Łęczna IGCC Project: High Costs and Unreliable Operations Can Be Expected

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A number of the key assumptions submitted by ENEA SA for its proposed Łęczna integrated gasification combined cycle (IGCC) project are very unrealistic and bias the results of ENEA's net present value (NPV) analysis in favor of completing the project. These flawed assumptions include:

- Plant construction cost
- Likely Net Installed Capacity
- Plant operating costs
- Plant heat rate

This assessment is based on the actual construction and operating experience at the only two IGCC plants built in the U.S. in the past 10 years: The Edwardsport IGCC Project (Edwardsport) built in Indiana by Duke Energy and the Kemper IGCC Project (Kemper) built in Mississippi by the Southern Company.

Overall, the U.S. experience has shown that it is extremely expensive to build and operate new IGCC power plants, and that, once completed, these plants do not operate reliably. This is especially true for systems involved in the gasification of coal.

As background, during the past 15 years, many U.S. utilities considered but then rejected IGCC projects because the technology was untested and involved higher financial risk than conventional power plants. In the end, Edwardsport and Kemper were the only two to proceed, while more than 25 proposed plants in the U.S. were cancelled because of customer and/or investor risks. Only Edwardsport actually operates on gasified coal, as Kemper's gasification systems proved too expensive and unreliable (Kemper runs now instead on natural gas).

Construction began at the 618 MW (net) Edwardsport IGCC Project in 2007, and the plant was declared to be in service in June 2013, although it didn't complete pre-operational testing until April 2014. Construction began at the 824 MW (net) Kemper IGCC Project in 2010 and ended in 2017 when the decision was made to operate the plant as only a natural gas-fired combined cycle unit.

IGCC Plant Construction Costs

The Ministry of Energy has estimated that the proposed Łęczna IGCC project would cost somewhere in the range of 7.8 million PLN/MW to build.[1] As the following discussion indicates, this is one-third to one-fifth of what it actually cost to build Edwardsport and Kemper.

Duke Energy, Edwardsport's owner, originally said that the IGCC plant would cost just under US$2 billion. The plant's cost ultimately ballooned to US$3.5 billion, a figure that does not include $397 million in financing costs that Duke's customers paid before the plant produced a single megawatt hour (MWh) of electricity.[2]

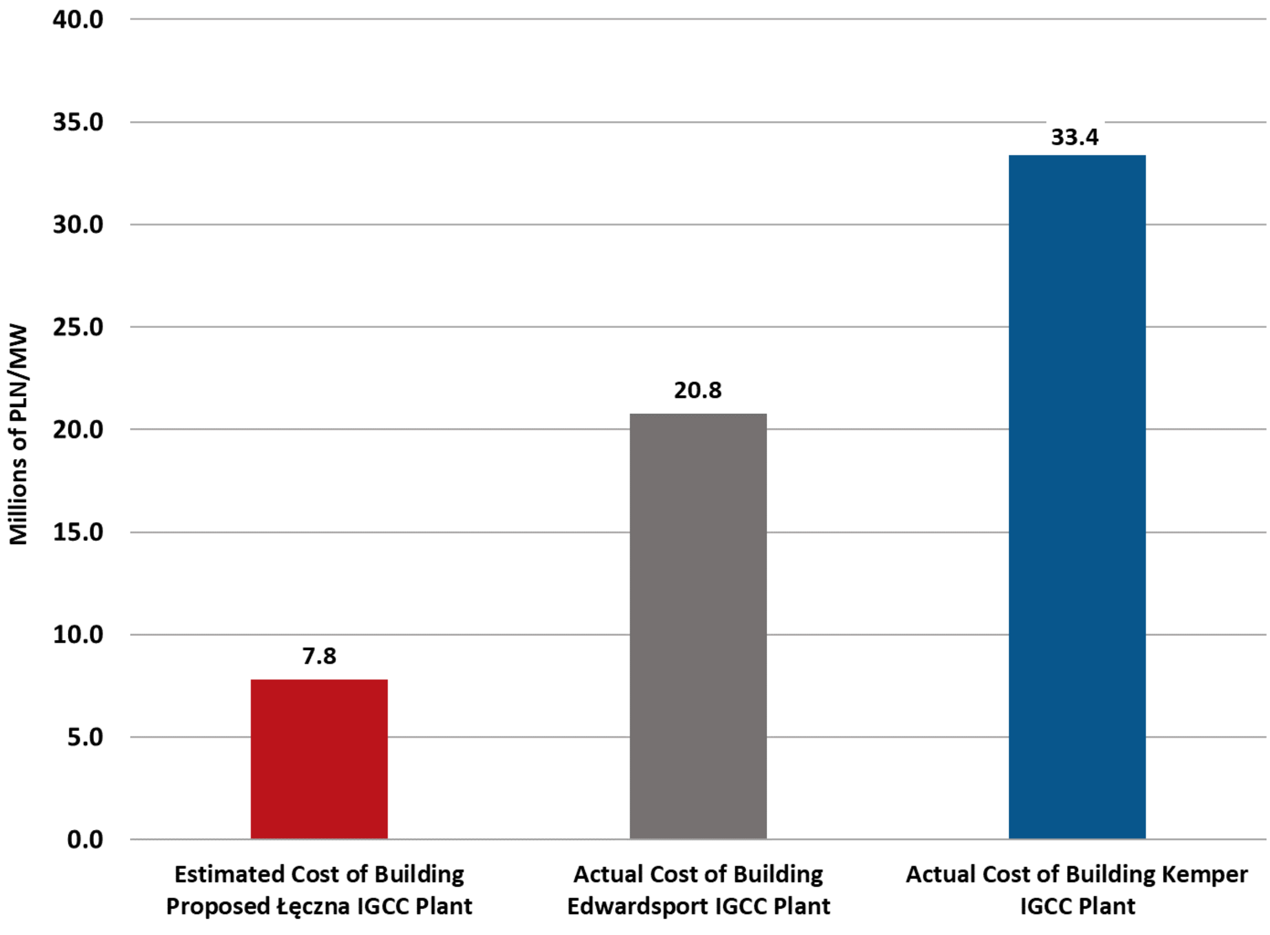
[1] http://orka2.sejm.gov.pl/INT8.nsf/klucz/658C47F2/%24FILE/i19192-o1.pdf.

[2] Duke Energy was allowed to recover the financing costs for Edwardsport from its customers before it went into service. This is a somewhat common practice in some states in the United States and is called allowing CWIP (Construction Work in Progress) into rate base before a plant is completed.

