Resource Insight, Inc.

# Municipal Coal in Ohio

## Implications of PJM's Behind-the-Meter Generation

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# Executive Summary

## Purpose of this Report

Around the United States, municipal utilities have retired dozens of coal-fired generation units in recent years in the face of increased competition and tighter environmental regulations. In Ohio, three municipalities continue to operate city-owned coal-fired plants: Dover (Tuscarawas County), Orrville (Wayne County), and Painesville (Lake County). These Ohio municipal coal-fired plants face the same market and regulatory pressures other municipal coal-fired units – for example, the Orrville and Painesville unit have accepted 10% capacity factor coal-operational restrictions to comply with U.S. EPA's Boiler MACT rule.

This report examines the economic status of these three plants from two perspectives.

- **Municipal budget**: Is continued operation in the interest of the cities and utility customers?
- **Regional utility market**: Are these plants delivering the value to PJM power markets that they are credited for?

The cost of operation for each plant includes fuel and O&M (operations and maintenance). The market revenues include electricity sales as well as credits for capacity and transmission value delivered to the regional power market.

## Conclusions

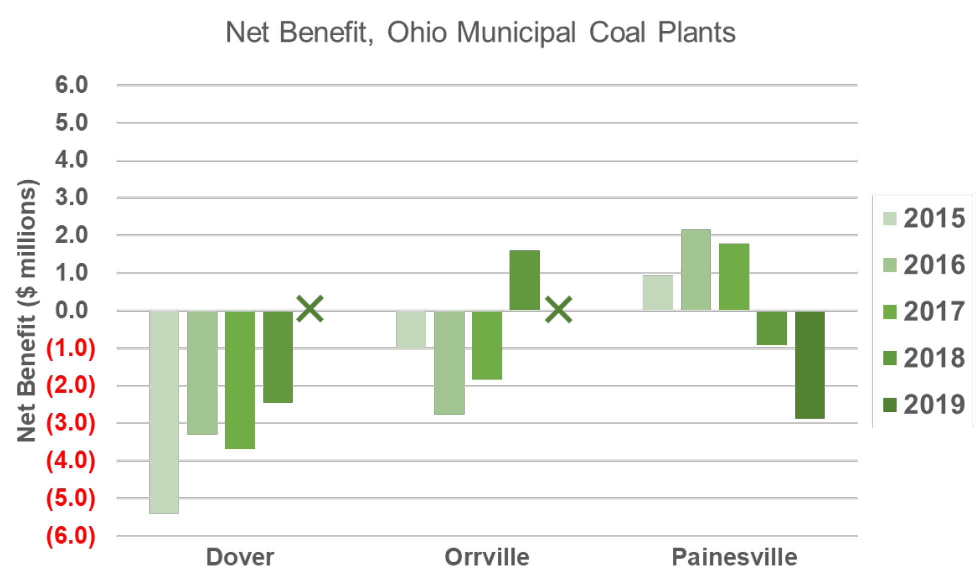
The Dover Municipal Light Plant and the Painesville Municipal Electric Plant are currently losing money, placing a costly burden on their customers, assuming the plant O&M costs we obtained from the cities are correct. (See Figure ES-1) Dover's high cost to operate makes it particularly unlikely that it will ever break even.

Since new EPA regulations triggered reduced plant operation, the Orrville Plant had one year in which it provided a modest net benefit to its customers. Prior to implementing the regulations, the plant had a net cost to utility customers. Orville expense data for 2019 were unavailable, so we do not know whether the net benefit that occurred in 2018 may be sustained.

### *Retirements Recommended*

We recommend that the city governments closely evaluate whether it is in their financial interest to continue operating these plants. The Orrville plant was cost-effective under 2018 cost and revenue conditions, but unless costs can be consistently kept below the recent averages, it would be better to retire the plant. That is particularly true if Orrville faces any significant capital investment. In the case of Dover and Painesville, immediate retirement of those plants should benefit the utilities' customers.[a]

**Figure ES-1: Net Benefit of Municipal Coal Plants in Ohio, 2015-19**




X – Incomplete data availability for Dover and Orrville in 2019. See discussion on p. 12.
*Source: EIA, PJM, and municipal utility supplied data.*

The main sources of plant revenues for the three plants are PJM capacity market credits and transmission system credits. Only at Dover have energy market revenues also been a significant source of value for the plants. Energy market revenues are measured as the locational marginal price, or LMP,

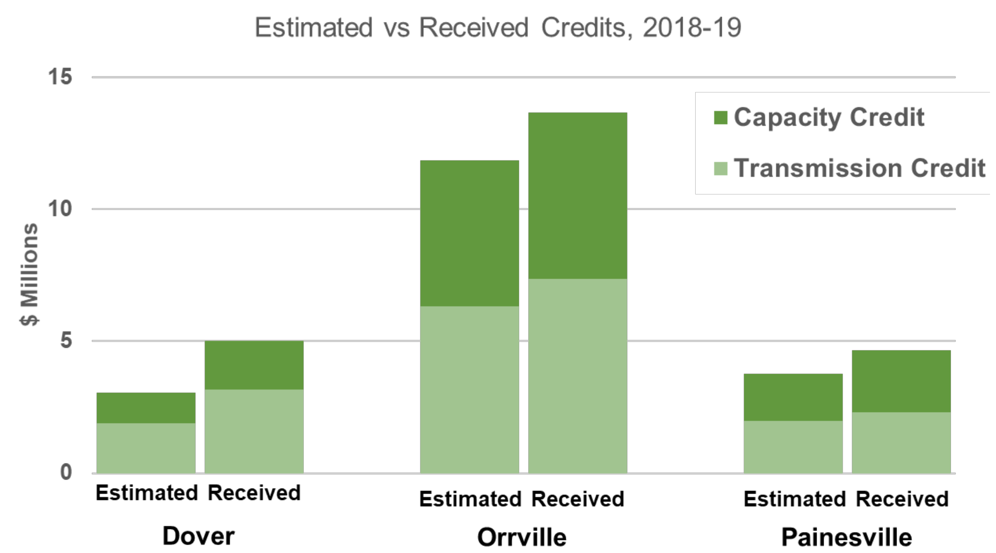
[a] All these conclusions assume that the data we obtained from the cities are substantially correct.

multiplied times the electric generation from the plant. Thus, financial success of these plants depends on not running a loss – variable costs being less than LMP – when generating electricity, and covering plant O&M costs with power market credits for capacity and transmission.

***Reform PJM Market Rules***

Not only might capacity and transmission credits be propping up the three municipal coal plants, but capacity and transmission credits may be imposing a hidden cost on customers throughout the PJM region. As shown in Figure ES- 2, the three plants may be overcompensated by PJM power markets for contribution of capacity and transmission value to the grid.

**Figure ES-2: Estimated vs Received Credits for Capacity and Transmission Service, 2018-19**




*Source: PJM data and municipal utility supplied AMP invoices.*

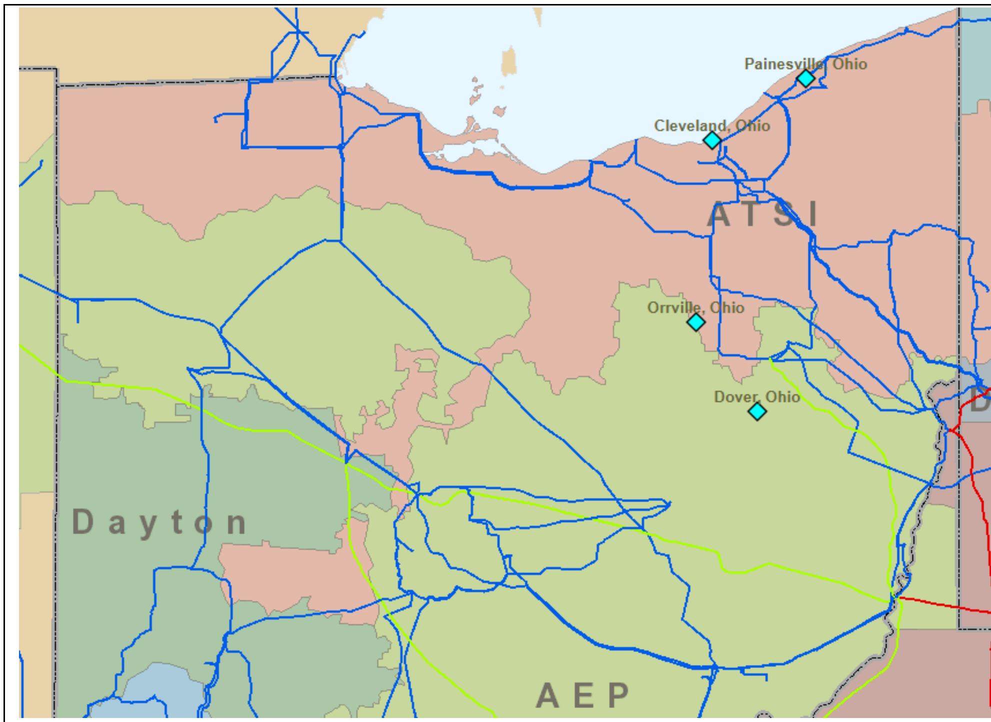
Furthermore, one plant manager said that he expects transmission charges – and hence credits for keeping the plants online – to continue to increase.[1] The justification to continue operating these plants may be as a hedge against rising transmission charges.

