Institute for Energy Economics and Financial Analysis

Hydrogen as Economic Development: Benefits and Challenges

Presentation to the Third Meeting of the Economic Development and Policy Commission of the New Mexico Legislature

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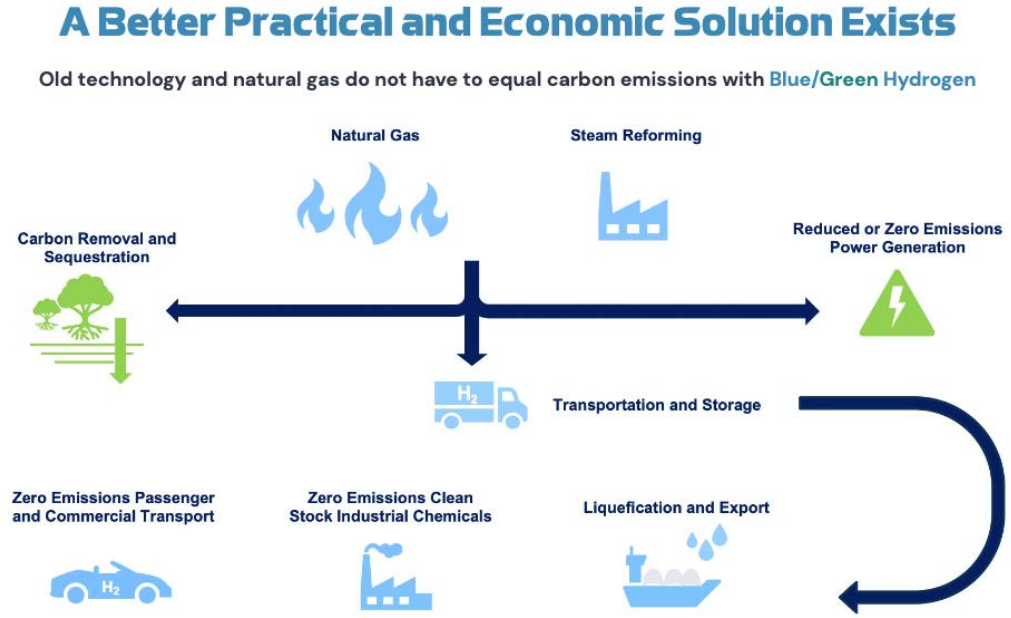
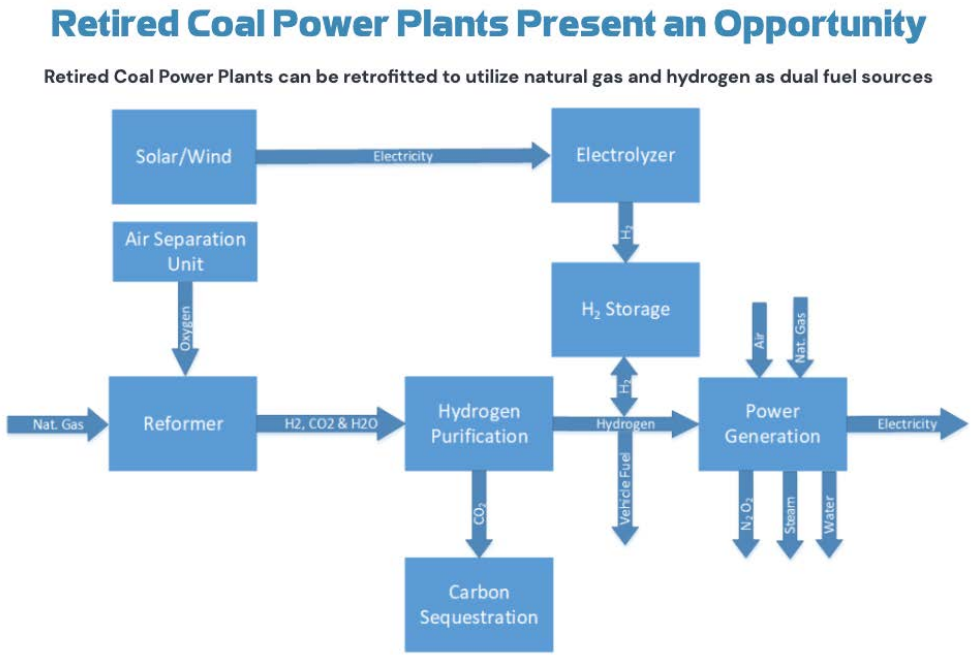
My Background

