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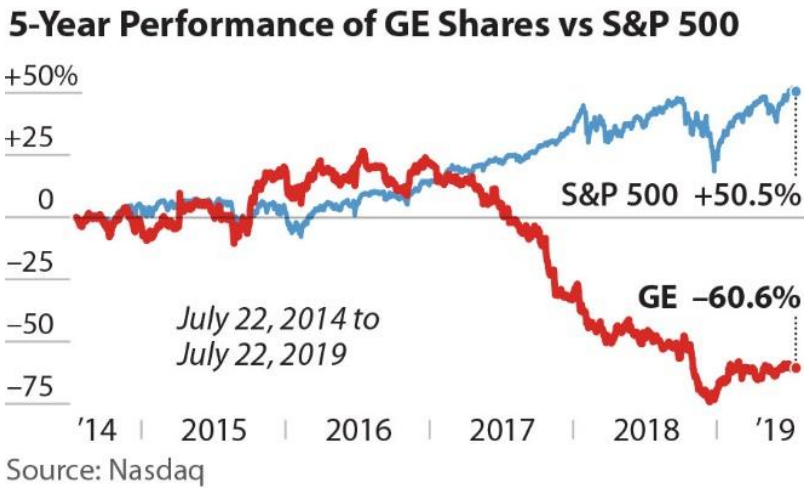
New Risk Factors Emerge as GE Shutters California Power Plant—20 Years Early

Lackluster Demand for Natural Gas May Doom New and Existing Plants

GE will close its $1 billion[1] natural gas power plant in southern California, only 10 years into its planned 30-year life cycle. Why? GE's once state-of-the-art efficient gas plant that promised baseload usage and steady revenues now features obsolete technology, declining usage and unsustainably low revenues.

The energy system includes growing amounts of lower-cost solar and wind generation. With renewable energy already cost competitive and with the clear prospect of continuing technological improvements leading to increased efficiencies in renewables, California's regulatory design is moving away from fossil fuels. Gas plants now serve as back-up generation. This requires different gas plant operating systems if the plants are to stay competitive.



The end result: this huge California plant, which cannot operate under these new market conditions, is uneconomic and being closed.

This latest problem comes on the heels of the collapse of GE's power unit. The bet the company made on natural gas plants and turbine development proved to be value destroying.[2] GE's current and continued wager on natural gas is also showing signs of coming up short.

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[1] Capital costs to build coal and natural gas plants based on 2013 estimates from the Energy Information Administration (EIA), natural gas-fired power plants cost from $676 to $2,095 per kilowatt (kW), according to MarketRealist. That would put the cost to build the Inland Empire plant, with 800 MW, at $540 million to $1.66 billion, with $1 billion as a reasonable estimate. See also: Reuters. GE to scrap Calironia power plant 20 years early. Scott, Alwin. June 21, 2019.

[2] IEEFA. GE made a massive bet on the future of natural gas and thermal coal, and lost. Buckley, Hipple & Sanzillo. June 2019.

The Inland Empire Power Plant

Undermined by Game-Changing Technology from Wind and Solar Energy

The Inland Empire Power Plant, listed by the California Energy Commission as Inland Empire Energy Center Project (IEEC), will close at the end of 2019.

GE had high hopes for this gas plant when it was approved in 2003. It would be the first power plant in the U.S. to use its then recently unveiled H-class turbine. These turbines sold for roughly $300 million each, and IEEC would need two.

The H-class turbines were hailed in the trade publications as the "industry's most fuel-efficient CCGT technology."[3] Books written about GE's turbines described them as "an unqualified success from a technology perspective."[4] They ran 200 degrees hotter than their predecessors and were expected to increase thermal efficiency to 60%, which was described in trade publications as the 'four minute mile' of gas turbine technology.[5]

The company anticipated sales in the thousands,[6] confident that the improvements would build on the company's earlier F-class model. But despite the hype, H-class sales were disappointing. In fact, only six combined cycle plants were built using these turbines.[7]

Despite the hype, H-class sales were disappointing.

It took three years and more than one million work-hours to build and test the new turbines at the Inland Empire site. More than 500 workers were involved.[8]

From the start, the H-class turbines' complexity caused exceptionally long outages for routine maintenance.[9] And the application of the technology in specific operating environments proved troubling.