The Kemper IGCC project was even more expensive to construct. When seeking approval for the project in 2010, Southern Company, Kemper's owner, claimed that the 824 MW IGCC project would cost slightly less than US$3 billion to build. By July 2017, the estimated cost had jumped to US$7.5 billion. As the cost of building Kemper skyrocketed, Southern Company took nearly US$6 billion in pre-tax charges in its estimated losses on the project.

In Polish currency, the actual cost of building Edwardsport was more than 20.8 million PLN/MW.[3] The actual cost of Kemper was more than 33.4 million PLN/MW. As shown in Figure 1, below, these costs are almost three to five times higher than the currently estimated cost for the Łęczna IGCC project.

Figure 1: Estimated Cost for Building Łęczna IGCC Project vs. Actual Costs of Edwardsport and Kemper IGCC Plants in the U.S.



Reviewing briefly other IGCC activity worldwide, it appears that several IGCC projects are under construction in Japan. However, estimates for the cost of these projects were not immediately available. In Europe, an important goal of IGCC proposals was to exploit the relatively pure carbon dioxide flue gas streams of such power plants to bolt on additional carbon capture and storage (CCS) technology. CCS in theory should dramatically reduce the carbon emissions of fossil fuel power plants, and thus achieve significantly lower carbon

[3] Assuming a PLN/USD exchange rate of 3.67 zlotys to one U.S. dollar.

costs under the EU's emissions-trading scheme. Low carbon prices have stifled such projects, however, while a trend toward coal phaseout means there is now little or no prospect for new coal IGCC plants with CCS being built in the EU. For example, the Nuon Magnum plant in the Netherlands was originally intended as an IGCC coal power plant using CCS technology.[4] However, it is now operating as a conventional gas-fired combined cycle unit. Given that the Netherlands has now announced a 2030 coal phaseout, there is zero prospect of conversion of the Magnum power plant to burn coal IGCC with CCS.[5]

Net Plant Capacity

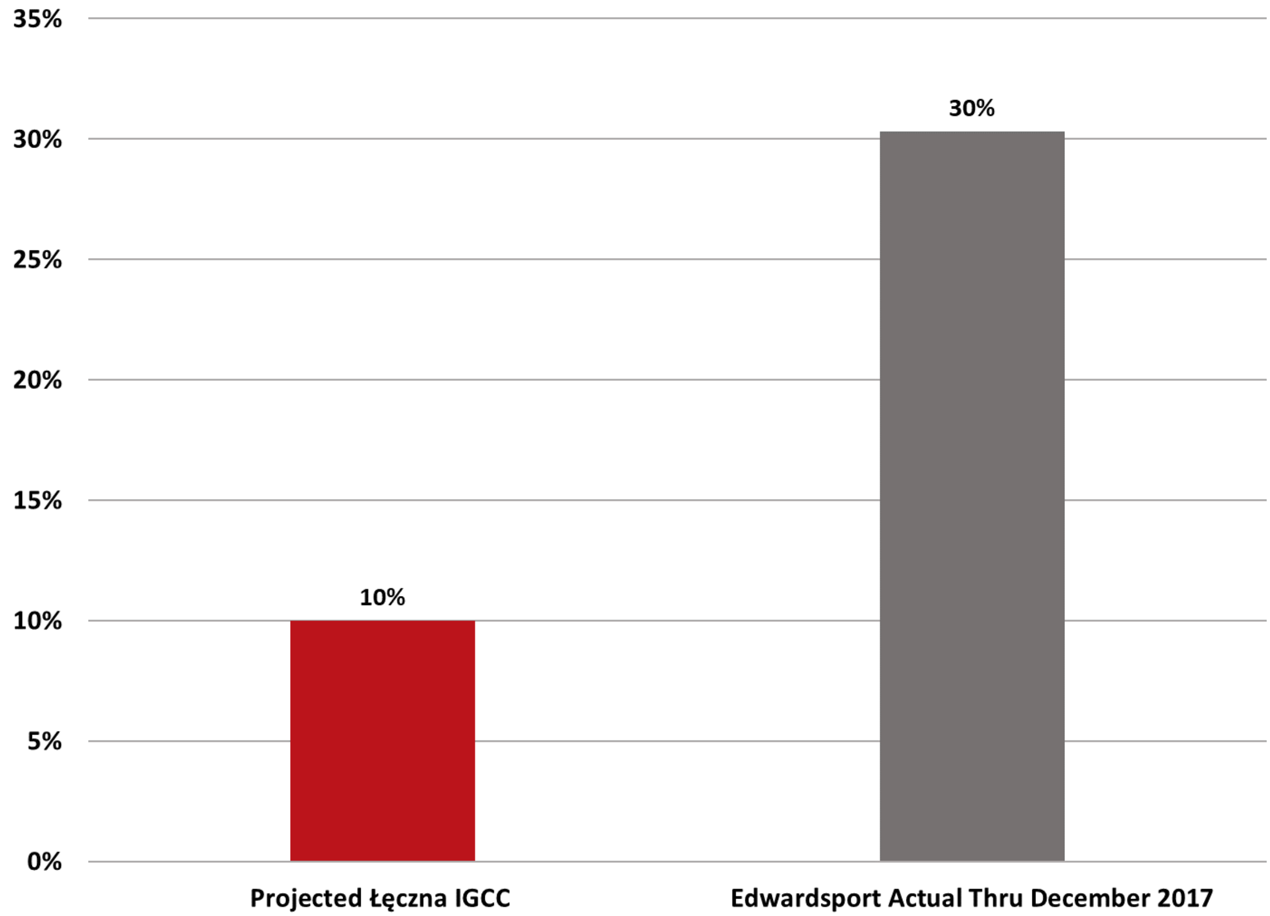
ENEA's EIA estimates that the gross capacity of the Łęczna IGCC Project would be 545 MWe, with a net capacity of ~488 MWe. This assumes that 57 MWe, or slightly more than 10% of the plant's output would be consumed running onsite plant equipment. These are called parasitic loads in the U.S. because they reduce the net output that can be delivered into the grid.

This assumption by ENEA is far too optimistic, if we consider a comparison with Edwardsport, which operates on gasified coal as intended. Operational data at Edwardsport through December 2017 show that the power plant has consumed, on average, 30% of gross capacity, just to run internal equipment including its gasifiers and other components of the gasification portion of the plant.