- I have engineering degrees from the Massachusetts Institute of Technology (MIT) and Stanford University, as well as a law degree from Stanford Law School. I also have studied nuclear engineering and project management in non-degree courses at MIT.
- I have worked on engineering and financial issues related to energy for over 48 years. I have presented testimony as an expert witness in proceedings before regulatory commissions in more than 35 states, including New Mexico, and federal agencies.
- My clients have included state utility commissions and other government agencies, including the New Mexico Public Regulation Commission, power plant owners, and local and national consumer and environmental organizations.
- My work has focused mainly on power plant construction and operating costs and performance and resource planning issues.

Has Escalante H2Power Offered Any Evidence to the Legislature or on its Website to Show that its Proposed Project is Technically Feasible and Financially Viable?

- No. All I've seen on the company's website and in its presentation to the Legislature is some marketing narrative, a few pictures and several numberless figures, such as those below. But not any economic, financial or engineering analyses.





Why is it Necessary for Escalante H2Power to Provide that Kind of Evidence?

- Any spending to support a proposed project is likely to lead to some level of economic development, such as jobs, income, and tax revenues, in the area where the project would be built.
- However, that does not guarantee that the economic development will be sustained unless the proposed project is technically feasible and financially viable.
- Moreover, it is certainly possible that different projects can lead to the same or even greater economic development at a similar or lower cost.
- Any party seeking funding should be required to demonstrate that its proposed project, in fact, will provide substantial levels of sustained economic develop at a lower cost than other available alternatives. Marketing claims should not be enough.
- Another key question that needs to be answered is whether a proposed project will draw resources (such as water) away from other beneficial uses.

The Proposed Escalante Project Faces Significant Technical Challenges

- The reuse of retired power plant sites does have benefits, such as providing transmission access to the electric grid. However, even with such benefits the proposed Escalante project still faces important technical challenges.
  1. The proposed use of hydrogen as a fuel.
  2. The proposed use of carbon capture technology.
  3. The uncertainty of how well a re-purposed Escalante will operate as it ages and what its future operating costs and necessary capital expenditures will be.

The Proposed Escalante Project Faces Significant Market and Economic Challenges

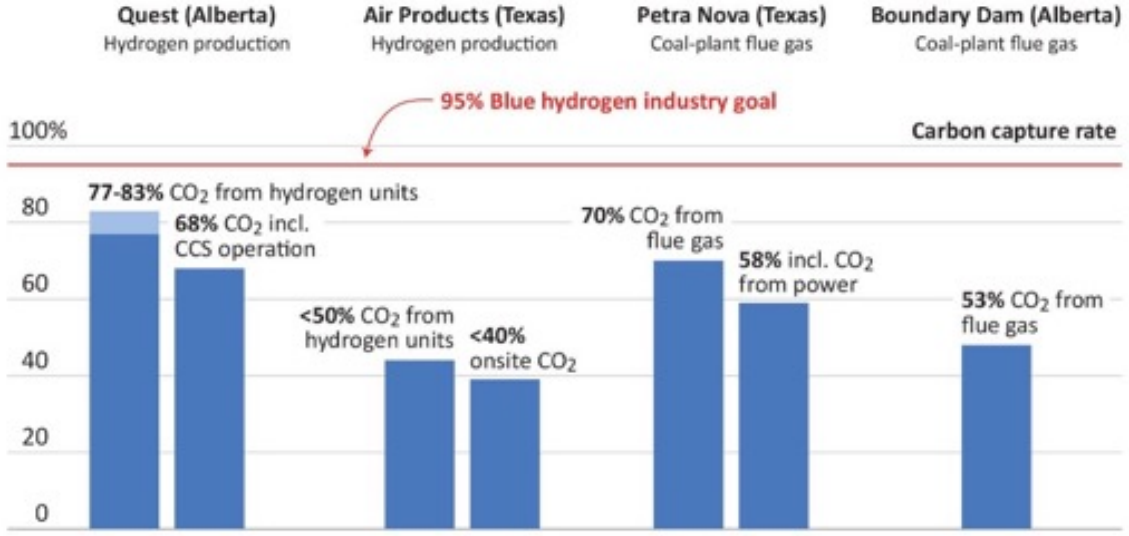
1. Uncertainty about how large the market for hydrogen will be.
2. Competition in the regional energy markets from declining cost renewable and battery storage facilities.
3. The impact that future natural gas prices will have on project costs.
4. Competition from other blue hydrogen facilities.
5. Competition from green hydrogen.