We recommend further investigation of the methods and practices associated with credits given to Behind-the-Meter Generation units on the PJM system. These units may be overvalued relative to capacity that participates in the RPM auction process and also overvalued relative to the cost to serve load with AEP and ATSI transmission system assets.

# Background

Dover, Orrville, and Painesville, the three Ohio municipal utility owners of coal generation, operate in the PJM Interconnection regional transmission organization region. Dover is connected to AEP Ohio Transmission's lines. Orrville and Painesville are connected to FirstEnergy's American Transmission Systems Inc. (ATSI) lines. The utilities are members of American Municipal Power, Inc. (AMP), a non-profit supplier of generation, transmission and distribution of electric power. Each of the utilities purchase whatever needed power they do not generate from AMP. AMP generates some of those power supplies, and purchases the rest in the PJM markets.

**Figure 1: Municipal Coal Plants in Ohio**




*Source:* [PJM System Map](). Cleveland is indicated for reference purposes only.

These three small, municipally owned coal plants are among the last standing. According to US Energy Information Form 860 data, at the end of 2010, there were 82 non-cogenerating coal units of less than 25 MW listed as operating or on standby. At the end of 2018, that number had shrunk to 28, of which six are studied in this report, and two others at Painesville and Dover reported as being on standby. Those eight units represent nearly one-third of the remaining small coal units in the US.

## EPA Regulatory Change

In 2011, the Mercury and Air Toxics Standards (MATS) were signed, requiring coal- and oil-fired power plants, mainly those larger than 25 MW, to reduce air pollution emissions. Although exempt from the utility MATS rule, smaller units were covered by the Boiler Maximum Available Control Technology (MACT) rule.[2] In 2015, the new rules triggered changes at three municipally-owned coal plants in Ohio.

In response to the Boiler MACT rule, Dover initiated upgrades to its 15 MW unit. Painesville and Orrville each accepted air pollution permit modifications to identify their coal-fired units as "limited use" boilers with certain operating limitations such as a maximum 10% annual capacity factor. Orrville converted one coal boiler to natural gas operation.

## Dover Municipal Light Plant

Dover Municipal Light Plant has single coal unit in operation with an operating capacity of 15.2 MW. Since at least 2015, Dover appears to have elected BTMG status for its participation in the PJM market. This means that the majority of its energy is used to meet its own load requirements.

The unit dates to 1962 and is grandfathered under the Clean Air Act, its hazardous air pollutant emissions are regulated.[3] These regulations required new environmental controls, "In 2015, however the EPA enacted new regulations for coal burning electric generation plants. Therefore, we needed to update our boiler. We issued a five year bond for $2,245,000 to allow the upgrade to happen in a timely fashion."[4]

The plant requires continued upkeep and repairs; the last 5 years have all been "year(s) for maintenance and upgrades to the City's largest asset… the boiler, the turbine, the coal handling equipment, and various other pieces of equipment received yearly inspection, maintenance, and upgrades."[5]

In addition to the coal unit, Dover also operates several smaller gas and diesel fueled units, as summarized in Table 1.[6] Based on data reported to EPA, coal fuels the vast majority of the Dover Municipal Light Plant's operations. The maximum output of Dover's plant from 2015-2019 was 17.8 MW, indicating that Dover does not concurrently maximize output from its coal and gas units.

**Table 1: Dover Municipal Light Plant**

| Generator | Capacity (MW) | Boiler | Technology | Heat Input (MMBtu/hr) | Operating Limit |
|---|---|---|---|---|---|
| **6** | 15.3 | 2 | Gas-fired combustion turbine | 252 | 756 hours per 12 months |
| **3** | < 1 | 3 | Gas-fired compressor engine | 4.86 | 99 hours per 12 months |
| **4** | 15.2 | 4 | Stoker-fired coal boiler | 247 | n/a |
| **5** | 2.4 | 5 | Diesel | 19.5 | n/a |

## Orrville Plant

The Orrville electric plant has three generating units with a total operating capacity of 66 MW. Since at least 2015, Orrville appears to have elected Non-Retail BTMG status for its participation in the PJM market. This means that the majority of its energy is used to meet the wholesale requirements of American Municipal Power wholesale customers (including Orrville itself).

While its generation units originally operated as baseload coal resources, Orrville has transitioned to operating a mostly natural gas-fired peak shaving plant. In 2016, one 23 MW generator was converted to primarily natural gas, and the other coal-based units were designated as "limited-use."[7] The remaining coal-fired units are subject to an annual operating limit as well as a 10% annual capacity factor limit. Particulate emissions from each coal-fired boiler are controlled by an electrostatic precipitator (ESP). The maximum output of the Orrville plant from 2015-2019 was 63.6 MW.

**Table 2: Orrville Plant**

| Generator | Capacity (MW) | Boiler | Technology | Heat Input (MMBtu/hr) | Operating Limit (MMBtu/year) |
|---|---|---|---|---|---|
| **9** | 20 | 10<br>11[a] | Stoker-fired coal boiler | 110.9<br>170 | 97,148<br>148,920 |
| **10** | 23 | 12 | Pulverized coal boiler | 315.6 | 276,466 |
| **11** | 23 | 13 | Natural gas boiler | 365.4[8] | n/a |

## Painesville Municipal Electric Plant

The Painesville Municipal Electric Plant has three coal-fired boilers that collectively supply steam to four turbine generators. In addition to the coal unit, Painesville also operates two gas-fueled boilers that are too small to be included in its Title V permit, as summarized in Table 3.[9] In addition to annual operating limits on heat input, each coal unit is subject to 10% annual capacity factor limit, a combined hourly limit, and a requirement that only one boiler may be operated on coal at any time. Coal fuels the vast majority of the Painesville plant's operations.

Prior to implementation of the EPA Boiler MACT rules, Painesville generated as much as 37.7 MW from its plant. Since those rules were implemented, the maximum output was 21.2 MW.

[a] Generator 9 is powered by two boilers.

**Table 3: Painesville Municipal Electric Plant**

| Generator | Capacity (MW) | Boiler | Technology | Heat Input (MMBtu/hr) | Operating Limit (MMBtu/year) |
|---|---|---|---|---|---|
| **2** | 7 | 5 | Pulverized coal boiler | 250 | 219,000 |
| **3** | 7 | 3 | Stoker-fired coal boiler | 218.5 | 191,406 |
| **5** | 15.5 | 4 | Stoker-fired coal boiler | 379 | 332,004 |
| **7** | 17.5 | n/a | n/a | n/a | n/a |
| | | | Combined coal boiler limit | | 249 MMBtu/hr |
| | 1.8 | 6<br>7 | Gas-fired boiler (EPA)<br>Petroleum liquid (EIA) | 5.2<br>5.2 | n/a |

## PJM Revenue Model for Municipal Coal Plants

### *Overall Financial Model*

The basic financial model for municipal coal plants involves expenses and revenues. On the expense side of the ledger:

- Fuel – primarily coal, except at Orrville which also uses natural gas
- Operation & Maintenance (O&M) – staff, supplies, and services required to sustain the power plant

Expenses are incurred within the utility, and will be discussed in more detail later in this report. On the revenue side of the ledger:

- Energy market revenues – including revenues from the sale of power, as well as avoided expenses of purchasing power
- Capacity and transmission market credits – the value of not purchasing the right to generation capacity and transmission services

Revenues are reflected as credits on the utility's monthly invoice from AMP, and are regulated under PJM's power market rules.

### *AMP Billing*

The AMP invoice is complicated, and must be reviewed closely to determine the revenue credits that municipal utilities receive for operating a power plant. The AMP invoice bills the utilities for power charges (which are based on peak demand and total energy consumption), transmission charges, and a few other small charges and fees. Some other energy and capacity charges depend on PJM power markets and vary with market conditions.

Other charges and credits are set by regulation or contract. For example, transmission charges from AEP and ATSI are regulated. For 2020, transmission rates are:

- AEP: $80,306 per MW-year, or $6,692 per MW-month
- ATSI: $57,482 per MW-year, or $4,790 per MW-month

The charges are based on the annual peak demand from the municipal utility.

AMP member utilities jointly contract for wholesale generation to meet some of their power needs. These contracts are reflected as both charges and credits on the AMP invoice. For example, each AMP member utility is charged for its peak demand under PJM market rules, but then is credited for the portion of the AMP-supplied generation that is attributed to the member utility. This complicated system of charges and credits is used because the rates (prices) for serving demand from customers and providing generation to the grid are calculated differently.

### Behind-the-Meter Generation

AMP's invoices are similarly complicated for municipal-owned generation, including both charges and credits. The charges are rare, and usually relate to occasions when the municipal utility commits to generate power in advance, but then decides to purchase power in lieu of generation in real time.