The California plant went online in 2009 with its first unit, generating 400MW output. The second unit went online in May 2010. Troubled from the start, Unit Two was "shut down at the time of commissioning because it was damaged, reasons for

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[3] Power Technology.com. The Inland Empire Power CCTG Power Station Project. Accessed July 24, 2019.
[4] S. Can Gulen. *Gas Turbines for Electric Power Generation*. Published February 14, 2019.
[5] ModernPowerSystems.com. First 60Hz 'H' takes shape at Riverside. September 1, 2007.
[6] CA.gov. Docket log for Inland Empire Energy Center Project Compliance.
[7] Powermag.com. A brief history of GE gas turbines. Patel, Sonal. July 8, 2019.
[8] Power Technology.com. The Inland Empire Power CCTG Power Station Project. Accessed July 24, 2019.
[9] Reuters. Four General Electric power turbines shut down in U.S. due to blade issue. September 20, 2018.

which were not disclosed by GE."[10] The restart of that unit was further delayed because needed spare parts were slow to arrive. GE closed Unit Two in March 2017, less than seven years into its life cycle, citing "economic considerations."[11]

Calpine, which managed the plant's construction and output and fuel requirements, expected to buy the plant from GE to become its sole operator.[12] The sale never went through.[13]

Ironically, GE currently plans to sell the power plant site to a battery storage manufacturer. That actually strengthens competition from wind and solar, since battery storage solves the intermittency problem, but it does so with a non-fossil fuel compatible technology. It also ensures that the closure will have minimal impact on the local tax base and offer employment opportunities in a part of California with a relatively strong economy.[14]

Despite the difficulties at the Inland Empire plant, the market outlook for continued low natural gas prices and declining coal usage solidified GE's decision to move forward with its gas turbine sales—though it had evolved to a new turbine design, the HA class.

Continued low natural gas prices and declining coal usage solidified GE's decision to move forward with its gas turbine sales.

Regulatory Priorities for Least Cost Options Rendered Natural Gas Plant "Uneconomical"

In its filing to the California Commission[15] to close the Inland Empire Power Plant at the end of 2019, GE noted that there were market and regulatory forces that led to its closing. Regulatory factors would also make retrofit economically unfeasible.

Most crucially, these particular legacy turbines could not accommodate the fast-start capabilities required for peak demand periods—when gas is needed to supplement southern California's plentiful supply of solar and wind energy.

Regulatory decisions supported cheaper and less environmentally problematic power sources for utilities. This rendered the retrofit plans impractical. For example, California's air permit standards also limit total start/shut-down hours per

[10] Power Technology.com. The Inland Empire Power CCTG Power Station Project. Accessed July 24, 2019
[11] CA.gov. Docket log for Inland Empire Energy Center Project Compliance.
[12] ModernPowerSystems.com. First 60Hz 'H' takes shape at Riverside. September 1, 2007.
[13] Green Tech Media. California's Gas Plant Pipeline Dwindles as Calpine Drops Mission Rock Application. May 31, 2019.
[14] CA.gov. Docket log for Inland Empire Energy Center Project Compliance.
[15] Ibid.

unit to limit emissions. Without a "guaranteed energy revenue stream, the retrofit of IEEC (to reduce emissions) could not be funded."[16] (Parentheses added).

Market Forces Support Renewables and Make Gas Uncompetitive

Renewable energy has become less expensive than other sources of energy (coal, natural gas, nuclear) that have traditionally served California. IEEC sold electricity to the grid on a merchant basis to the California Independent System Operator (CAISO). The plant faced stiff price competition from both wind and solar and a changed regulatory landscape in California. Between 2009 and 2018, the levelized costs of energy (LCOE) for wind and solar dropped by 88% and 69% respectively, according to Lazard,[17] which tracks this number annually. With the Los Angeles Department of Water and Power announcing in July 2019 the Eland solar project at US1.997c/kWh (zero escalators for 25 years) and 200MW/800MWh of energy storage at 1.3¢/kWh,[18] gas baseload is now an uncompetitive outdated concept.