There is No Commercial Scale Power Plant Running on 100% Hydrogen

- In fact, although GE and Siemens are working on turbines that can burn a mix of hydrogen and natural gas (methane) the first commercial plant in the U.S. that will do so (the Long Ridge 495 megawatt [MW] plant in Ohio) will use only a 5% hydrogen, 95% gas fuel blend.
- Siemen's has said that its 12 MW pilot plant might be the first 100% hydrogen plant but it will be starting with a 30% hydrogen blend in 2023. And 12 MW is a very small development project.
- Both GE and Siemens have indicated that they expect to have operational turbines in 2030 that will operate on 100% hydrogen. But nothing is guaranteed.
- Bottom line, it should be expected that Escalante will be running on at least a blend of natural gas for a long time.
- In any event, the project will still be using natural gas for the foreseeable future as the raw material for hydrogen.

Carbon Capture Risk – Relevant Industry Experience

- Tallgrass has told the legislature that the Escalante project will capture 97% of the carbon dioxide (CO_2) created during the production of hydrogen.
- However, as shown below, neither of the two existing projects that produce hydrogen has captured close to 97% of the CO_2 they've produced.
- And only two commercial scale coal burning power plants have captured CO_2. Neither has captured anywhere near 97% of their CO_2.



Increased Challenge in Capturing CO_2 from Gas-Fired Generators

- There is no commercial natural gas-fired generator in the world with carbon capture.
- Moreover, it is expected that capturing CO_2 from gas-fired plants will be more difficult, and likely more expensive, than doing so from coal-fired generators, as the following assessment by the DOE's National Energy Technology Laboratory (NETL) indicates:

> One of the biggest challenges in post-combustion capture is separating the relatively low concentration of CO_2 from the large amounts of nitrogen in the flue gas. In addition, carbon capture applied to various types of flue gas streams involves unique challenges. In general, natural gas power generation produces an exhaust with essentially zero heavy metal content, lessening flue gas pre-treatment requirements. However, flue gases from natural gas combined cycle (NGCC) plants typically contain ~4% CO_2 by volume (compared to a CO_2 concentration of 12-15% in flue gases from coal plants) which provides less driving force for CO_2 separation, and therefore, requires greater energy input.

Carbon Capture – The Need for a Full Life Cycle Analysis

- When evaluating proposed carbon capture projects, it is important to look at the expected life cycle emissions which include all the expected upstream and downstream emissions
- Even if Tallgrass intends to capture the CO_2 produced during both the hydrogen production process and the generation of electricity that does not include all the greenhouse gases associated with the project. Significant amounts of fugitive methane (a potent global warming gas) can be expected to be leaked during the production of the natural gas and more can be expected to be leaked during the piping of the natural gas to the plant.
- Similarly, there is a risk that CO_2 captured at Escalante will be leaked during the piping to the underground storage site and/or from the site.