[4] https://powerplants.vattenfall.com/en/magnum

[5] https://www.reuters.com/article/us-netherlands-energy-coal/netherlands-to-ban-coal-fired-power-plants-in-blow-to-rwe-idUSKCN1IJ1PI

Figure 2: Plant Internal "Parasitic" Loads



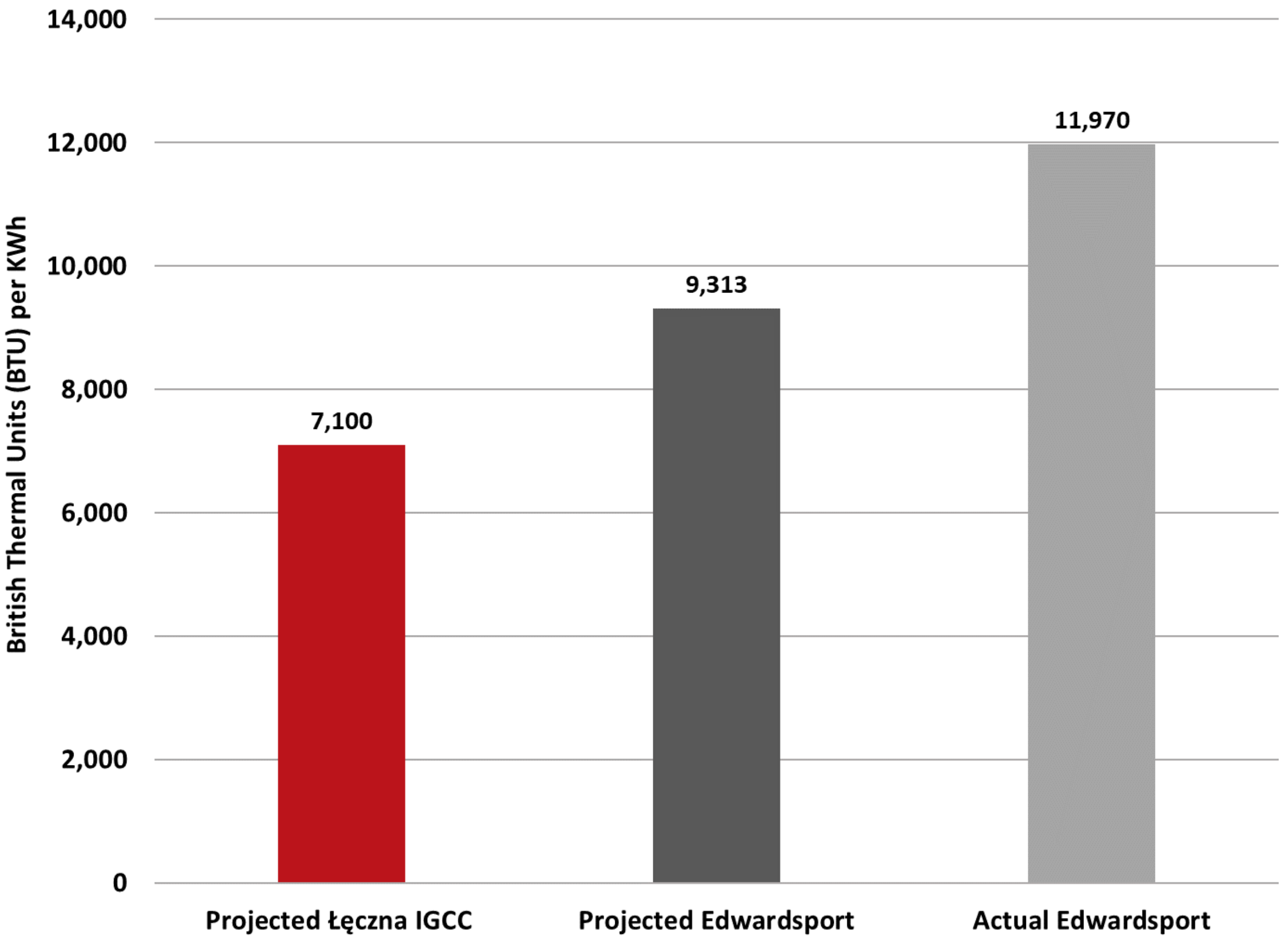
Higher parasitic loads can hurt plant performance (and customers) in several ways. First, the plant will either have to be built larger to produce the same 488 net MWe of output, or its actual net MWe will be substantially lower than proposed. Building a bigger power plant will increase the cost of building the plant. At the same time, the plant will have to burn substantially more fuel in order to both operate the gasification system equipment and sell its net output into the grid.

Plant Efficiency

A power plant's heat rate measures how efficiently the plant burns fuel. The higher the heat rate, the less efficiently the plant burns fuel. The lower the heat rate, the more efficient the plant is. In other words, the higher the plant's heat rate, the more fuel it must burn to generate the same exact amount of electricity.

ENEA's EIA application assumes that Łęczna's gross efficiency will be ~53% and that its net efficiency will be ~48%. This translates into an assumption that the plant will achieve somewhere in the range of a 7,100 BTU/KWh heat rate. As shown in Figure 3 below, a 7,100 BTU/KWh heat rate would be substantially lower than Edwardsport's actual heat rate during its first 55 months of operations (June 2013 through December 2017). This is the most recent data available.

Figure 3: Plant Heat Rate



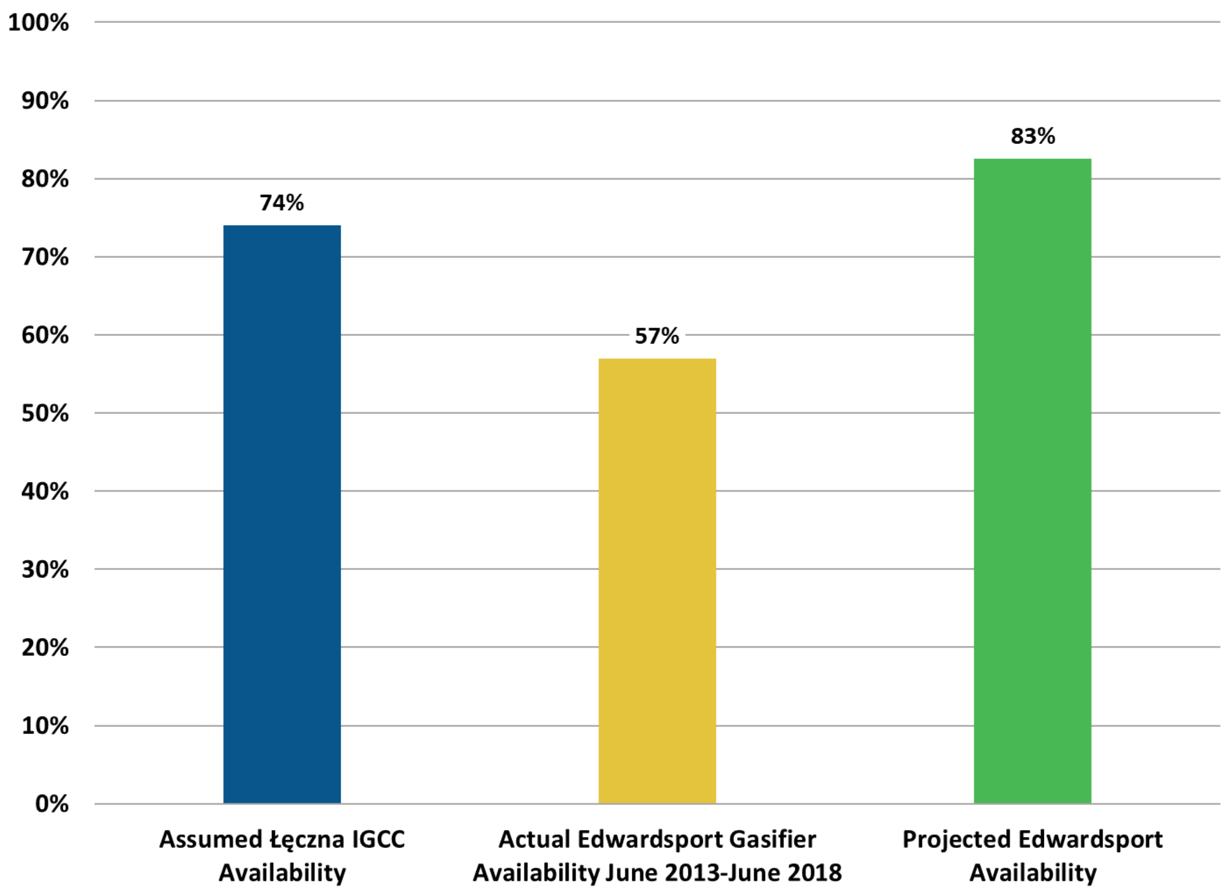
A higher heat rate will mean Łęczna will be more expensive to operate as it will need to burn much more coal to produce the same amount of electricity.