The credits on AMP invoices related to the municipal-owned generation are calculated under PJM's rules for Behind-the-Meter Generation (BTMG).[10] PJM uses that term to refer to generation located within a wholesale customer, either behind an end-use customer meter or within a utility that is a wholesale customer.

The generation output from BTMG must be delivered directly to load, used to reduce load from retail end-use customers, or used to reduce load at the wholesale area level (e.g., across the entire AMP system).[11] The first two cases are considered to be Retail BTMG, while the third is called Non-Retail BTMG. When determining charges for energy, ancillary services, capacity, transmission and administrative fee charges, the net load is defined as gross load minus operating BTMG.

- For administrative fees and ancillary service charges, net load and generation (gross load minus operating BTMG) can be measured in real time.
- For capacity and transmission service credits, however, the netting method is more complex.[12] The capacity credit is based on the average

output of the BTMG unit during the five PJM peak hours (system 5CP method) in the prior year. The transmission credit is based on the BTMG generation during the transmission-zone peak demand hour for the prior year (zonal 1CP method).

The Dover and Orrville plants operate as retail BTMG units,[a] and thus their capacity and transmission service credits depend on their operating performance.

***Non-Retail BTMG***

However, because the Painesville plant is used to reduce load at the wholesale level instead of netting municipal load, it operates as Non-Retail BTMG.[13] Essentially, the Painesville plant serves all AMP municipal customers across multiple energy nodes on the PJM system.[b]

The same credit calculations are used, but Non-Retail BTMG has the additional performance requirement that it must operate at its maximum output during the first ten occurrences of maximum generation emergency (MGE) conditions in the zone each year.[c] If a Non-Retail BTMG fails to meet its expected performance level during a MGE event, then its allowed netting is reduced by 10% of the shortfall.

## Sources, Assumptions and Discrepancies

***Plant Capacity Data***

Data regarding plant capacity, technology, heat input, and operating limits were obtained from relevant Ohio EPA air permits and EIA Form 860 data. Where available, we refer to the operating capacity of a generating unit, rather than its nameplate capacity. In some cases, we used professional judgement based on other data sources to determine how to represent inconsistent data.

[a] PJM does not appear to make very much data related to BTMG units publicly available. The BTMG status of specific generating units must be inferred from financial data or confirmed with the operator.

[b] The PJM Independent Market Monitor recommends, in a slightly different context, that “load and generation located at separate nodes be treated as separate resources,” because they do not “pay for the appropriate level of transmission service.” It appears that Non-Retail BTMG operates contrary to this recommendation. *See* Monitoring Analytics, LLC, *2019 State of the Market Report for PJM*, Vol. 2. (March 12, 2020), p. 390.

[c] A review of PJM’s emergency procedures postings did not identify any applicable MGE events during the 2015-19 time period.

### Hourly Generation Data

Hourly generation data was obtained from each of the three utilities in response to open records requests. Painesville and Dover provided total hourly generation for the entire plant, while Orrville provided generation for each of its three units.

Orrville was unable to produce data for most of the month of March 2015 due to data corruption. As a result, analysis of 2015 data may omit some load and benefit to the system.

Monthly generation data are also available from EIA Form 923 and AMP Invoices. As shown in Table 4 below, these three data sources are generally consistent but never identical.

### Hourly Energy Prices

Hourly energy prices were obtained from PJM real time market data.

None of the documentation provided by the municipal electric departments or available from PJM identifies the relevant PJM energy pricing nodes for the power plants. We assumed the following PJM nodes:

- **Dover**: Dover aggregate LMP node
- **Orrville**: Aggregate AMP-ATSI node
- **Painesville**: Painesville aggregate LMP node

### Monthly Generation, Revenues, and Credits

Each of the utilities provided monthly invoices from AMP. In the case of Orrville, a monthly invoice to AMP from Orrville was also provided. These invoices provided several different kinds of data, including the following:

- Monthly generation, which we organized into self-generation and sales to market.
- Energy revenues for sales to market.
- Transmission and capacity credits for BTMG.

We also analyzed monthly transmission and capacity charges to the utility for its overall load for comparison to the transmission and capacity credits.

### Fuel Costs

Fuel costs for 2015–2018 were derived from monthly data filed by the utilities on EIA Form 923. Fuel consumption data are available for all three utilities, and are reported by unit and fuel type. However, fuel prices are derived from plant-level fuel expenditure data and are not reported by unit. Total fuel costs are simply the fuel consumption times the fuel price.

In the case of Dover Municipal Light Plant, fuel expenditures were not reported on EIA Form 923. Although we also obtained monthly fuel costs from Dover, those costs were not consistent with monthly fuel use and the calculated monthly fuel prices were not meaningful. Instead, we assumed Dover paid the average of the fuel prices for Orrville and Painesville (whose fuel prices were quite similar). For 2018, there were also no reported fuel expenditures for Orrville Plant. We assumed that Orrville paid the same prices in 2018 as it did in 2017 (Painesville paid similar prices in those two years.)

We obtained 2019 fuel costs for the Painesville Municipal Electric Plant from data supplied by the utility in response to a record request.

### O&M Costs

Plant operating and maintenance costs were obtained from city financial reports. Ideally, these reports would have expenses by generating unit, excluding fuel costs (which are separately reported), power costs (the AMP bill), distribution system expenses, and depreciation of assets.

However, the actual cost data provided by each city were somewhat less specific. In addition to deducting the AMP bill and fuel costs, the following adjustments were made to data obtained from each municipal utility.

- **Dover**: Plant expenses were provided in Dover's Comprehensive Annual Financial Report (CAFR), to which we added a pro-rated portion of utility office expenses and deducted a pro-rated portion of depreciation. Data were available through 2018.
- **Orrville**: Production expenses were provided in the Orrville Utilities Annual Report, to which we added pro-rated portions of administrative, general, technical services, finance, and law. We did not have any evidence that the annual report included depreciation of assets among the expenses. Data were available through 2018.
- **Painesville**: We used electric plant expenses provided in response to an open records act request. However, the response was ambiguous in terms of what expenses were included. Although we filed a second open records act request, to which additional data were supplied, the second response did not clarify the initial response.[14] Data were available through 2019.

Because O&M data were not provided by Dover or Orrville for 2019, we were unable to calculate net benefits for those two plants for 2019.

# Dispatch of Municipal Plants

The PJM regional market provides substantial economic incentives for dispatch to serve load cost-effectively. If demand is forecast to be high, the day ahead market energy prices should also be high. Similarly, the real time market energy prices should also be high when demand is high. The three municipal plants should generally be dispatched to meet that demand.

However, if the plants are not operating when demand is high, then it may not be cost-effective to incur startup costs to meet day ahead or real time demand.

## Typical Dispatch Patterns

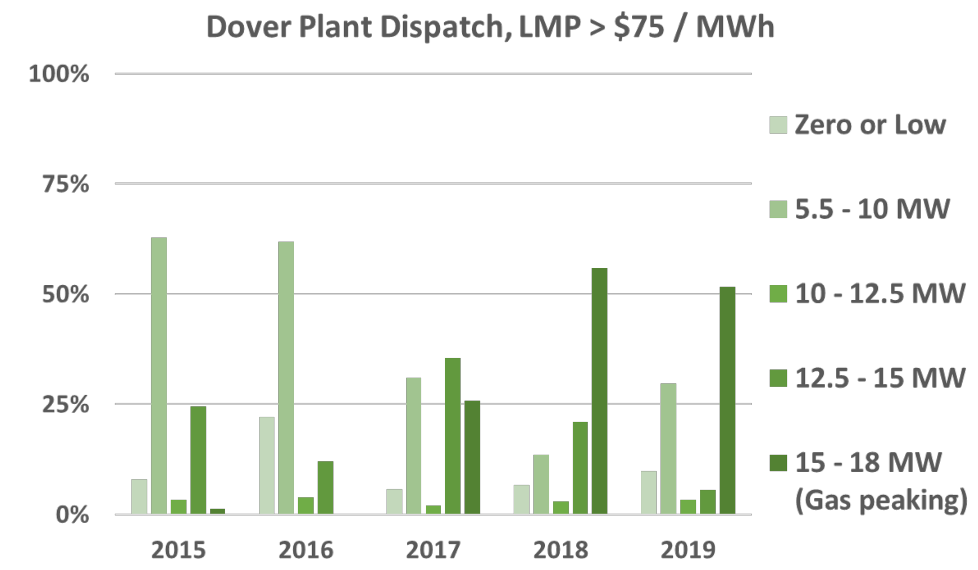
### *Dover*

According to its plant manager, the Dover Municipal Light Plant is committed based on the day-ahead energy prices in coordination with AMP, and then dispatch is modified based on real-time pricing by Dover's plant operator.[15] The decision to commit is based on a comparison of the day-ahead and real-time energy prices with the annual average cost per MWh to operate the plant. In the winter, the gas turbine generation is used to peak shave.

As noted above, the hourly generation data for Dover is the total for all its generation units.

Analysis of hourly load data from 2015-2019 indicates that dispatch became more sensitive to energy market prices in late 2017. As illustrated in Figure 2, Dover dispatched its plant at its highest levels (15-18 MW) during half of high energy price hours in 2018 and 2019. Prior to 2017, the plant was generally dispatched at less than 10 MW during high energy price hours.