California's IEEC also faces growing competition from wind power. The nearby San Gorgonio Pass is the site of one of California's largest wind farms, producing 666MW at the end of 2017.[19] Developers plan to replace aging wind turbines with more efficient newer models before the wind tax credit expires at the end of 2019.

GE's Natural Gas and Fossil Fuel Investments Underperform

The company's problem in California is the latest in a string of losses for the company in its fossil fuel investments.[20] Recent results from continued investment in this area show signs of additional red flags. The limited transparency offered to investors regarding these significant failures should only push investment interest further away. The company is unlikely to regain its

The company's problem in California is the latest in a string of losses for the company in its fossil fuel investments.

[16] Ibid.
[17] Lazard.com. Levelized cost of energy and levelized cost of storage in 2018. November 8, 2018.
[18] PV Magazine. Los Angeles seeks record-setting solar power price under 2C/kWh. Weaver, John. June 28, 2019.
[19] DesertSun.com. Palm Springs is famous for its wind farms. They may look a lot different in the future. October 24, 2018.
[20] These changes are also taking place against broader backdrop of a major company reorganization. The company has sold its Transport Operations and Big Pharma business recently. Additional asset sales and streamlining is anticipated in the credit and power divisions. Moody's Investor Service, General Electric Company: Update and Credit Analysis, May 31, 2019. (PBC # 1169138).

position as a world class, blue chip market leader so long as it continues to invest in an increasingly speculative part of the market with a negative outlook.

New Natural Gas Product Line Experiencing More Red Flags

The California gas plant loss punctuates a series of investment forays into natural gas that have failed the company and its investors.[21] After the failure of the H class, GE continued its commitment to gas turbines based on the market outlook for continued low natural gas prices and declining coal usage. To serve the market, it developed a new turbine design, the HA class.

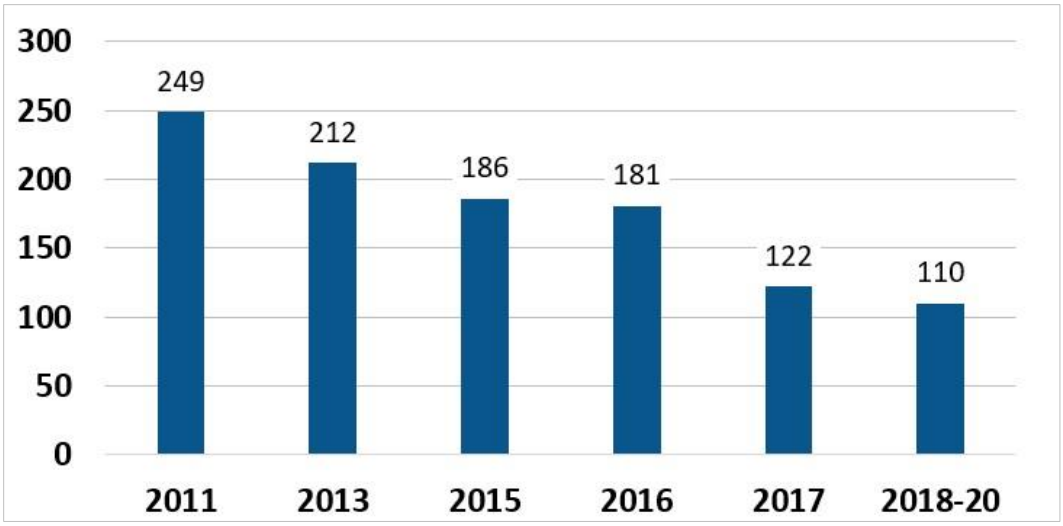
But the new "HA-class" turbines are also facing technological problems. Four turbines in Texas had to be shut down to repair blades in 2018. Late last year, information surfaced that power plant operators in Japan, Taiwan, France and throughout the U.S. had plans to shut down at least 18 of the 55 new turbine models GE had shipped, according to a Reuters report.[22] GE set aside nearly half a billion dollars to repair them.[23]

GE Misread Demand for Large-Scale Gas Turbines

GE's bet on future sales of natural gas plants has been a costly mistake, including a $23 billion impairment charge in 2018.[24] The loss was driven largely by its mistaken assumption that demand for gas and coal plants would continue to grow. As global demand for large-scale natural gas turbines dropped precipitously in 2017 and 2018, GE's gas turbine unit sales dropped 60% year on year, from 102 in 2017 to just 42 in 2018.

