MANAGING NEW ELECTRIC LOADS IN A CHANGING INDUSTRY

A LOOK AT CRYPTOCURRENCY MINING AND CANNABIS GROW FACILITIES

AMERICAN PUBLIC POWER ASSOCIATION

Powering Strong Communities

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About the American Public Power Association

The American Public Power Association is the voice of not-for-profit, community-owned utilities that power 2,000 towns and cities nationwide. We represent public power before the federal government to protect the interests of the more than 49 million people that public power utilities serve, and the 96,000 people they employ. We advocate and advise on electricity policy, technology, trends, training, and operations.

About Utility Financial Solutions

Utility Financial Solutions, LLC (UFS) is a financial services firm specializing in financial projections, cost of service analysis, and rate design for electric, water, wastewater, gas, telecommunications, and solid waste utilities. UFS is committed to maintaining a leadership role in the utility industry by listening to the needs of clients, staying current on new developments, and incorporating feedback from industry professionals. Their services and recommendations are independent assessments of the utility's financial condition and are structured to assist utilities in meeting their financial goals.

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INTRODUCTION

Numerous trends — such as decentralization, smart grid, resiliency, electrification, increasing deployment of clean energy resources, and changing customer expectations — are impacting the evolution of the electric grid. As public power utilities embrace new opportunities and tackle challenges associated with moving to the "grid of the future," they also remain focused on providing reliable and affordable electricity to the communities they serve. Utilities are examining how to adjust everything from connection costs to power supply and transmission charges to best accommodate as new types of electric loads emerge. An increasing number of public power utilities have received inquiries from cryptocurrency miners or cannabis grow facilities on the cost to provide electricity. In addition to the increased demand, electric load from such facilities raise considerations for utilities, including legal questions, customer stability, and community perception.

Cryptocurrency mining operations and cannabis grow facilities are being built throughout the United States. Cryptocurrency miners often seek to locate in communities where electricity prices are relatively low because of the high amount of electricity they use. Due to limited building needs, miners can locate almost anywhere. Cryptocurrency operations often have a consistent usage pattern and may have flexibility in their operations to shift usage if needed. Cannabis grow facilities locate in states where cannabis has been legalized for medical or recreational use and have load patterns similar to commercial or general service customers.

Before a cryptocurrency miner or cannabis grow facility chooses a location, it will often inquire about the cost for electric service. Most utilities, including public power utilities, have procedures in place to provide guidance when speaking with a prospective customer. The utility typically assesses its ability to provide the service, estimates the connection costs, and determines what rate structures are available. Additionally, for public power, a key consideration is a prospective business' value to the community. Cryptocurrency miners and cannabis grow facilities may present potential benefits, such as additional employment or increased tax base for the community, but could also create adverse impacts, such as noise, odor, or negative community perception.

Utilities might consider developing new rates and policies or updating existing rates and policies when adding cryptocurrency mining or cannabis grow facilities to their system to ensure that this new growth does not adversely impact existing customers. When rates and policies are designed according to the utility's cost structure, they often result in more efficient use of infrastructure and lower rates for existing customers. This paper reviews key aspects of rate tariff development, potential rate offerings, characteristics of cryptocurrency operations and cannabis grow facilities, considerations for managing cryptocurrency mining and cannabis grow facility loads, and utility experiences with these types of customers.

DEVELOPMENT OF RATE TARIFFS FOR NEW LOADS

The overriding consideration for utilities when setting new rates for any type of load is to ensure revenues will exceed the marginal costs of providing service. Appropriate rate setting is a utility's main tool to keep rates stable or lower the cost for existing customers. Ideally, load growth will not result in higher rates for existing customers due to additional investments in infrastructure or higher power supply costs. To ensure existing customers benefit from the new load, utilities should consider the marginal costs for the following five categories:

1. Power supply
2. Transmission
3. Distribution (grid)
4. Capital costs to connect new customers
5. Contribution to the city and other taxes

Power Supply

Correctly assessing the marginal cost of power supply depends on how the utility obtains its energy. Power supply often represents between 50% and 80% of the cost of electricity, and under-recovery from a large customer can have unexpected effects on other customers. Most public power utilities receive their power supply in one of two ways:

a. Purchased power under a **full requirements contract,** either from a joint action agency (JAA), cooperative utility, independent power producer, or investor-owned utility.

b. The utility **self generates** its power supply or is part of a project-based JAA. Project-based JAAs generally allow each member to participate in generating resource projects, or they may purchase specific contracts or hedging options.