**Figure 2: Dover Municipal Light Plant Dispatch for High Energy Price Hours, 2015-19**




*Source: Analysis of data supplied by Dover Light & Power, response to public records request (January 20, 2020) and PJM locational marginal pricing data.*

The Dover plant has generally run continuously, with the exception of what are presumably maintenance periods in April and May. For example, in 2018 and 2019, other than an April-May shutdown, Dover's plant only went offline during what appear to be four unplanned outages of up to five days. However, even though it is operating during most hours, its annual capacity factor is only 30-40%, operating at the higher end of that range beginning in 2017.

The Dover plant could be operated more cost-effectively by dispatching it more responsively to market prices. During low energy-price hours (less than $40/MWh), the plant usually runs at about 8 MW. Yet the plant also runs at a low dispatch rate during roughly one third of the high energy price hours (more than $75/MWh).[a]

### *Orrville*

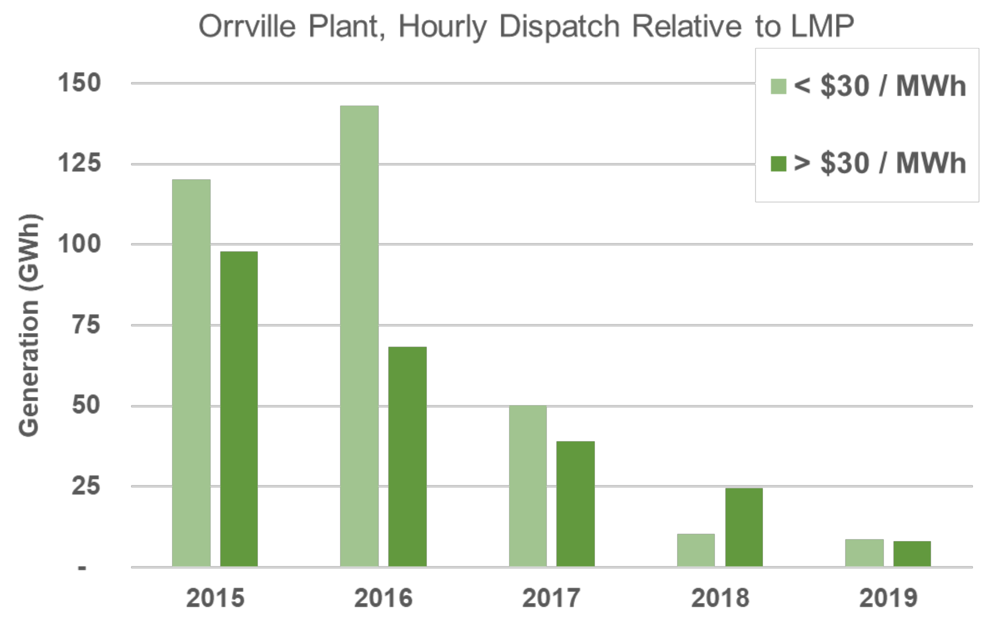
According to Orrville Utilities, the three units of the Orrville Plant are dispatched based on a weekly schedule provided by Orrville to AMP, and Orrville provides AMP guidance on marketing excess generation in PJM

[a] In 2018-19, the Dover plant operated at less than 10 MW for about a quarter of high energy price hours. When operating, the average dispatch during those hours was about 7 MW.

energy markets.[16] AMP provides advanced notification to the utility about potential peak events, and the utility determines the response.

Prior to the implementation of the Boiler MACT rules in 2017, Orrville's plant often operated at an hourly loss, even though it only operated at a 37% capacity factor. As shown in Figure 3, more than half of the power generated by the Orrville Plant in 2015-17 occurred during hours with energy market prices less than $30 per MWh, which is less than the average fuel cost to operate the plant.

**Figure 3: Orrville Plant Dispatch, 2015-19**



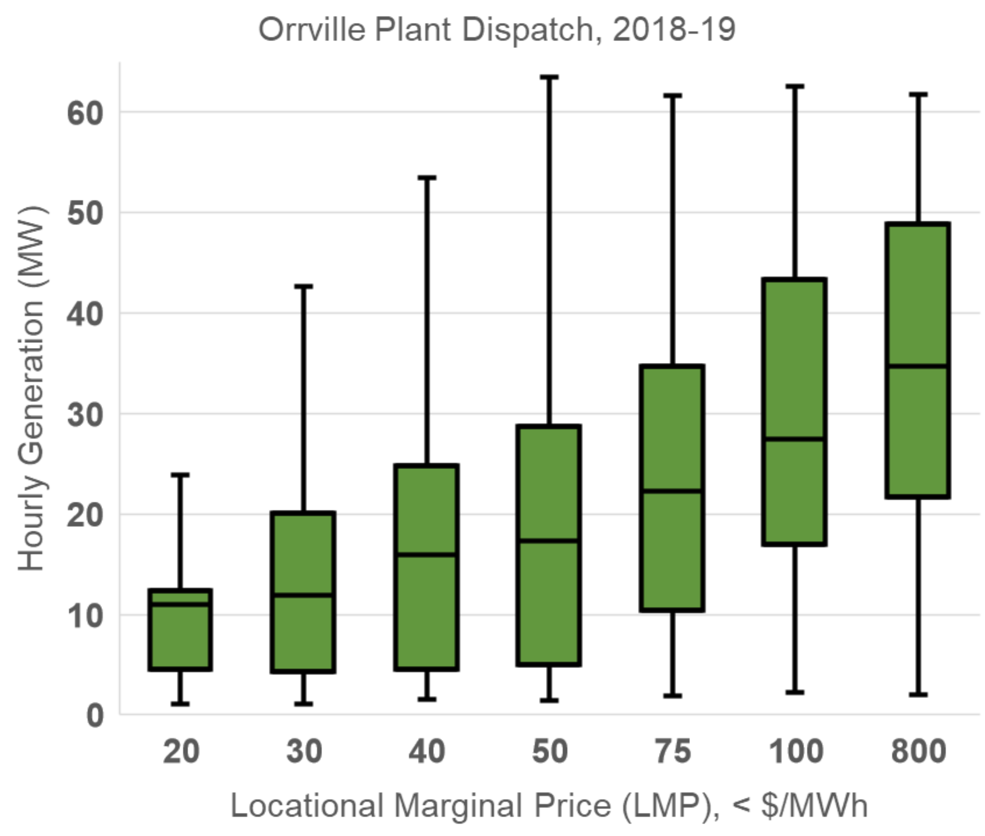

*Source: Analysis of data supplied by Orrville Utilities, response to public records request (February 10, 2020) and PJM locational marginal pricing data.*

Orrville's plant dispatch changed significantly in 2017, when one boiler was converted to natural gas. Prior to 2017, the plant operated nearly year-round, and the 66 MW plant was generally dispatched from 10-30 MW. However, beginning in April 2017, the plant was idled more often than not. The capacity factor declined to less than 5% in 2018 and 2019. The plant was only active about one-fifth of the year, typically dispatched for 1-3 day periods.

However, even though unit 11 was converted to natural gas in 2017, the relative dispatch of the three units did not change. In 2015-16, the 22 MW unit 9 was the source of about 20% of the plant's generation, and the 25 MW units 10 and 11 were each the source of about 40% of the plant's generation. In 2018-19, after unit 11 was converted to natural gas and total plant generation dropped, the unit generation shares were still 20%-40%-40%. While the fuel price data we have for Orrville are incomplete (see p. 11), it appears that the cost to operate Orrville's natural gas unit is slightly more than the cost to operate the coal units (in terms of $/MMBtu).

While Orville dispatched its plant more often during hours with higher energy market prices, it may not have been able to optimize its generation with those market prices. As shown in the box-and-whisker style five-number summary in Figure 4, plant dispatch generally increases with energy market prices.

**Figure 4: Orrville Plant Dispatch Compared to Energy Market Prices, 2018-19**




*Source: Analysis of data supplied by Orrville Utilities, response to public records request (February 10, 2020) and PJM locational marginal pricing data.*

However, at all levels of pricing, hourly dispatch of the Orrville plant varied widely. For example, for real-time hourly prices of $30-40, half of the hourly dispatch was 5-25 MW, but a quarter of the hourly dispatch was well above 25 MW. A close review of the dispatch data did not suggest any tendencies to elevate dispatch for several hours in order to catch high-value hourly prices, or lower dispatch when most of the day would tend to have lower-value hourly prices. There may be operational constraints that prevent the plant operators from capturing more economic value from the plant's limited operating hours.