[21] Moody's Investor Service, General Electric Company: Update and Credit Analysis, May 31, 2019. (PBC # 1169138).
[22] Reuters.com. GE's push to fix power turbine goes global. Scott, Alwin. December 7, 2018.
[23] Moody's notes the technology problem and retrofit costs as another stumbling block in the company's recovery prospects. Moody's Investor Service, General Electric Company: Update and Credit Analysis, May 31, 2019. (PBC # 1169138).
[24] IEEFA. GE made a massive bet on the future of natural gas and thermal coal, and lost. Buckley, Hipple & Sanzillo. June 2019.

Figure 1: Number of Large Gas Turbine Units (>100MW) Sold Worldwide



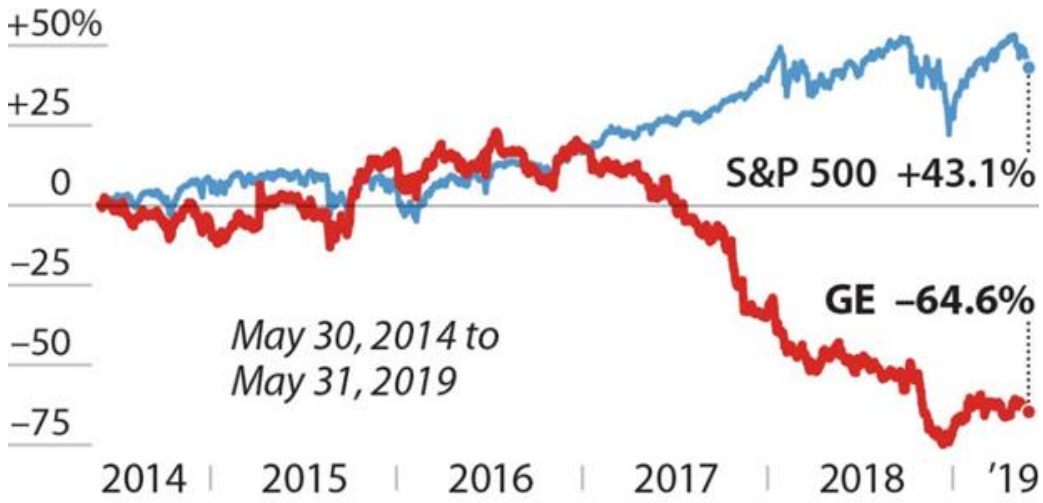
Source: Siemens.

The shifting energy mix throughout the world, along with energy efficiency gains that held down demand for electricity, were blamed for the sudden drop-off in global demand for large-scale natural gas turbines, a market GE had led for decades. Sales of gas and coal turbines and lucrative follow-on service contracts comprised the bulk of GE's Power division, which had literally powered the company's revenues and profits for the past several years.

This failure of a new product line and natural gas emphasis occurred as the company acquired Alstom and Baker Hughes, two companies with substantial investments in fossil fuels. In short order, both acquisitions failed to provide the expected growth opportunities presented to investors to support the transactions.

With lackluster demand for its turbines and failed acquisitions, GE, a thirty-year top ten performer in the Standard and Poor's 500, slashed its dividend and fired its CEO after just one year on the job. The market punished the company harshly, sending the stock down 64% between May 2014 and May 2019, while the S&P 500 rose 43%. The stock decline was costly for GE's owners, including investors across BlackRock, Vanguard and State Street's key products.

Figure 2: 5-Year Performance of GE Shares vs. S&P 500, May 2014 - May 2019



Source: Nasdaq.

Continued Lack of Transparency Masks Financial Risks

Investors have yet to receive a full report on the losses related to the early closure of the California plant or the investment logic for continuing with the gas turbine product line. The California plant had two large H-class turbines, which cost $300 million each[25] and an estimated total cost of $1 billion with a 30-year likely life. Now, it will close in just under ten years from the date of commercial operation, representing an estimated $670 million loss.

The necessity for greater transparency is apparent, especially as the company is much smaller today. The loss of an estimated $670 million in value at the company's current market capitalization of $82 billion is far more significant than a loss of this magnitude when the company was worth $600 billion.