Plant Reliability

ENEA's EIA application assumes that Łęczna will operate an average of 6,500 hours a year, for an average plant availability of 74%. However, based on the experience of Edwardsport, Łęczna cannot be expected to operate these many hours on gasified coal. Nor can the plant's gasification system be expected to operate reliably.

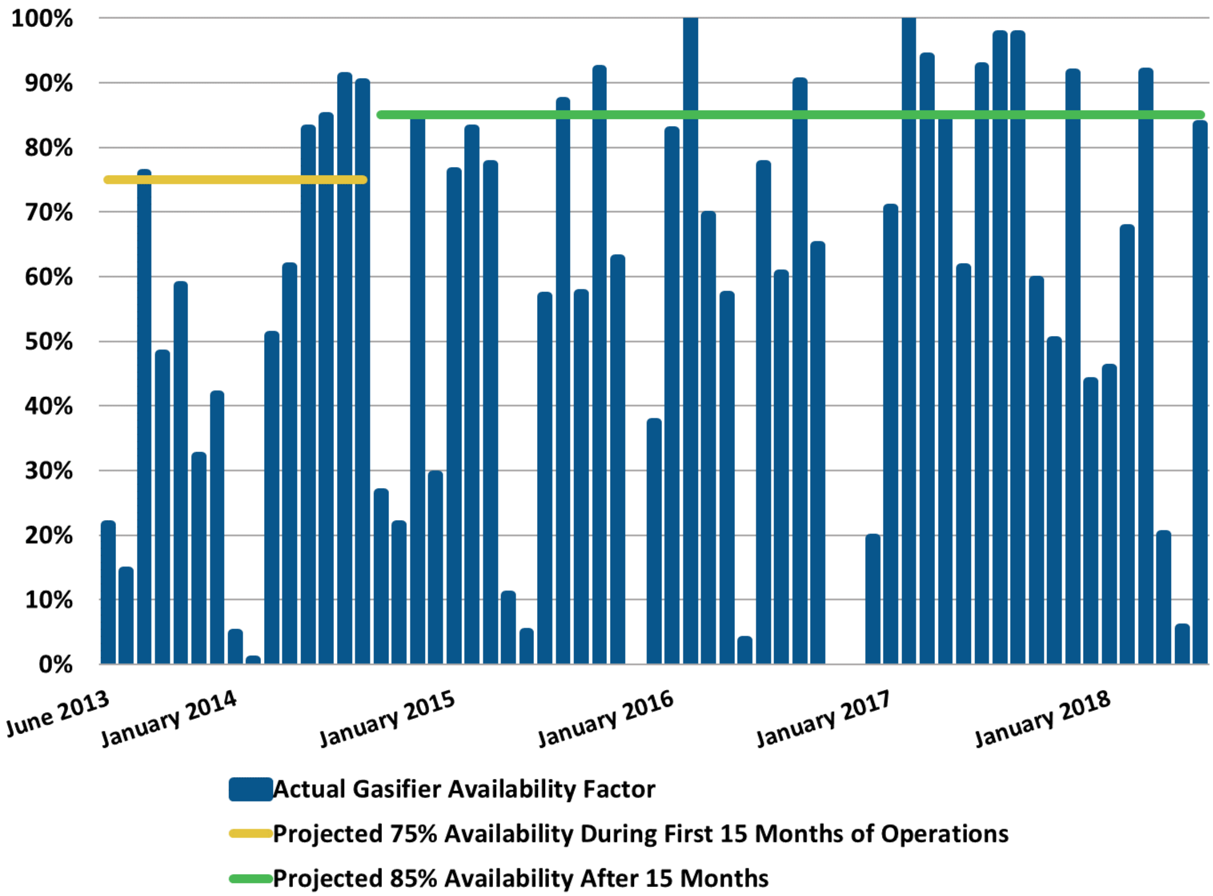
For example, Edwardsport's gasifier availability has been significantly worse than the 83% availability Duke had said the plant would achieve, averaging only 57% during the plants first 61 months of commercial operations. It also is far lower than the 74% availability ENEA assumes for Łęczna.

Figure 4: Assumed Łęczna vs. Actual Edwardsport Gasifier Availability



Moreover, as Figure 5 shows, the plant's gasifiers have operated erratically and unreliably, high some months and extremely low in others.