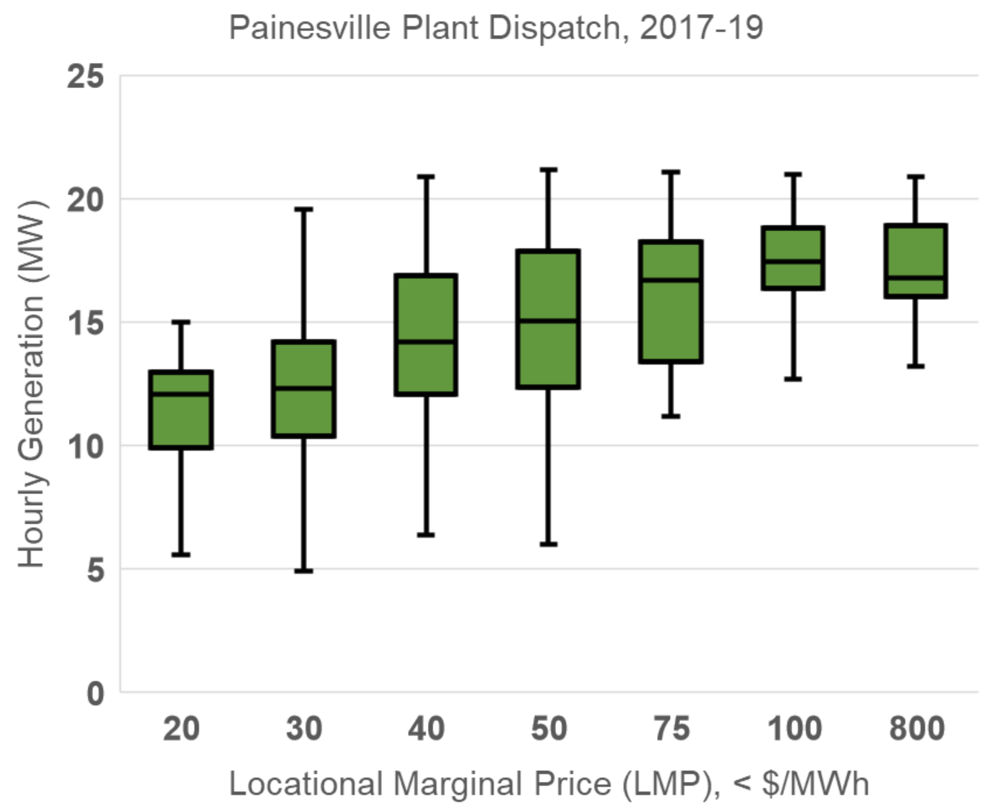
### *Painesville*

Painesville is the least-dispatched plant of the three plants studied. The plant typically operates for ½ to 2½ days at a stretch, about 9 times per year. In 2017, as a result of the Boiler MACT rules, the plant's maximum output was limited to 22 MW. At that time, it reduced its capacity factor to just 2%.

The operational hours for Painesville do not match peak market price hours. Even though market energy prices over $60 /MWh are available to Painesville for an average of 7% of the year, the vast majority of Painesville's generation has occurred when real-time prices are less than $35/MWh, less than the average fuel price to operate the plant.

Even when the Painesville plant is operating, the plant's dispatch doesn't necessarily reflect real time market pricing. As shown in the box-and-whisker style five-number summary in Figure 5, even though plant dispatch generally increases with energy market prices, the plant is often dispatched at relatively high generation rates even when prices are low. For example, for when real-time hourly prices are $30-40, the plant is likely operating at a loss. Even during these unprofitable operating hours, half of the hourly dispatch was 12-16 MW, and a quarter of the hourly dispatch was well above 16 MW. There may be operational constraints that prevent the plant operators from capturing more economic value from the plant's limited operating hours.

**Figure 5: Painesville Plant Dispatch Compared to Energy Market Prices, 2017-19**




*Source: Analysis of data supplied by the City of Painesville's Electric Division, response to public records request (December 30, 2020) and PJM locational marginal pricing data.*

## Discussion of Dispatch to Market

None of the three plants are efficiently dispatched. Although all have relatively low capacity factors, Painesville stands out as being operated most like a peaker, but its dispatch does not closely follow market prices. Dover and Orrville showed some improvement in price-sensitive dispatch since the EPA Boiler MACT rules were implemented in 2017.

The Orrville and Painesville plants have been offline, or only partially dispatched, during most hours with very high LMPs. In 2018-19, the Orrville and Painesville plants were fully dispatched less than one-tenth of the hours with LMPs greater than $75/MWh. Even Dover, which operated to some extent in almost all hours, was fully dispatched less than half of the high-priced hours. None of the three municipal utilities has been optimizing the financial value of their plants by achieving the most cost-effective dispatch.

PJM market rules allow BTMG units to adjust dispatch in response to real-time market prices. Even though all three plants make day-ahead scheduling commitments, PJM market rules allow the plants to generate above their scheduling commitment when real-time prices are higher than day-ahead prices, or to purchase power in lieu of generation when real-time prices are lower than day-ahead. The AMP invoice record shows all three plants engaging in real-time dispatch in some hours.

Better plant dispatch could enable each of these plants to receive the same levels of revenue while reducing generation, fuel costs and emissions. Although plant operational issues may affect the opportunity to optimize plant output, the savings the plants could achieve can be estimated using a simple dispatch model. Without reducing revenues, and assuming that fuel costs and emissions are proportionate to generation, our rough estimates suggest the following opportunities for savings.

- At Dover, reducing output at uneconomic times could reduce fuel costs and emissions by 20%.
- At Orrville, reducing output at uneconomic times could reduce fuel costs and emissions by 10%.
- At Painesville, optimizing plant output would likely require operating the plant during additional high-value hours and fewer low-value hours. We estimated that the same revenues could be achieved while reducing fuel costs and emissions by 20%.

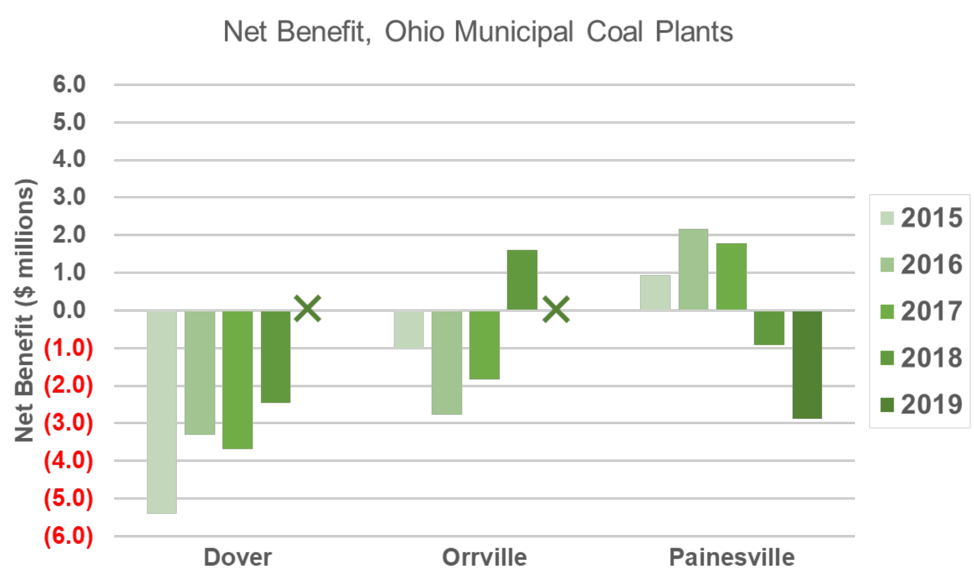
These estimates are an indication of the potential savings that could result from an improved match between dispatch and market prices.

# Benefit-Cost Analysis of Municipal Coal Plants

## Overview of Benefit-Cost Analysis

In general, the cost of operating the three municipal coal plants has exceeded the benefits, as shown in Figure 6. The analysis in this section of the report is at the plant level, and includes some costs and benefits associated with gas-fueled units. However, only at the Orrville plant is gas a significant fuel source, and only in 2017 and 2018. The vast majority of the costs and benefits reported here are associated with the coal units.

**Figure 6: Net Benefit of Municipal Coal Plants in Ohio, 2015-19**




X – Incomplete data availability for Dover and Orrville in 2019. See discussion on p. 12.
*Source: EIA, PJM, and municipal utility supplied data.*

The Orrville plant appears to have operated profitably in 2018, perhaps as a result of its adaptation to the EPA Boiler MACT rules put in place in 2017. The profitable operation does not appear to be a result of converting one unit to natural gas since coal was actually the least-cost resource at Orrville (see p. 14). Whether that improvement continued into 2019 will only be known once Orrville releases 2019 fuel costs.

Most of the revenues associated with these plants are actually bill credits for capacity and transmission, as explained above (see discussion beginning on p. 8). The major costs are plant operations and maintenance.

The worst performing plant is Dover. However, as discussed below, the plant's O&M costs appear to be much higher than suggested by reference unit costs. If the plant costs were similar to those at Orrville and Painesville, then the costs would still exceed the benefits, but not by nearly so much.

## Revenues (Benefits)

***Self-supply***

As discussed above (see discussion beginning on p. 9), Dover and Orrville operate as Behind-the-Meter Generation, and Painesville operates as Non-Retail BTMG. Because Painesville operates as Non-Retail BTMG, all its power is delivered to the AMP wholesale market, so the Painesville generation does not have any self-supply value.

