky path because coal is more resilient than natural gas. A coal plant may have pile of coal on hand to last a month or more. Some natural gas plants can run on oil in local tanks, but the supply is usually limited. Most Las Vegas natural gas for generation is dependent on the Kern River Pipeline bringing gas from Wyoming. Given that Nevada is only 1% of the U.S. population, converting half the natural gas burn to solar would reduce U.S. emissions by a small fraction of 1%.

Increased CO2[18] in the atmosphere promotes plant growth with less water, greening the Earth and supporting agriculture. On rarely hears about this amid the climate worries.

Conclusion and Comments

I don't think we should put too much blame on Nevada's politicians. Politicians are responsive to pressure groups and the people in general. If the people or well-organized pressure groups demand a bad policy, the politicians will give it to them. We see this in many states when public employee unions demand and get pensions that will bankrupt the same state 30 years later.

Nevada has a Governor's Office of Energy. The mission is defined as:

…to ensure the wise development of Nevada's energy resources in harmony with local economic needs and to position Nevada to lead the nation in renewable energy production, energy conservation, the exportation of energy and transportation electrification.

The contradiction is between "wise development" followed by several unwise missions. Even if the experts in the energy office realize the problem, the politicians, not the experts make the policy.

Nevada has competent newspapers such as the Las Vegas Review-Journal, the Reno Gazette and the Nevada Independent. There are many other small newspapers. There are major television channels too. These media have not been sufficiently critical of renewable energy mandates.

The Review-Journal editorialized against the 50% renewable energy constitutional amendment when it first appeared on the ballot in 2018:

Proponents claim that failing green energy prices mean this initiative will save consumers money. If that's true, a law won't be necessary to force utilities to increase purchases of renewables. And what happens when the green subsidies dry up?

They get it that something is wrong if you mandate green energy, but they don't seem to realize just how expensive green energy is. The constitutional amendment mandate passed in the 2018 election with 59% of the vote. It has to appear in two consecutive elections to become a part of the constitution. It will appear again in 2020. Having the mandate in the constitution will only complicate extracting ourselves from the green energy nightmare. Essentially the constitutional amendment ensures that solar companies will have an iron rice bowl.

The economic analysis of renewable energy is complex and easily abused. The people who are most aware of the true costs are the members of the renewable energy industry, but they don't publish this information, for competitive reasons. It is very difficult to know what interest rate, or rate of return, to use in estimating the unsubsidized cost of solar energy. A big problem is that there isn't any unsubsidized utility scale solar energy. It isn't economic without subsidy. Neither is it economic with current subsidies. But it is being built because it is mandated.

The price of natural gas is volatile.[19] In Feb 2016 the Henry Hub price was $1.77 per million Btu. In November 2018 it hit $4.73. Then in March 2020 it hit $1.79. In June 2008 it hit $15.59. The all-time high seems to have been $19.31 in September 2005. This affects estimates of costs in previous articles I've written. Another factor affecting previous numbers is interest rate assumptions.

Other countries further down the renewable energy path than the U.S. have experienced severe problems. See this article: https://www.forbes.com/sites/michaelshellenberger/2019/09/05/renewables-threaten-german-economy-energy-supply-mckinsey-warns-in-new-report/#756f892d8e48

A movement inspired by academic theorizing calls for a reorganization of the electric utility industry. This is called deregulated markets by the advocates and organized markets by those who realize that more, not less, regulation is created. The idea is to make the generating plants independent of the utility, reducing the utility to a distributor of electricity. The theory is that periodic auctions would be held to determine which plants supply electricity at what price. Supposedly this will result in less costly electricity. A number of states and regions have adopted this scheme to varying degrees. Proposition 3 on the 2018 ballot would have introduced this scheme in Nevada. This was opposed and defeated by NV Energy to the tune of $63 million in political advertising, a huge amount in the small state of Nevada. The problem is that the market in electricity is not

like other markets because supply and demand have to match minute by minute. All kind of problems were encountered in places where this was implemented, including manipulation of the markets (Enron) and sky-high prices (California). In response a blizzard of regulation had to be added to make the scheme work. It also misses the fundamental point that reliability of supply is the first priority for electricity, not price. Support for the deregulated market model comes from those who can benefit. The traditional model of the regulated utility, for whatever the faults, is much better than the so-called deregulated model.