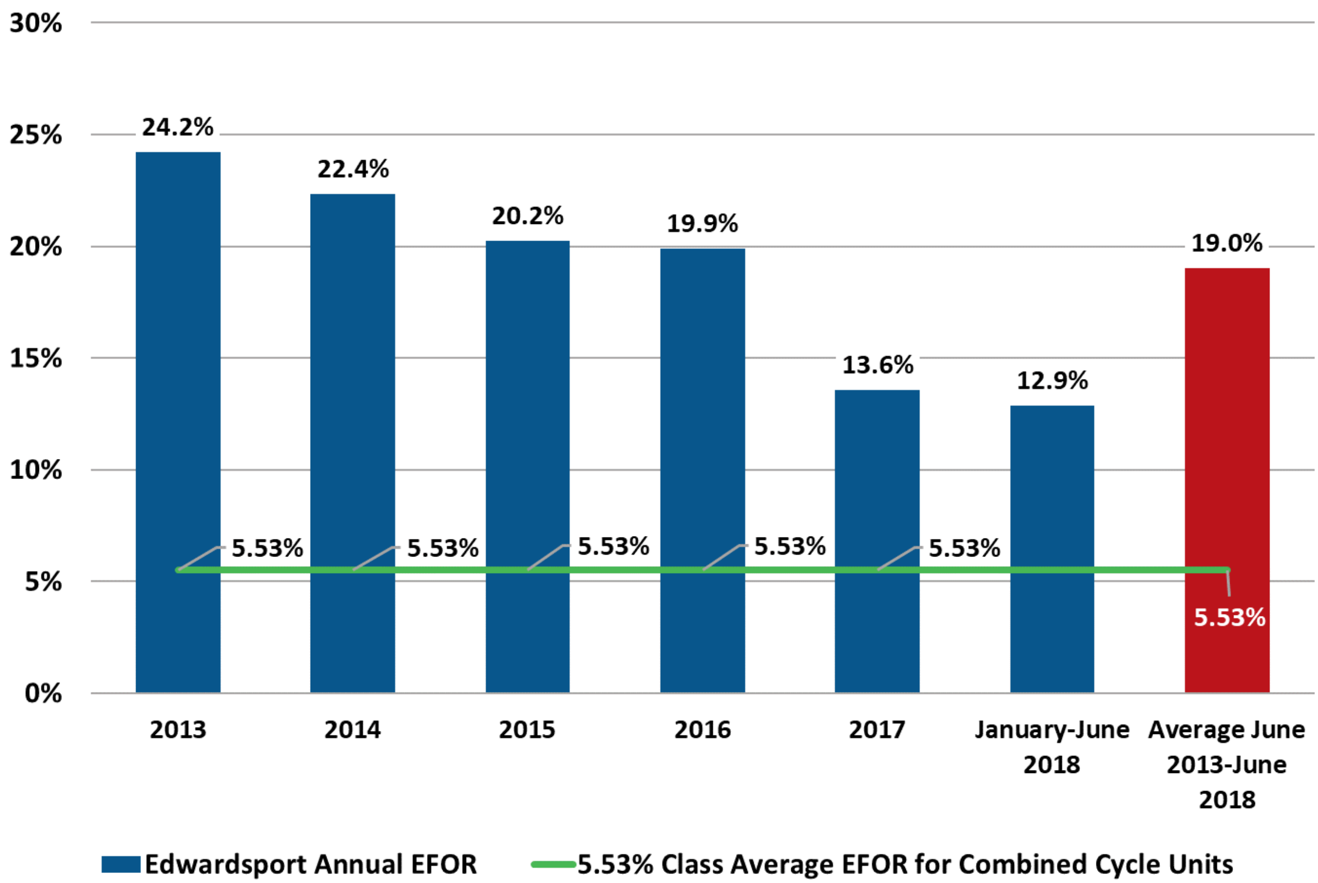
Figure 5: Edwardsport Monthly Gasifier Availability



Another commonly used measure for evaluating a power plant's operating performance is its Equivalent Forced Outage Rate (EFOR). EFOR is a measure of the probability that a unit will not be available, accounting for both (1) forced outages when the entire plant is out of service and (2) derating of the plant below its rated full power net capacity (that is, where the plant is available to generate but only at a lower output due to unplanned equipment problems or technical issues).

Figure 6, below, compares Edwardsport's EFOR to the average EFOR for combined cycle units. This was the comparison group that Duke used in its Generator Verification Test Capacity submission to the Midcontinent Independent System Operator (MISO) in 2013. As can be seen from Figure 5, Edwardsport's EFOR between June 2013 and June 2018 was much worse than the average EFOR of the relevant industry comparison group.

Figure 6: Edwardsport's Equivalent Forced Outage Rate (EFOR) vs. Relevant Industry Comparison Group's EFOR



Edwardsport's average 19.0% EFOR from June 2013 through June 2018 was more than three times the average EFOR of the industry comparison group.

Plant Generation

Due to the reliability issues identified above, Edwardsport has generated far less energy (MWh) than its owner predicted.

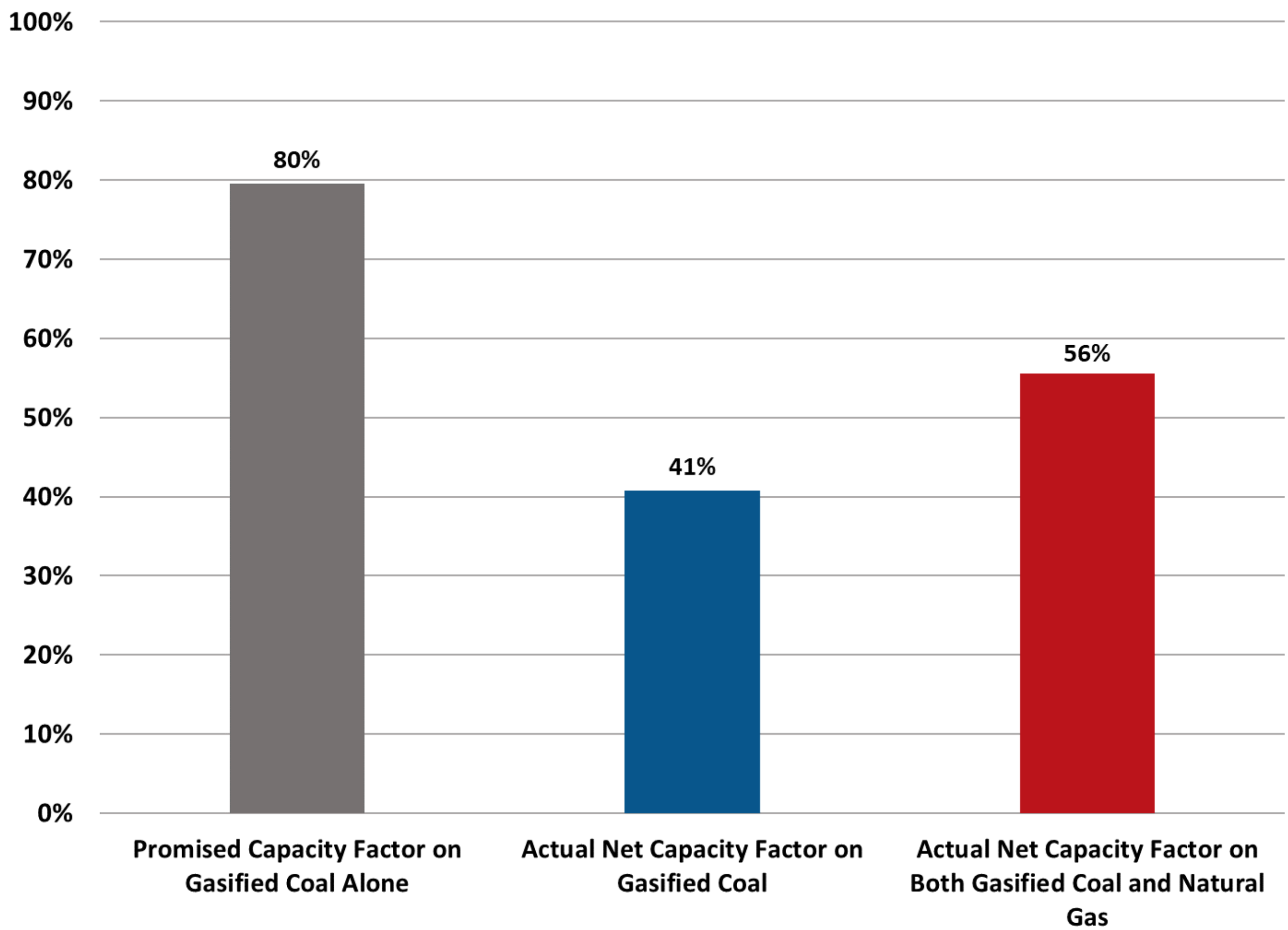
A plant's availability only reflects how many hours it is connected to the grid but not the amount of power it generates during each of those hours. An hour during which the plant generates only one MW is considered the same as an hour during which it operates at full power.