For Dover and Orrville, self-supply value is calculated as the total annual value of generation (hourly generation times hourly real-time LMP), less the energy to market revenues reported on monthly AMP bills. (See Table 4 below.)

***Energy to market***

All three utilities are credited for the electricity they deliver to the grid on the monthly AMP bill. The utilities sell power in the day-ahead (scheduled generation) market and in the real-time market. Energy market revenues are summarized in Table 4.

As discussed above (see p. 11), there were some discrepancies among data sources for the monthly and annual generation at the three utilities' power plants. These generation totals reflect all sources of generation at the municipal plants. Generally, the three utilities generated 90-100% of power using coal from 2015-18. Orrville was the sole exception in 2017 and 2018, when it switched one boiler to natural gas, and reduced coal to fuel 47% and then 40% of generation.

In the case of Painesville, which does not self-supply, we could compare our computations of the market value of its generation (hourly generation times hourly real-time LMP) to its monthly AMP bill credit for energy generation. The AMP credit was about one quarter less than we computed in 2015. In all other years the calculated value closely matched the AMP energy bill credits.

**Table 4: Generation, Self-Supply, and Energy Market Revenues, Ohio Municipal Utilities, 2015-19**

| | | Source | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|
| | **Dover Municipal Light Plant** | | | | | | |
| A | **Generation (MWh)** | EIA | 45,704 | 46,080 | 51,908 | 58,326 | n/a |
| B | **Generation (MWh)** | AMP Invoices | 48,225 | 47,934 | 52,359 | 59,016 | 51,729 |
| C | **Generation (MWh)** | Utility Records | 53,203 | 47,908 | 57,290 | 65,470 | 58,820 |
| D | **LMP Value ($ million)** | Hourly LMP * C | $2.00 | $1.18 | $1.85 | $2.82 | $1.44 |
| E | **Energy Market Revenues ($ million)** | AMP Invoices | $0.20 | $0.32 | $0.33 | $0.38 | $0.11 |
| F | **Self-Supply ($ million)** | D - E | $1.80 | $0.84 | $1.56 | $2.44 | $1.33 |
| G | **Average LMP ($ / MWh)** | D / C | $38 | $25 | $32 | $43 | $25 |
| | **Orrville Plant** | | | | | | |
| A | **Generation (MWh)** | EIA | 221,087 | 185,513 | 80,760 | 31,210 | n/a |
| B | **Generation (MWh)** | AMP Invoices | 220,599 | 187,844 | 84,482 | 30,948 | 14,264 |
| C | **Generation (MWh)** | Utility Records | 217,861 | 213,663 | 94,002 | 28,572 | 15,663 |
| D | **LMP Value ($ million)** | Hourly LMP * C | $7.92 | $6.60 | $2.98 | $2.15 | $0.60 |
| E | **Energy Market Revenues ($ million)** | AMP Invoices | $0.92 | $0.68 | $1.81 | $1.22 | $0.54 |
| F | **Self-Supply ($ million)** | D - E | $6.99 | $5.93 | $1.17 | $0.93 | $0.06 |
| G | **Average LMP ($ / MWh)** | D / C | $36 | $31 | $32 | $75 | $38 |
| | **Painesville Municipal Electric Plant** | | | | | | |
| A | **Generation (MWh)** | EIA | 9,440 | 10,397 | 3,333 | 3,369 | n/a |
| B | **Generation (MWh)** | AMP Invoices | 4,763 | 11,733 | 3,664 | 3,719 | 3,016 |
| C | **Generation (MWh)** | Utility Records | 10,658 | 12,015 | 3,682 | 3,607 | 3,018 |
| D | **LMP Value ($ million)** | Hourly LMP * C | $0.44 | $0.50 | $0.13 | $0.20 | $0.10 |
| E | **Energy Market Revenues ($ million)** | AMP Invoices | $0.33 | $0.49 | $0.13 | $0.18 | $0.09 |
| F | **Self-Supply ($ million)** | D - E | n/a | n/a | n/a | n/a | n/a |
| G | **Average LMP ($ / MWh)** | D / C | $41 | $42 | $36 | $55 | $35 |

***Capacity and transmission payments***

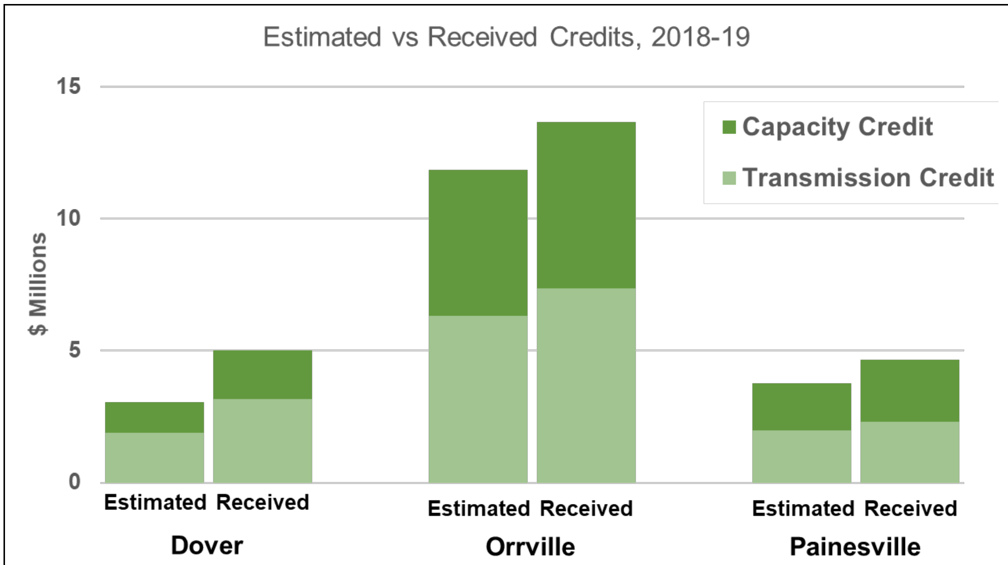
Under the BTMG rules, each municipal utility receives substantial credits for capacity and transmission. Capacity credits are based on the reduction to the utility's peak load contribution (PLC) and valued at the capacity market price set under the Reliability Pricing Model (RPM). The RPM value is set in an annual auction.

Transmission credits are valued based on the reduction to the utility's network service peak load (NSPL) and valued at regulated rates from the transmission provider. Dover is connected to the AEP system; Painesville and Orrville are connected to the ATSI system.

Despite requests to all three utilities for information on the credits, we did not receive data that specifically identified the basis for the amounts of the credits on the AMP invoices. As discussed on p. 9, BTMG capacity and transmission credits relate to the prior year performance of the generation during peak hours. We calculated an estimate of the credits that each plant should have received based on hourly generation data from the utilities, PJM rules and market data, and AEP or ATSI rules and rates.

As shown in Figure 7, all three municipal utilities appear to be receiving transmission and capacity credits that are higher than can be explained by PJM rules.

**Figure 7: Estimated vs Received Credits for Capacity and Transmission Service, 2018-19**




*Source: PJM data and municipal utility supplied AMP invoices.*

The higher credit values are not explained by the utilities failing to operate their plants during system peak hours. Since the BTMG credits relate to prior year performance during peak hours, we took that into consideration in calculating the credits that we believe the plants should have received under PJM market rules. In most years, the plants achieve capacity values within 15% and transmission service values within 10% of maximum plant generation, as shown in Table 5.

**Table 5: Capacity Performance Data, Ohio Municipal Utilities, 2015-19**

| | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| **Dover Municipal Light Plant** | | | | | |
| **Maximum Hourly Output (MW)** | 15.3 | 15.3 | 15.5 | 16.4 | 17.8 |
| **Capacity Value (MW)** | 15.2 | 5.7 | 12.5 | 16.0 | 14.9 |
| **Transmission Service Value (MW)** | 13.9 | 0.0 | 14.4 | 15.4 | 16.0 |
| **Orrville Plant** | | | | | |
| **Maximum Hourly Output (MW)** | 63.6 | 60.3 | 58.8 | 61.9 | 63.4 |
| **Capacity Value (MW)** | 66.0 | 51.9 | 42.7 | 59.1 | 35.4 |
| **Transmission Service Value (MW)** | 63.2 | 49.5 | 53.3 | 61.6 | 56.5 |
| **Painesville Municipal Electric Plant** | | | | | |
| **Maximum Hourly Output (MW)** | 37.7 | 36.4 | 19.9 | 21.2 | 19.8 |
| **Capacity Value (MW)** | 38.7 | 36.4 | 7.0 | 18.7 | 12.1 |
| **Transmission Service Value (MW)** | 36.3 | 35.4 | 16.6 | 19.4 | 18.8 |

Notes: Capacity value based on 5CP method, adjusted for weather normalization factor. Transmission service value based on 1CP method. Capacity value is used to calculate credit in the following year beginning in June. Transmission service value is used to calculate credit in the following calendar year.

Sources: PJM data and municipal utility supplied hourly generation data.