Finally, obviously, we should stop developing almost all renewable energy. There is no point to it.

Norman Rogers is the author of the book: Dumb Energy: A Critique of Wind and Solar Energy (Amazon). A retired physicist, engineer and businessman, he lives in Las Vegas.

Notes

[1] https://www.sierraclub.org/virginia/100-virginia

[2] Getting to 100% is possible if renewable energy credits are used. This is a bookkeeping scheme where a generator of renewable energy can sell the renewable attribute without actually supplying any electricity to the political division or company reaching for 100% renewable energy. It is a scheme to convert fossil fuel energy to renewable energy by an accounting trick.

[3] https://www.activistfacts.com/organizations/194-sierra-club/

[4] BNEF outlook is here: https://about.bnef.com/new-energy-outlook/ There are absurd claims such as wind and solar being cheapest and touting rooftop solar.

[5] My article on Deloitte and Lazard- https://www.americanthinker.com/articles/2019/11/green_energy_studies_consulting_or_advertising.html

[6] The federal ITC subsidy is a 30% subsidy scheduled to decline to 10% by 2022 and to zero percent for residential rooftop solar. An additional federal subsidy is rooted in complicated tax rules and special depreciation rules for renewable energy plants. This can be a substantial subsidy. The state mandates result in 25-year power purchase agreements the consequence being lower interest rates and lower rate of return required by the developer. It is difficult to nail down the subsidy since there generally isn't any free market renewable energy to compare the subsidized energy to. Roughly the full federal and state subsidy is 75%.

[7] The renewable energy cheer leading organizations are numerous, and most seem to have little awareness of the economic and technical issues. The Solutions Project:
https://thesolutionsproject.org
is committing 100% of its resources to elevate feminine leadership and frontline leaders of color to make 100% renewable energy a reality for everyone. One of the cofounders is Mark Z. Jacobson, is a Stanford professor who sued a critic of his 100% renewable energy by 2050 plan for $10 million:
https://www.latimes.com/business/hiltzik/la-fi-hiltzik-jacobson-lawsuit-20180223-story.html
Many of the non-profits like ACORE and SEIA are trade organizations that lobby for the industry.

[8] Solar energy cannot exceed the threshold for grid stability reasons. See for example this:
http://large.stanford.edu/courses/2015/ph240/burnett2/
Adding batteries can absorb midday overgeneration and discharge the energy at peak times in the evening or late afternoon.

[9] Current Nevada electricity consumption 40-million megawatt hours per year, 8 of which is renewable. Assuming 1.5% population growth for next 10-years, by 2030 demand will be 46 million Mwh. New renewable must be 50% of 46 or 23 million. 23-8=15 million Mwh per year needed.

[10] A spreadsheet with these calculations can be downloaded at: Download Spreadsheet
Or use: https://www.nevadasolarscam.com/uploads/6/0/1/0/60100361/cost_of_solar.xlsx

[11] The annual cost is 15 million megawatt hours of new solar times $130 per megawatt hour or about $2 billion. The population of Nevada in 2030 will be about 3.5 million and the average household size is 2.5 persons.

[12] At https://atb.nrel.gov/electricity/data.html (Annual Technology Baseline 2019)
Download the ATB spreadsheet (the mac friendly version did not work for me) Select Solar – Utility PV. Click on future projections. I took the Daggett, Ca mid projection. Capex 2020 $1076 and 2030 $862. 862/1076 = 0.80 or 20% decline.