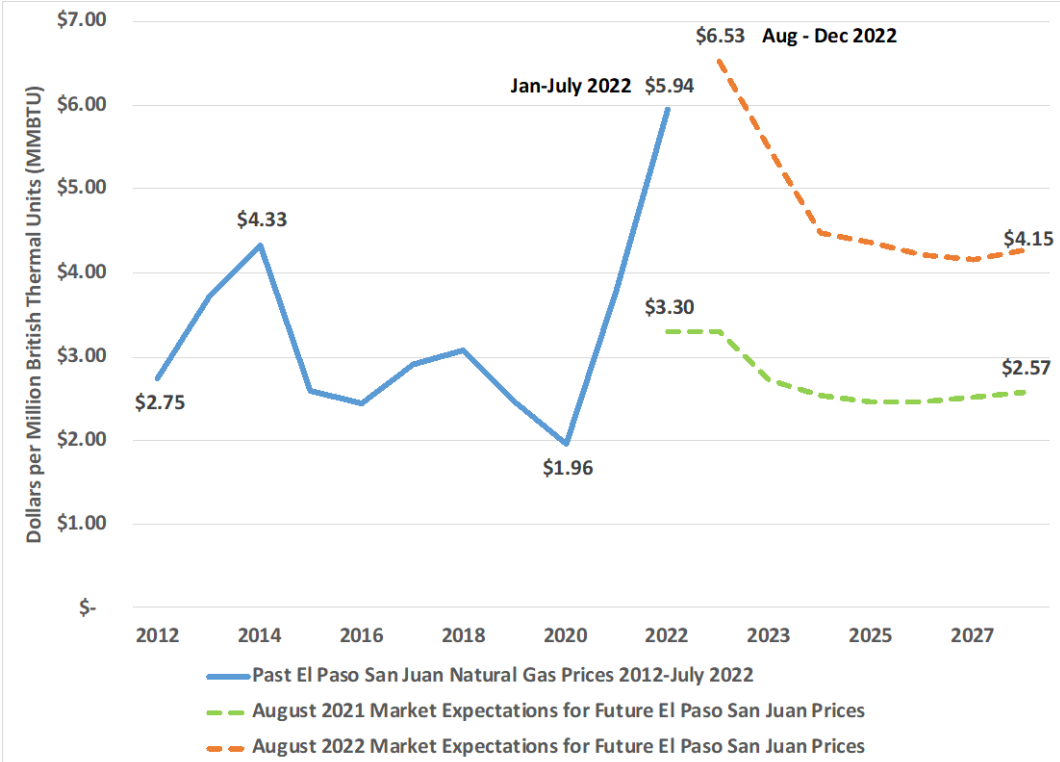
Natural Gas Price Risk

- Future natural gas prices will impact the financial viability of the project in two ways: through the cost of fuel to power the source of power for the project and the cost of the raw material from which hydrogen will be produced.