These losses do not include future revenue lost from the early closure of the plant. Sales of gas turbines are only part of the revenue stream for GE. The long-term service agreements (LTSAs) are profitable sources of recurring revenue. In 2016, for example, GE's power division had revenues of $27 billion. Gas turbine sales were $10 billion. Gas services were $15 billion.[26]

[25] Forbes.com. Pared-Down GE will offer investors a big bet on future demand for natural gas. Helman, Christopher. June 27, 2018.
[26] SeekingAlpha.com. GE Power and Renewable Energy Investor Presentation. March 2017. Slide 13

GE's Future

Loss of Blue-Chip Status Should Not Lead to Greater Speculation in Fossil Fuels

Absent a more thorough-going analysis of its Power Division failure, investors are left to draw their own conclusions about management's judgment and plans for future investments.

On the technological side, the company's failure to assess the changing energy landscape suggests that its measure of efficiency in its power products is wrong for the current environment.

The company's natural gas technology investments typically claim improved efficiency using its prior technology as the benchmark. This misses several points:

1. The company faces competition within the sector.[27] The market is now saturated with natural gas technologies as well as equipment and supply providers. GE's benchmarks and efficiency standards no longer serve as the natural gas industry's main measure.

2. Its technologies have experienced operational problems that have further hindered the company's recovery plans and harmed its reputation. Again, in the absence of competition, these start-up costs could have been seen as simple costs of doing business. Now they are disqualifying defects.

3. Its technologies have proven to be obsolete when compared to the efficiencies offered by renewable energy, a market competitor with a fundamentally different scientific basis, technological configuration and business proposition. GE's products no longer set the energy industry standard.

On the market side of the equation, the challenges to its technological leadership in natural gas and the rise of new players in the market argue for a smaller-scale GE fossil fuel operation. The company has been projecting the growth of natural gas usage based on it continuing to follow growth in the economy as a whole and has used that as a justification for its capex investments. That connection between natural gas demand and economic growth no longer holds.

The challenges to its technological leadership in natural gas and the rise of new players in the market argue for a smaller-scale GE fossil fuel operation.

[27] Moody's Investor Service, General Electric Company: Update and Credit Analysis, May 31., 2019, (PBC # 1169138)

There is now widespread concern in the oil and gas industry that the current production glut, driven by important technological efficiencies created by the industry itself, has weakened the financial underpinnings of the industry.[28] Plans to slow production are designed to raise the price of natural gas and oil at a time when the industry faces historically unprecedented competition. The market outlook all along the fossil fuel chain[29] is negative. There are reasons why the industry may not succeed in raising gas prices, but if it does, that will only make gas less competitive in the energy generation market.

Energy regulators in many parts of the United States, and increasingly, around the world, see renewable energy as a least cost option, with significant additional efficiency gains for the energy sector still on the horizon. The shutdown of a natural gas facility with state-of-the-art technology highlights the risk that these plants, which typically have 30-year life spans, will increasingly be incapable of recovering investments as newer technologies provide system savings that will retire them early.

States throughout the U.S.[30] are adopting ever-higher renewable targets that would have seemed outlandish only five years ago. New York State, for example, passed a renewable energy mandate in June calling for 70% clean energy by 2030.[31] A week later, Maine passed a mandate calling for 80% renewable energy by 2030.[32] As states adopt increasingly aggressive targets for renewable energy to supply their electricity grids, future and existing natural gas plants will be at risk.

The shifting energy mix in the United States has been mirrored throughout the world, as solar and wind costs have increasingly become cheaper than natural gas.