Since 2015, the transmission service credits that AMP has provided to three plants almost always exceeds the amount that we estimated the plant should have been credited. The only exception is Orrville's 2019 transmission service credit, which we estimated should have been about $0.5 million (13%) higher than received. However, the amount has varied considerably by plant and year. From 2016-19, our estimate suggests that the transmission credits were inflated by about 28%.

With respect to capacity credits, the history is uneven across both plants and years. The capacity credit received by the Dover plant exceeded the amount we estimated it should receive in each year, but Orrville and Painesville plants received less than we estimated in some years. Overall, the three plants received 23% less than we estimated they should have in 2016-17, but 23% more than we estimated they should have in 2018-19.

We did not find a convincing explanation for these discrepancies. As noted above, we requested but did not receive more specific information on these credits from each utility. One possibility is that credit terms with AMP include modifications to the PJM BTMG rules, or simply differences in accounting that are not apparent from the AMP invoices.

According to one plant manager, the credits also include load reduction programs, such as demand response.[17] These programs relate to the energy reduction, calculated as the difference between the utility's customer baseline (CBL) and real-time load. However, it is questionable whether these programs are included in the credits since they are not dependent on the operation of the power plant, and we only found evidence of these credits on AMP bills for cities with BTMG units, and did not find evidence of these credits being provided to other members of AMP.[18] We are also doubtful that these credits consider additional, privately-owned BTMG. We found no evidence of privately-owned BTMG units on the three utility systems.

Regardless of why the credit payments are so high, they provide what little economic justification there is for continued operation of these plants. While we found no evidence that any of the cities have reviewed the cost-effectiveness of their plants, the only potential argument for keeping a plant that is currently losing money open is that it provides a hedge against rising transmission charges. However, given that the plants are generally operating at a loss, the forecast value of that hedge would need to be fairly large to provide a significant net benefit.

Furthermore, we found very little discussion of the methods and practices associated with credits given to Behind-the-Meter Generation units on the PJM system. For example, neither the PJM Operating Committee nor the PJM Independent Market Monitor appears to have given significant attention to the methods and practices that we examined in this analysis over the past decade.[a] Any problems with these three units could easily be symptomatic of problems with other BTMG units on the PJM system.

## Plant Costs

Costs to own and operate the municipal power plants can be broken down into four categories:

- Fuel
- Variable O&M
- Fixed O&M
- Depreciation

[a] Other issues related to BTMG credits have received significant attention.

The data sources for fuel and O&M costs are discussed above (see p.11). We were unable to distinguish between variable and fixed O&M costs. However, utilizing generic assumptions from EPA for variable ($2 /MWh) and fixed ($42 /kW-yr),[19] we were able to account for roughly half of the O&M costs at Orrville and Painesville plants, and less than one-fifth of the O&M costs at the Dover plant. This suggests that these plants are either unusually expensive to operate and maintain (although there may be some non-plant costs included in the cost data we obtained from the three cities). Given the small size and advanced age of the coal units, the high costs are not surprising.

**Table 6: Fuel and Plant O&M Costs, Ohio Municipal Utilities, 2015-2019**

| | Source | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| **Dover Municipal Light Plant** | | | | | | |
| **Fuel ($ million)** | EIA 923 | 1.92 | 1.96 | 2.26 | 3.34 | |
| **Plant O&M ($ million)** | Utility Records | 6.66 | 4.27 | 5.09 | 4.82 | |
| **Fuel price ($ / MWh)** | EIA 923 | 36 | 41 | 38 | 51 | |
| **Orrville Plant** | | | | | | |
| **Fuel ($ million)** | EIA 923 | 8.18 | 7.14 | 3.48 | 1.42 | |
| **Plant O&M ($ million)** | Utility Records | 6.71 | 8.49 | 6.76 | 6.18 | |
| **Fuel price ($ / MWh)** | EIA 923 | 38 | 33 | 37 | 50 | |
| **Painesville Municipal Electric Plant** | | | | | | |
| **Fuel ($ million)** | EIA 923 | 0.39 | 0.49 | 0.17 | 0.20 | 0.28 |
| **Plant O&M ($ million)** | Utility Records | 4.02 | 2.38 | 2.16 | 3.48 | 4.76 |
| **Fuel price ($ / MWh)** | EIA 923 | 37 | 41 | 47 | 55 | 91 |

The Dover plant O&M costs are much higher than those at the other two utilities on a dollars per MWh or MW basis. Even if the Dover plant O&M costs are actually similar to those at the other two municipal plants, Dover plant costs would significantly exceeded benefits in most years.

The high O&M costs at the Dover plant are surprising since the plant is operated relatively continuously, and thus does not have the significant startup and shutdown costs associated with multiple operating cycles.

Regarding depreciation, and related debt service, we were unable to obtain sufficient data to reach any substantial findings. As discussed above (see p. 12), we did exclude depreciation costs from our estimate of annual O&M costs for the Dover plant. Otherwise, the financial information we were able to obtain was insufficient to determine what the ongoing debt service associated with the three plants might be. In any event, depreciation and related debt service are not relevant to the plant's operating economics.

# Summary of Benefit-Cost Findings

In general, the cost of operating the three municipal coal plants has exceeded their benefits. The Orrville plant may be operating cost-effectively since the EPA Boiler MACT rules were put in place, based on just one year of data.

Since the EPA Boiler MACT rules were implemented in 2017 at the three Ohio municipal coal plants, the utilities' main sources of revenues have been PJM capacity market credits and transmission system credits. Only at Dover have energy market revenues also been a significant source of value.

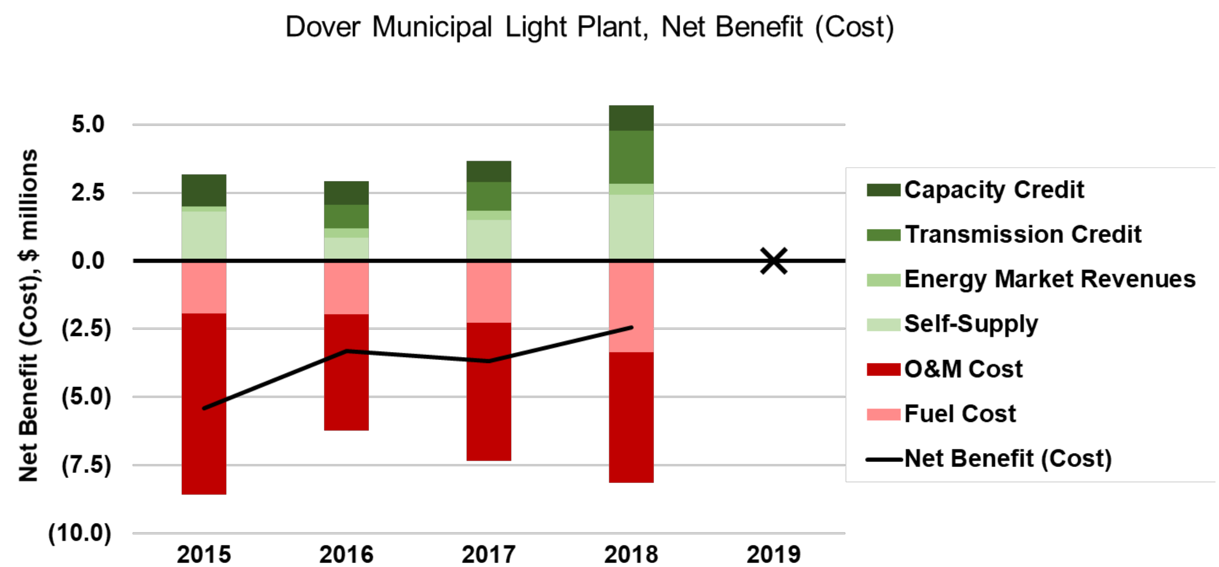
All three plants have O&M costs that exceed EPA's generic unit benchmark costs, and the Dover plant costs seem particularly high. Since 2017, plant O&M costs have substantially exceeded fuel costs at the three plants. These high costs are unsurprising, since the plants are small (lacking economies of scale) and older (potentially requiring higher-than-average maintenance). Nevertheless, we were not able to determine specific reasons that the plants had high O&M costs.

The plants' cost-effectiveness might be improved through more optimal dispatch, which would lead to fuel savings and/or higher per-MWh revenues. However, as discussed above (p. 18), potential savings appear to be limited to around 10%–20% of fuel costs, which would not be enough to make the plants profitable.

The Dover and Painesville plants show significant recent losses, as shown in Figure 8 and Figure 10. These plants do not appear to be cost-effective to operate, even if more optimal dispatch were to be used to reduce fuel costs.