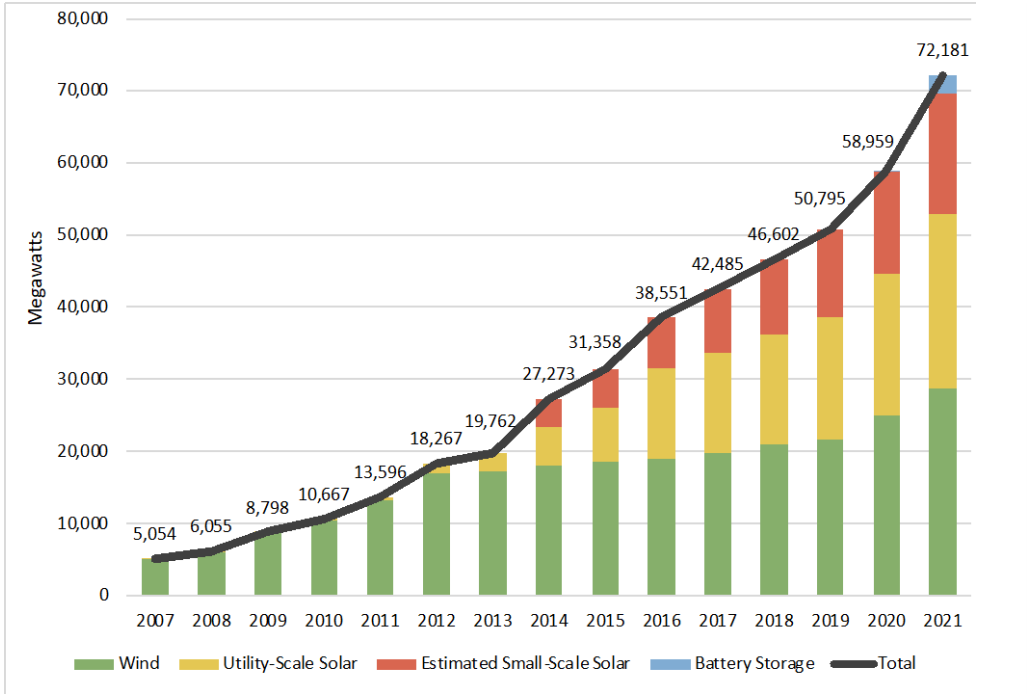
- Natural gas prices have skyrocketed in the past year and although financial markets expect that prices will decline from current levels in coming years, they still expect them to remain much higher than were experienced in the past.

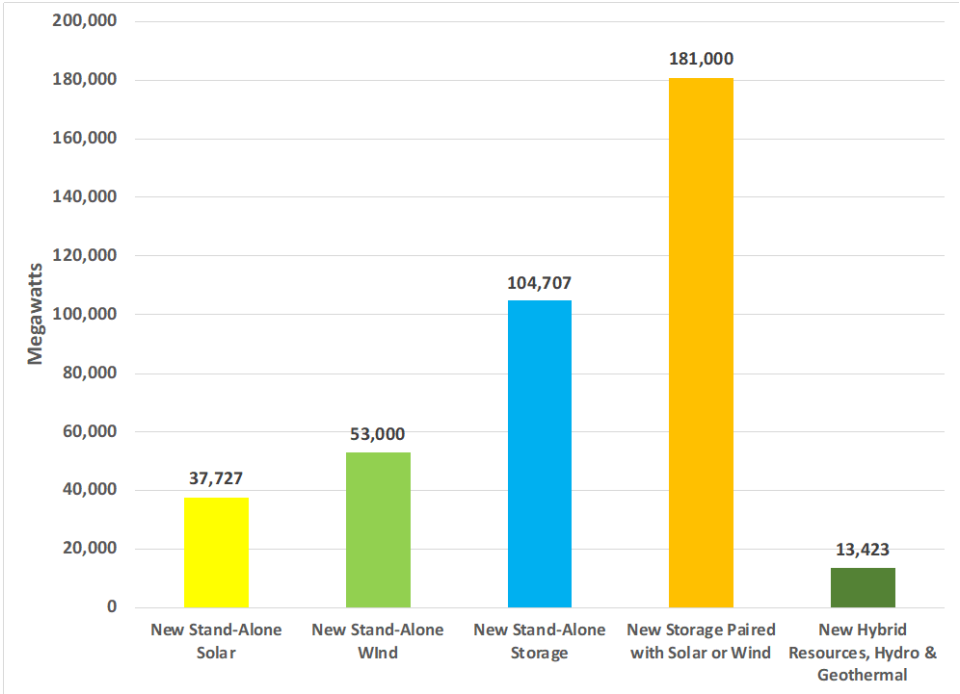
  Gas prices spiked above $21 per MMBTU during February 2021 cold storm.

  The expected future gas prices in this chart do not include any price premium that the project can be expected to have to pay for Responsibly Sourced Gas.