Instead of availability, net capacity factor is the most important measure of a plant's operating performance because it reflects how much energy (that is, how many MWh) the power plant actually generates to serve customers during a particular period of time. Capacity factor is expressed as a percentage, comparing actual output and what the output would have been if the power plant were operating at full power for the entire period. A plant's capacity factor is a function of how well and at what power levels it operates, and its relative operating and maintenance cost compared to the cost of other plants on the grid.

When it was seeking a permit to build Edwardsport, Duke claimed that the plant would achieve a 72% capacity factor during its first 15 months of operations, and an 82% capacity factor after that. This would mean that the plant should have achieved a 79% capacity for the period June 2013 through June 2018, its first 61 months of commercial service, all of which the company claimed would be from burning gasified coal.

However, the plant only achieved a 41% capacity factor burning gasified coal during this period, and only a total 54% capacity factor when burning either gasified coal or natural gas.

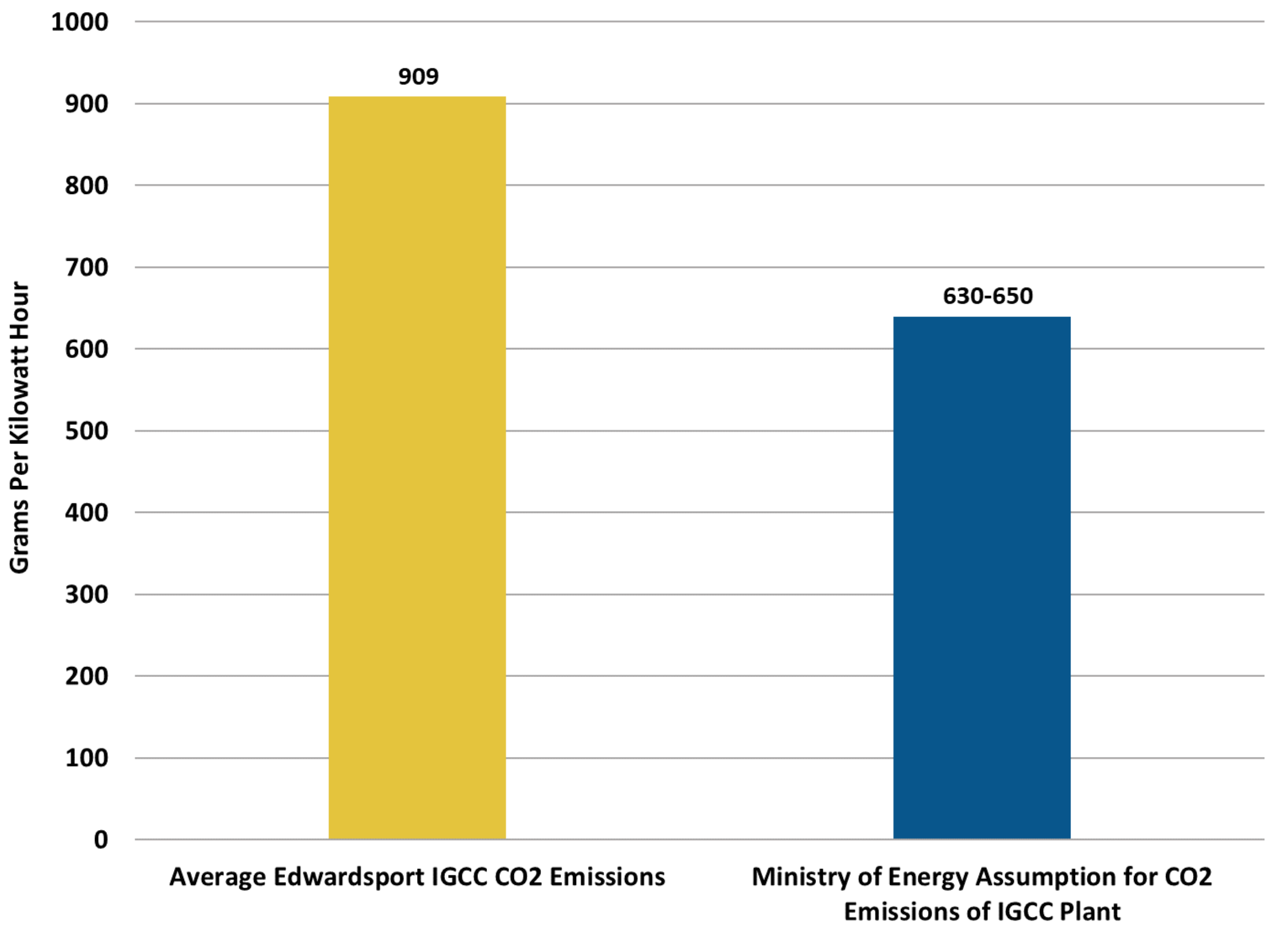
Figure 7: Edwardsport IGCC's Actual vs. Promised Capacity Factors



Plant CO_2 Emissions

The Ministry of Energy has assumed that a new IGCC power unit will emit, on average, 630-650 grams of CO_2 per KWh. As shown in Figure 8, this is far below Edwardsport's actual CO_2 emissions during the five-year period June 2013-June 2018.