The shifting energy mix in the United States has been mirrored throughout the world, as solar[33] and wind costs have increasingly become cheaper than natural gas. India, Brazil and Chile, which have an abundance of solar and wind, are achieving

[28] Federal Reserve Bank of Dallas. Dallas Fed Energy Survey. June 26, 2019.
[29] GlobalEnergyMonitor.org. The new gas boom: Tracking global LNG infrastructure. Nace, Ted et al. June 2019 questions whether LNG facilities , which have a 60-year life time, are financially viable in a rapidly shifting global energy transition.
[30] Frontier Group & Environment America Research & Policy Center. Renewables on the Rise: 2018. Weissman, Sargent, and Fanshaw. July 2018.
[31] pv Magazine. New York State passes the biggest baddest renewable energy mandate in the nation. June 19, 2019.
[32] Associated Press. Maine governor signs sweeping renewable energy bills. June 26, 2019.
[33] IEEA.org. Solar is driving a global shift in electricity markets. Buckley, Tim and Shah, Kashish. See also: EVs and batteries can drive growth in rooftop solar in Europe and beyond. Wynn, Kunze, and Flora. May 2019.

ambitious renewable targets decades ahead of schedule.[34]

Finally, institutional investors are, in theory, long-term investors.[35] Pension funds and sovereign wealth funds, such as Norway's US$1 trillion Oil Fund, and the Japanese US$1.7 trillion Government Pension Investment Fund (GPIF), have long term investment horizons. When investment managers, such as BlackRock, who serve these institutions and other long-term investors, ignore energy-transition risks, they literally short-change their clients, and in GE's case, this has cost them billions.

Conclusion

The ill-fated Inland Empire Power Plant illustrates how supposedly cutting-edge gas turbine technology may quickly become obsolete. An even larger risk factor is whether other existing gas-fired power plants are at risk of becoming stranded assets. With an installed base globally of 7,000 gas turbines, this is no small matter for GE or its investors.

GE's California problem plant also provides a backdrop for a discussion of the energy transition that is occurring. The entire economic chain that supports fossil fuel extraction, processing and usage is at risk. The technological, regulatory, market and business risks touched on above have a cumulative impact. Companies like GE must adopt a 'double vision' when they assess new technologies and the new investments that accompany them. First, they need to assure themselves and their investors that the investments are good enough to add value to the fossil fuel sector. Second, the promised efficiencies must stack up against GE's increasingly lower cost renewable energy competitors. GE's approach, in the instances we have examined, demonstrates that management looks at its product line largely against its own past products. GE must compare its fossil fuel products within a wider lens, including the market trajectory of wind and solar energy.

Promised efficiencies must stack up against GE's increasingly lower cost renewable energy competitors.

[34] IEEFA.org. Emerging economies 'catching up' in global renewables' race. April, 3, 2018.
[35] Institute and Faculty of Actuaries. Investment risks for long term investors. Jinks et al. March 18, 2019.

The most troubling aspect of this examination is that GE's core branding has historically been its ability to stay ahead of the innovation curve. One of the most trenchant critiques of the coal industry, made by former GE CEO Jeffrey Immelt, is relevant here.

"Still looking for more proof of how uninnovative we've been in the energy field? Ask Jeffrey Immelt, chairman and CEO of General Electric, one of the world's premier manufacturers of power systems. He told me the following story: He has worked for General Electric for twenty-six years. In those twenty-six years, he has seen 'eight or nine' generations of innovation in medical technology in GE's health care business—in devices like X-ray equipment, MRIs, or CAT scans—because the government and the health market created prices, incentives, and competition that drove a constant flow of invention. It was very profitable to innovate in this field and fairly easy to jump in. But in power? said Immelt. One—one generation of real innovation is all that he has seen."

"'Today, on the power side,' said the GE CEO, 'we're still selling the same basic coal-fired power plants we had when I arrived. They're a little cleaner and more efficient now, but basically, the same model.' Nine generations of innovation in health care – one in power systems. What does that tell you? It tells you that you have a market that simply has not been shaped to produce clean energy innovation. 'You can't look back at the last thirty years,' concluded Immelt, 'and say that the market in energy has worked.'"[36]

GE's staff of scientists and engineers were—and are—capable of seeing beyond current science and technology and across industry sectors and scientific disciplines. Until now, company leaders took those insights and developed winning investment strategies that led the company, the nation and the world. This was the GE business model.

The coming realignment of the company's business model will be an uphill battle as GE continues to struggle with the underlying unstable and speculative natural gas market.

[36] Thomas L. Friedman, *Hot Flat and Crowded,* (New York: Farrar, Strauss and Grioux), p.247-248

About IEEFA

The Institute for Energy Economics and Financial Analysis conducts research and analyses on financial and economic issues related to energy and the environment. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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