Escalante Faces Increasing Competition from Renewable Resources and Battery Storage





More than 6,300 MW of the proposed stand-alone wind is offshore.
The 181,000 MW of storage paired with solar and wind is just the generator capacity – doesn't include the storage capacity.
If only 20% of this 390,000 MW of proposed capacity is built in next 5-8 years, region's renewable & storage capacity would double.

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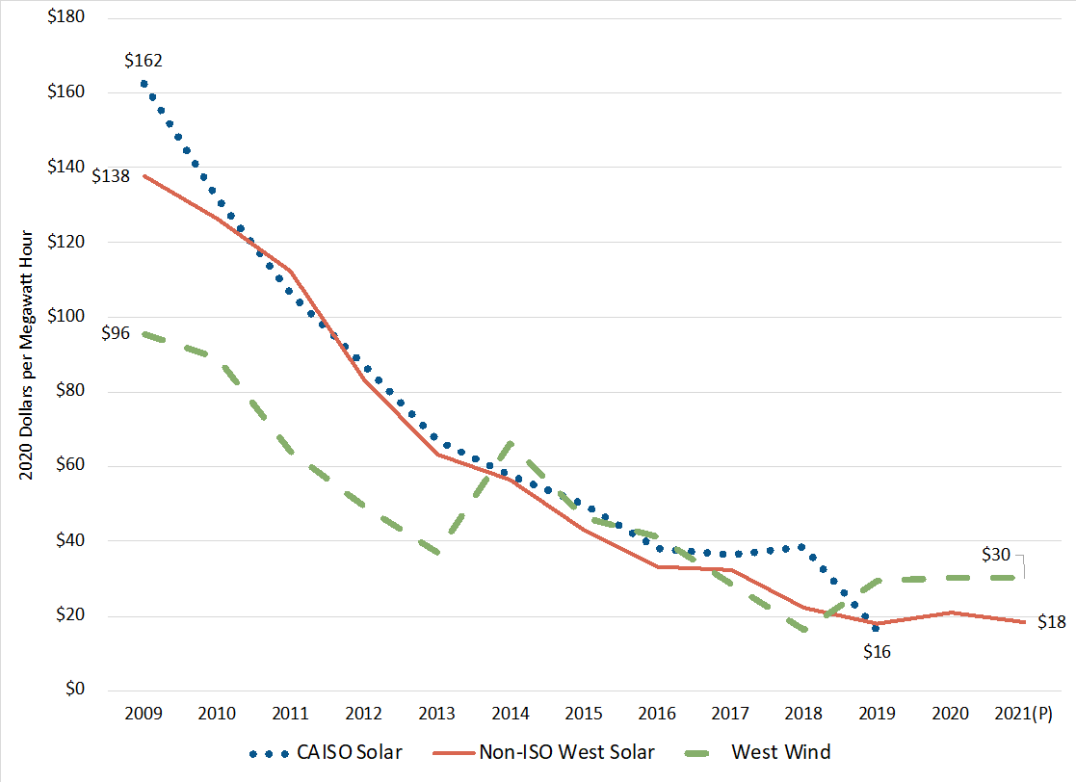