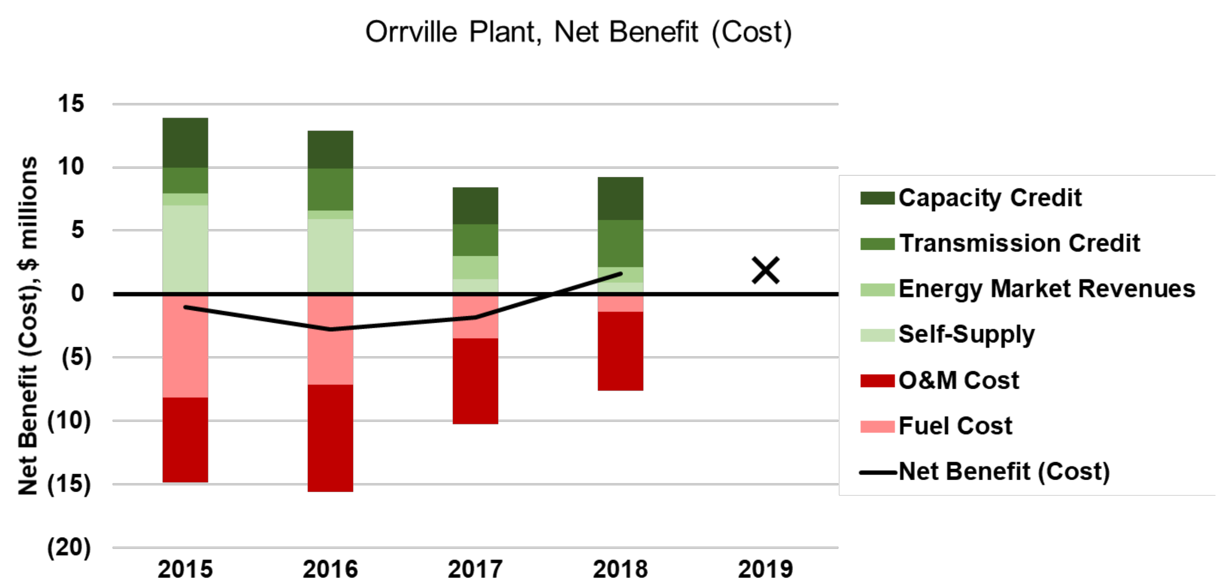
The Orrville plant shows a net benefit in 2018, as shown in Figure 9. In 2019, revenues to the Orrville plant declined by $2 million, primarily due to lower energy market revenues. Since O&M and fuel cost data for 2019 are not yet available, we do not know if the Orrville plant will show a net benefit in 2019. If those costs remained about the same as 2018, the Orrville plant will have been unprofitable again in 2019.

**Figure 8: Dover Municipal Light Plant, Net Benefit (Cost), 2015-19**



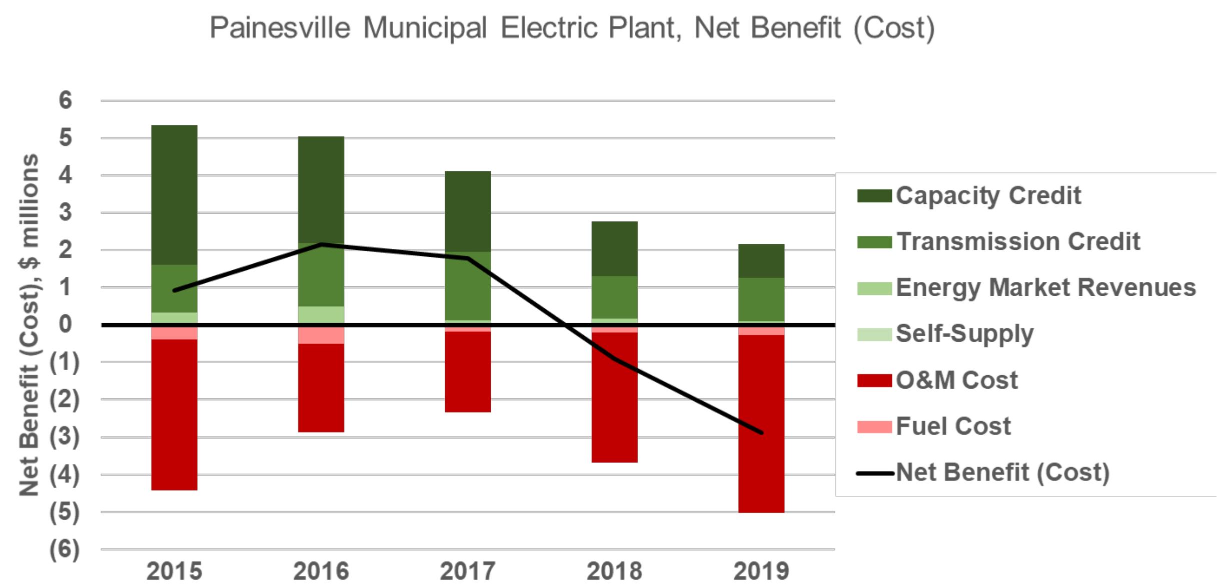

*Sources: See Table 4, Figure 7, and Table 6.*

**Figure 9: Orrville Plant, Net Benefit (Cost), 2015-19**




*Sources: See Table 4, Figure 7, and Table 6.*

**Figure 10: Painesville Municipal Electric Plant, Net Benefit (Cost), 2015-19**




*Sources: See Table 4, Figure 7, and Table* 6.

# Endnotes

[1] David Filippi, Dover Municipal Light Plant, personal communication (March 12, 2020).

[2] US Environmental Protection Agency, Boiler Maximum Achievable Control Technology (MACT) Rule, 40 CFR Part 63, Subpart DDDDD.

[3] Per a 2014 Ohio EPA extension, the coal unit was required to comply with NESHAP Subpart DDDDD by January 31, 2017. Ohio Environmental Protection Agency, Title V Permit P090801, Facility 0679010146 (December 20, 2016).

[4] City of Dover, Ohio, *Comprehensive Annual Financial Report for the Year Ended December 31, 2015* (June 27, 2016), p. 14.

[5] City of Dover, Ohio, *Comprehensive Annual Financial Report for the Year Ended December 31, 2018* (June 21, 2019), p. vii.

[6] Ohio Environmental Protection Agency, Title V Permit P090801, Facility 0679010146 (December 20, 2016).

[7] Ohio Environmental Protection foo, Title V Permit P0125633, Facility 0285010188 (December 4, 2019). *See also* US Environmental Protection Agency, Consent Agreement and Final Order in the Matter of City of Orrville, Docket No. CAA-05-2015-0057 (September 16, 2015).

[8] The maximum heat input of 365.4 MMBtu/hr was listed for the previous coal-fired boiler. The maximum heat input for the natural gas boiler is not listed in permits.

[9] Ohio Environmental Protection Agency, Title V Permit P0108442, Facility 0243110008 (September 15, 2017); *see also* Permit Strategy Write-Up P0120614 (October 31, 2016).

[10] Unless otherwise cited, the following text is based on: PJM, PJM Manual 14D: Generator Operational Requirements, Appendix A: Behind the Meter Generation Business Rules (Revision 51, December 19, 2019). BTMG status is elective. A unit's capability, or a portion thereof, may be changed among the Capacity Resource, Energy Resource, or BTMG status options once per year. BTMG resources are recognized in PJM transmission and generation adequacy planning models, and may participate in PJM demand side response programs.

[11] Each BTMG user must have a load serving entity (LSE) responsible for services not provided by BTMG and must have a Network Integration Transmission Service agreement with PJM.

[12] The credit value is based on the final zonal net load price, published in: Final Zonal UCAP Obligations, Capacity Prices & CTR Credit Rates. For existing units, the BTMG capacity value is obtained by adjusting the 5CP BTMG generation value for zonal metered load. Theresa Esterly, "Existing Non-Retail BTMG Business Rules," presentation to PJM Operating Committee (May 14, 2019), p. 11. For new generation, until the capacity and transmission credits can be determined using the coincident peak methods, the capacity value is set at the summer rated installed capacity value based on PJM Manual 21, section 2. For solar and wind, Appendix B multiplied by the posted class average capacity factor., the initial values are not used.

[13] Non-Retail BTMG is not available to end-use customers. The amount of Non-Retail BTMG is limited at the PJM level by a threshold and a cap. In 2019, the threshold/cap system permitted full netting because total Non-Retail BTMG was less than 2,006 MW. If Non-Retail BTMG had been between 2,006 and 3,000 MW, netting would have been prorated back to the threshold. No netting is permitted for Non-Retail BTMG in excess of the 3,000 MW cap. PJM Operating Committee, "Determination of the Threshold and Cap for Non-Retail Behind the Meter Generation" (May 14, 2019). For delivery year 2020/2021, there are 1,171.5 MW of Non-Retail BTMG. PJM, "Non-Retail Behind-the-Meter Generation Amount, Threshold, & Ratio Adjustment," spreadsheet posted to Generation Resources on October 17, 2019.

[14] City of Painesville Finance Department, response to public records request (March 12, 2020).

[15] David Filippi, Dover Municipal Light Plant, personal communication (January 7, 2020).

[16] Orrville Utilities, response to public records request (December 20, 2019).

[17] Jeff Brediger, Orrville Utilities, personal communication (March 6, 2020).

[18] AMP invoices for Ellwood City (May 2016), Napoleon (April 2019), and Town of Berlin (September 2017 and July 2019).

[19] US Environmental Protection Agency, *Documentation for EPA's Power Sector Modeling Platform v6 Using the Integrated Planning Model* (November 2018), pp. 4-11 and 4-13.