Full Requirements Contracts

The determination of the marginal costs under a full requirements contract can be assessed by reviewing the contract rates. The most straightforward contracts often include a demand charge and energy rate. Determination of marginal cost takes into account a new customer's usage at the time the demand charges are calculated and the amount of energy consumed. Marginal power supply costs may be calculated as shown in Table 1.

In the example, any power supply rate must exceed $246,750 in revenue generated to prevent the cost from being recovered from other customers. Public power utilities may also utilize a coincident peak demand rate to charge customers based on their actual usage at the time of system peak demand. This rate structure can motivate new customers to shift usage and reduce their electric costs without adversely impacting existing customers.

Table 1 — Calculating Marginal Power Supply Costs

Power Supply Rate	Rate (a)	Usage (b)	Unit	Losses (c)	Cost	Formulas
Demand Charge	$15.00	5,000	kW	5.0%	$78,750	a*b*(1+c) = d
Energy Rate	$0.0500	3,200,000	kWh	5.0%	$168,000	a*b*(1+c) = e
Monthly Marginal Costs — Power Supply					**$246,750**	**d + e**

Self-Generation – Outside an Independent System Operator/Regional Transmission Organization

When utilities generate power supply outside an independent system operator (ISO) or regional transmission organization (RTO) region, marginal power supply costs are considered in one of two ways. Short-run marginal cost includes the variable cost for fuel and maintenance on the generating units plus the lost opportunity to sell generating capacity. Long-run marginal cost includes the variable cost for fuel and maintenance but replaces "lost opportunity" with the cost of future generation capacity.

Determining marginal power supply under long-run marginal cost is often theoretical and requires a review of either the dispatching operations, integrated resource plan, or purchased power supply contracts. The addition of a large customer may provide substantial benefits in the short term, such as additional revenue or potential delay of system rate increases, but have long-term cost impacts due to usage patterns and peak load. It is recommended that utilities consider the short and long-term power supply impacts from a new customer.

Self-Generation – Within an ISO/RTO

Operations, requirements, and billing methods vary, which can introduce complexities when reviewing and identifying marginal costs. Even if a public power utility's generation is considered "behind-the-meter," the marginal power supply costs are the market price of energy plus capacity. Often, charging market prices will not fully recover the utility's total power supply costs because market prices may be more or less than actual utility costs. Utilities make investments in generating resources to insulate them from fluctuations of market prices, thus providing price stability. However, the self-generating utility must consider market costs when weighing the marginal costs of providing service to new customers because it can still choose to purchase from — or sell excess generation into — the market.

Utilities are responsible for their portion of cost associated with generating facilities, which are often in different locations within an ISO/RTO. Generation is economically dispatched into the market, and utilities are credited with revenues from sales. Utilities then purchase energy back at the market price from their local node. When purchase prices are equal to sales prices, utility costs equal the cost of the generator. Table 2 shows an example of an equal cost transaction.

Table 2 – Marginal Cost Equals Generating Cost

Transaction	Energy Cost per kWh
Marginal kWh generating cost of unit	$ 0.0400
Less: Revenue from market sale	(0.0500)
Plus: Utility cost for purchase at local node	0.0500
Utility Energy Cost	**$ 0.0400**

If the utility adds generation, therefore purchasing additional energy from the market, then the marginal cost becomes the market purchase price.

Determining Customer Energy Use and Resource Adequacy

Identifying the marginal cost for power supply requires a review of the customer's usage profile. The marginal energy costs are then compared with the highest energy costs in each hour to obtain an indication of the marginal cost of energy. Since cryptocurrency miners run 24-hour operations, their energy costs benefit from operations during off-peak (lower cost) time periods. Cannabis grow facilities may have the opportunity to shift operations away from peak times if they can identify their usage profile with respect to hourly costs.

In most regions, utilities need to demonstrate resource adequacy. This means that they need generation capacity equal to their peak demand, plus a safety margin between 10% and 20%. On top of calling on existing generation capacity, utilities can meet the capacity requirement by constructing new generation, purchasing capacity from the market, or purchasing capacity from others. Under each of these situations, the marginal cost is the purchase cost of capacity or the "opportunity cost" to sell the generation if excess capacity exists.

In some markets, utilities need to demonstrate resource adequacy based on annual peak demand on an annual, monthly, or hourly basis.

New customers must be charged rates greater than the market price of energy and capacity, adjusted for system losses, to avoid adverse effects on existing customers.

Power supply capacity is identified by reviewing the customer's peak usage at the time the utility's capacity peak is determined. Marginal capacity costs are estimated by the utility through review of the capacity auction or recent capacity bids received by the utility. Cryptocurrency loads are often interruptible, meaning that the utility can cease providing power during peak times. Cannabis grow facilities have specified schedules for lighting and humidity that affect the load profile depending on the stage of plant growth, however they may be able to stagger the grow schedules between plant rooms to lower peak demand.[1]

[i] In the California Independent System Operator, transmission is charged on a per kWh basis.