Figure 8: Actual Edwardsport vs. Ministry of Energy's Assumed IGCC Plant CO_2 Emissions



Edwardsport's CO_2 emissions on gasified coal actually are higher than the 909 grams per KWh shown in Figure 8, as that figure includes the plant's average emissions when operating on either gasified coal or natural gas (which has significantly lower CO_2 emissions). And Edwardsport has produced a substantial portion of its generation when burning natural gas rather than gasified coal. For example, during the first six months of 2018, only 59% of Edwardsport's net generation came from burning gasified coal. Forty-one% came from burning natural gas.

Plant Operating Costs

No matter what claims are made, IGCC plants are expensive to operate and maintain.

Kemper

As the estimated cost of building Kemper rose, so did the estimates of how much it would cost to operate the project as an IGCC power plant. Projected operating costs jumped from an original 2010 estimate of US$205 million for the first five years, to a 2017 estimate of US$730 million, an increase of more than 250%. Forecast capitalized maintenance expenditures for the first five years of operations grew from $52 million to more than $270 million.

As a result of the rising costs and continuing problems with the gasification system at Kemper, the Mississippi Public Service Commission expressed its intention on June 21, 2017, to order that Southern Company, in the interest of customers, cease burning coal at Kemper and use only natural gas to run the plant.[6] The commission also expressed its belief that Kemper's gasifier technology was not and will not become "used and useful" in serving Mississippi customers and that Kemper's gasification technology has not operated reliably and is not likely do so in the near future.

In response, Southern Company announced on June 28, 2017, that it would stop burning coal at the plant, and the commission finalized its directive in an order issued on July 6.[7] Consequently, Kemper is now operating what is undoubtedly the world's most expensive natural-gas fired power plant, and it will not burn syngas made from gasified coal.

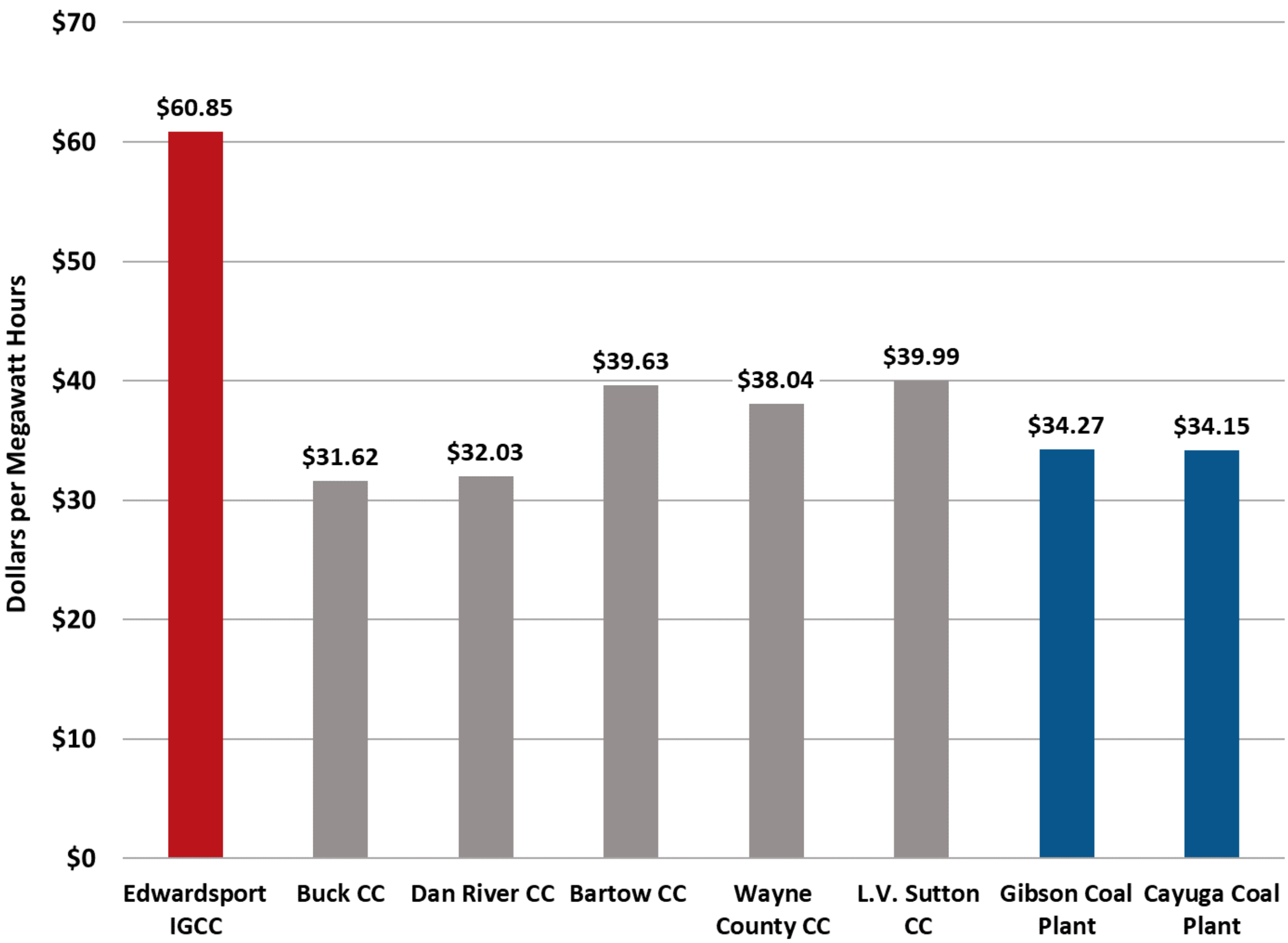
Edwardsport

As well as having been expensive to build, Edwardsport has had very high operating and maintenance (O&M) expenses, averaging nearly $61 per MWh in the four years from 2014 to 2017. Such O&M expenses have made Edwardsport far costlier to run than the five new natural gas-fired combined cycle units built by Duke between 2009 and 2013, and the two large baseload coal plants operated by Duke in Indiana.