[13] My specifications for a prototype solar installation is based on the proposed Gemini project but with 1.5 times the storage per megawatt that the Gemini project has. This allows 3/8th of the megawatt hours to be time shifted to the evening, rather than one forth in the Gemini project. That project uses single axis tracking and bifacial panels. The battery has a 4-hour discharge and a capacity in Mwh half the nameplate Mw. Berkeley lab gives a median capital cost of $1.62 per AC watt exclusive of storage.
https://emp.lbl.gov/sites/default/files/lbnl_utility_scale_solar_2019_edition_final.pdf
page 21. I increase this to $2 to allow for developer profit and union labor requirements. The solar array is amortized over 25 years.

According to NREL the cost of a 4-hour battery system
https://www.nrel.gov/docs/fy19osti/71714.pdf
Figure ES-1.

is $209 per Kwh for the battery and $171 per Kwh for the battery support. I amortize the battery for 5 years on the assumption it is replaced every 5 years and the support equipment over 25 years. I take maintenance as $10 per megawatt hour from the Berkeley document. Replacing the battery every 5 years assumes wear out after about 1800 cycles. The battery could probably run longer with reduced performance.

I use an interest rate of 6%. The end result is a cost of $130 per megawatt hour. Without the battery it would be $56.

A spreadsheet with these calculations can be downloaded at: Download Spreadsheet
Or use: https://www.nevadasolarscam.com/uploads/6/0/1/0/60100361/cost_of_solar.xlsx

Note: This is not an exact calculation. The cost can vary, and future costs are somewhat unpredictable. These numbers are based on projects completed in 2018. My interest rate of 6% is a compromise. Since there is no real market for unsubsidized solar one can't define an unsubsidized interest rate. Interest rates or rate of returns may be somewhat less in current projects but that is because the mandate and 25-year purchase agreements are an interest rate subsidy.

[14] The cost of a combined cycle natural gas plant is approximately $1000 per kilowatt of capacity. The cost of gas is approximately $15 per megawatt hour. The typical capacity factor or duty cycle is approximately 50%. A 500-megawatt plant will cost $500 million. The annual capital cost based on 25 years and 6% interest rates is $39 million. The annual generation is 500*.5*8760=2,190,000 megawatt hours. The cost per megawatt hour is $17 capital cost plus $15 fuel cost with an additional $3 per megawatt hour for operation and maintenance and 20% for developer profit and other costs. This comes to $41 per megawatt hour.

[15] The cost of natural gas with a million Btu of energy content is about $2.00. A million Btu is 293 Kwh. A modern combined cycle plant runs 60% efficient, so generates 293*.6=176 Kwh. To generate 1 megawatt hour will require 5.68 million Btu costing 5.68*2=$11.36. I have heard that NV Energy uses $15 as the cost, so that is the cost I use.

[16] See the article: The Energy Solution That Should Make Everyone Happy – The great potential future of nuclear electricity:
https://www.americanthinker.com/articles/2019/06/the_energy_solution_that_should_make_everyone_happy.html

[17] An example of how anti-nuke hysteria killed nuclear power in the U.S.:

Millstone 1 Nuclear Power Plant
660 megawatts Cost $101 million 1966

Shoreham Nuclear Power Plant
820 megawatts cost $6 billion 1973

Millstone 1, near New London, CT was constructed in 5 years and operated from 1970 to 1998. Two other reactors, units 2 and 3 are still operating on the site.

The Shoreham plant on Long Island, NY was under construction for 11 years. In June, 1979 thousands of protestors gathered at the plant and 500 were arrested. The plant was finally scrapped In 1989 and never generated electricity.

Nuclear Cost Escalation

[18] The CO2 Coalition has a website explaining the benefits of increased atmospheric CO2: http://www.co2coalition.org

[19] A chart showing historical natural gas prices: https://www.macrotrends.net/2478/natural-gas-prices-historical-chart