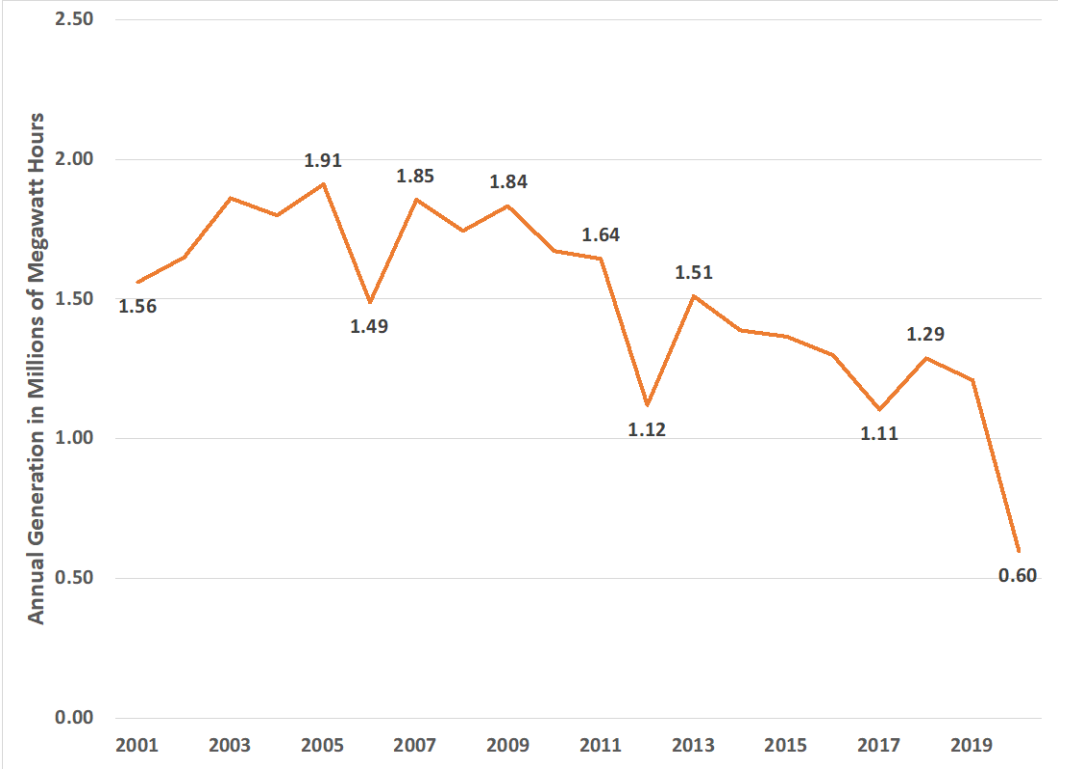
The wind and solar industries are currently experiencing higher costs due to supply chain issues. However, assessments by researchers at the DOE's Lawrence Berkeley National Laboratory (LBL) and the National Renewable Energy Laboratories predict that over the long term the prices of renewables will continue to decline.

For example, the LBL researchers conclude that the levelized cost of energy (LCOE) from wind can be expected to decline by between 23% and 41% by 2035. Solar's LCOE could decline by another 47% to 86% during the same period.

Battery storage prices fell by 72% between 2010-2019, according to U.S. DOE. National Renewable Energy Lab projects storage prices will decline by 28-58% by 2030 and by 28-75% by 2050.

Escalante's Operating History Raises Doubt About its Long-Term Prospects

- Tri-State retired Escalante in 2020 after it had determined that it was no longer economic to operate.
- This followed almost of decade of generally declining generation.
- Whatever the reason for this declining performance, if Escalante is unable to generate substantially more energy year after being re-opened than it did prior to its retirement it is unlikely to be financially viable. The fewer MWh that a plant generates, the higher its cost per MWh. This makes it less competitive against alternative power resources.



Escalante's Age Also Leads to Doubt About its Long-Term Prospects

- Escalante is 38 years old.
- This is important because as they age power plants, on average, tend to cost more to operate and maintain and are less reliable, according to analyses by the U.S. Department of Energy's Argonne National Laboratory and National Energy Technology Laboratory, which have found that coal plant heat rates increase with plant age, while plant availability declines.
- Heat rate is a measure of a power plant's efficiency in generating electricity; a higher heat rate means that a plant is less efficient. And, in general, power plants tend to become less efficient as they age. Plant availability measures the percentage of operating hours in which a plant was actually available to generate power, and plants tend to become less available to generate power as they age, in part because they tend to have more unanticipated problems and unplanned outages.
- This leads to higher operating costs and lower generation, making the plant less economic to operate and less competitive with other resources.

Contact

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