[6] http://www.psc.state.ms.us/mpsc/press%20releases/2017/Joint%20Press%20Kemper%20Stipulation%20Docket%206.21.17.pdf

[7] http://www.southerncompany.com/newsroom/2017/june-2017/0628-kemper.html

Figure 9: Operating & Maintenance Expenses



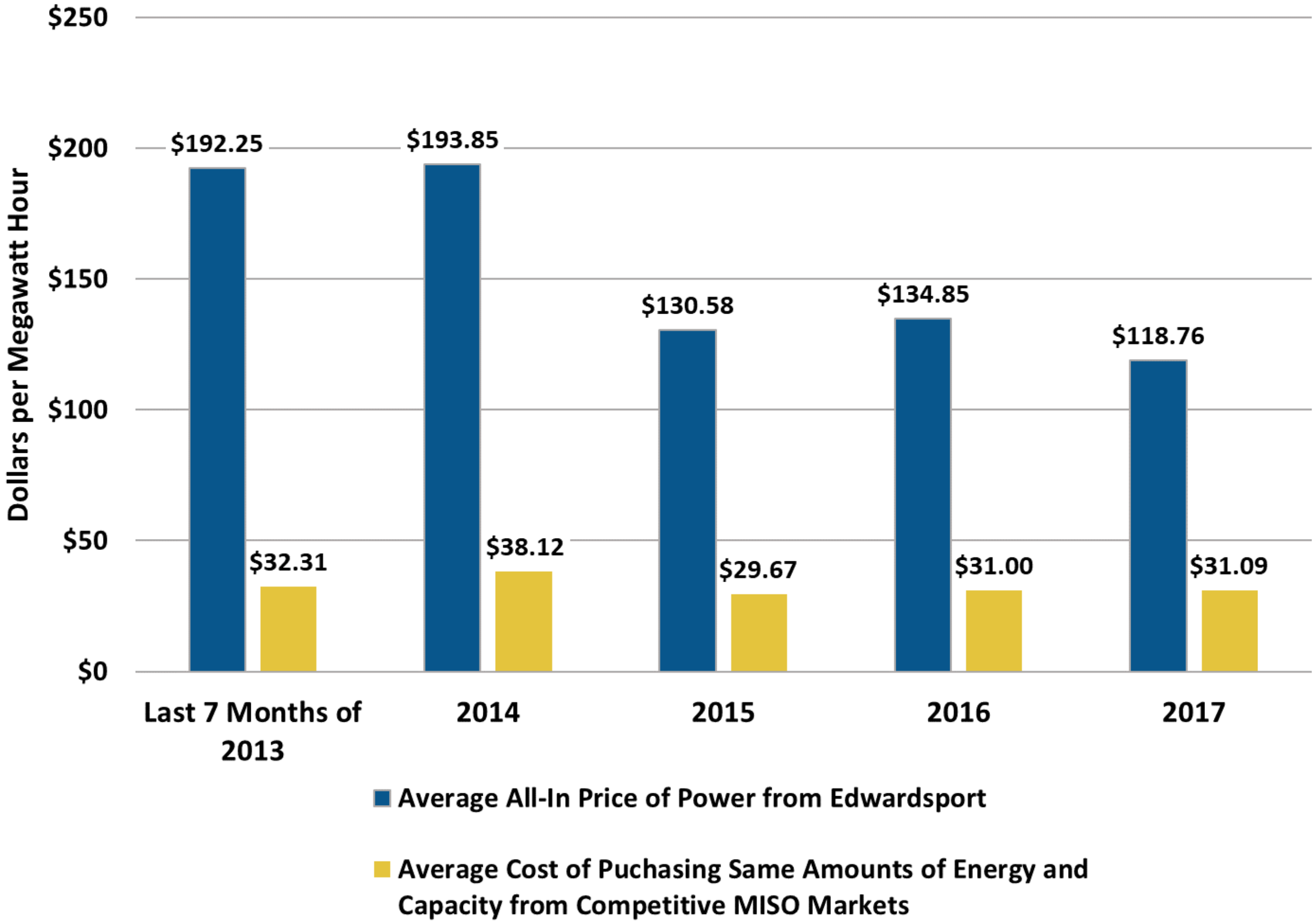
Edwardsport's fuel costs are relatively low compared to the other plants in Figure 7. However, its non-fuel O&M expenses are much higher. It appears that these extremely high non-fuel O&M expenses are due, in large part, to the high cost of operating and maintaining the plant's gasification systems.

Edwardsport IGCC Has Been an Economic Catastrophe for Customers

The all-in cost of Edwardsport, including financing costs, fuel and non-fuel O&M costs, has been extremely expensive for Duke's customers. In the 55 months between June 2013 and December 2017, customers paid $1.76 billion for only 12.3 million MWh from the plant during this period, equivalent to an average cost of $143.19 per MWh. Including the $397 million in financing costs that Duke's customers paid for the plant before it was declared to be in-service costs increases the all-in cost of Edwardsport to customers to $175.53 per MWh.

As a result, power from Edwardsport has been much more expensive than the cost of buying the same energy and capacity from the competitive wholesale markets.

Figure 10: Edwardsport IGCC's All-In Cost vs. the Cost of Buying the Same Energy and Capacity from the Competitive Wholesale Markets



In total, since June 2013, Duke's customers have paid nearly $1.4 billion more for power from Edwardsport than it would have cost to buy the same power from alternative sources, such as competitive wholesale markets. And there is absolutely no hope that customers ever will recover this $1.4 billion. In fact, there are reasons to believe that the relative economics of Edwardsport will become even worse in coming years.

Most importantly, design and technological improvements are driving down the costs of wind and solar resources. As more of these renewable resources are added to the electricity grid, it is likely that they will affect Edwardsport IGCC in two ways. First, their lower cost and increasing market share can be expected to keep market clearing prices lower, if not reduce them, thereby producing an even greater disparity between average energy market prices and the cost to produce power at Edwardsport. Second, the extremely low operating costs of wind and solar resources will mean that they will be dispatched ahead of fossil-fired units like Edwardsport and, as a result, will likely displace generation that would otherwise be produced at Edwardsport, which will therefore have a lower capacity factor, raising its costs per unit of electricity generation.

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The Institute for Energy Economics and Financial Analysis (IEEFA) 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 and to reduce dependence on coal and other non-renewable energy resources. More can be found at www.ieefa.org.

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David Schlissel, Director of Resource Planning Analysis for IEEFA, has been a regulatory attorney and a consultant on electric utility rate and resource planning issues since 1974. He has testified as an expert witness before regulatory commissions in more than 35 states and before the U.S. Federal Energy Regulatory Commission and Nuclear Regulatory Commission. He also has testified as an expert witness in state and federal court proceedings concerning electric utilities. His clients have included state regulatory commissions in Arkansas, Kansas, Arizona, New Mexico and California. He has also consulted for publicly owned utilities, state governments and attorneys general, state consumer advocates, city governments, and national and local environmental organizations. Schlissel has undergraduate and graduate engineering degrees from the Massachusetts Institute of Technology and Stanford University. He has a Juris Doctor degree from Stanford University School of Law.

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