Transmission

Power supply is delivered through transmission lines to the local utility and charged based on rates established by the Federal Energy Regulatory Commission (FERC) or billed by the JAA. The most significant transmission charges are typically based on the peak demands of the utility, plus ancillary service charges based on other factors.[i] The billing methodology varies by ISO/RTO, with some billing based on monthly demand and others billed on an annual peak or an average of four peak hours. The utility should consider how it is billed for transmission when determining this element of marginal cost for a new customer. Then, it should review how the new customer's projected usage might affect this cost, such as likely usage during the peaks.

Figure 1 depicts how marginal costs are identified assuming the monthly transmission charge is $5.50 per kW based on each month's peak. The utility has no transmission charges for 743 hours in the month of July, but is charged $5.50 per kW at 2:00 pm on July 28, which is the utility's peak for the month.

Some ISO/RTOs charge for transmission using a 12 coincident peak (12CP), a 4 coincident peak (4CP), or a single coincident peak (1CP) methodology. As illustrated

Figure 1 – Example of Hourly Transmission Cost in July

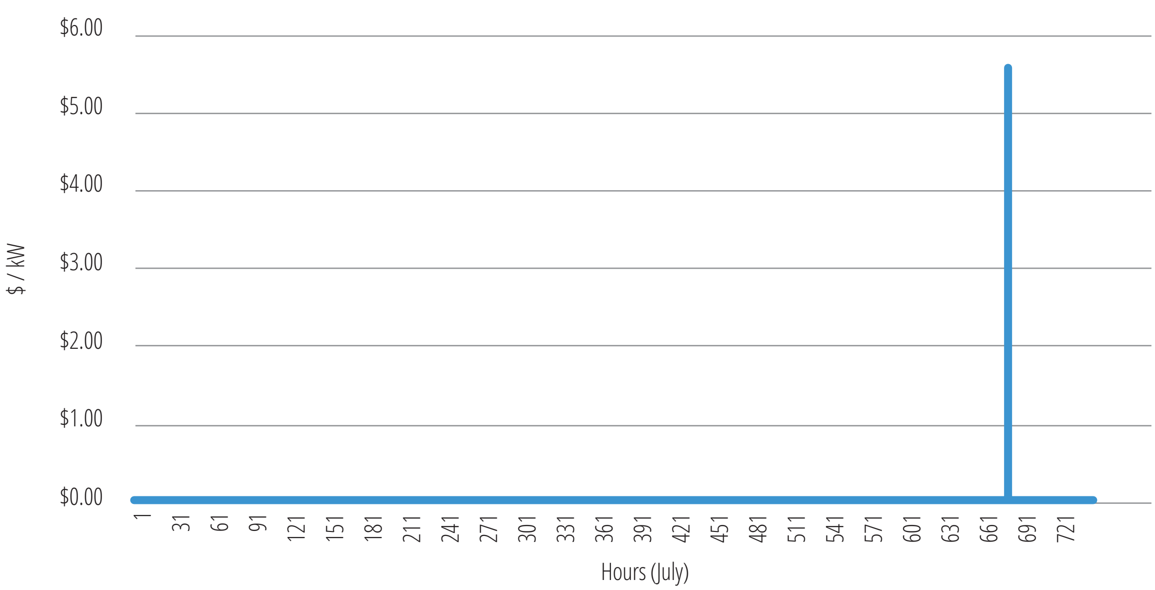


Table 3 – Determination of 12CP Marginal Rate

Transmission Peaks (Date/Time) 12CP	Monthly Use (kW) (a)	Monthly Rate ($/kW) (b)	Determination of Monthly Billings ($) (a * b = c)
January 10 @ 1PM	37,000	$5.50	$203,500
February 14 @ 3PM	31,000	$5.50	170,500
March 27 @ 2PM	32,000	$5.50	176,000
April 19 @ 2PM	38,000	$5.50	209,000
May 26 @ 1PM	40,000	$5.50	220,000
June 25 @ 1PM	55,000	$5.50	302,500
July 28 @ 2PM	50,000	$5.50	275,000
August 15 @ 1PM	55,000	$5.50	302,500
September 3 @2PM	40,000	$5.50	220,000
October 9 @ 3PM	38,000	$5.50	209,000
November 21 @ 3PM	45,000	$5.50	247,500
December 19 @ 3PM	42,000	$5.50	231,000
Total	**503,000**	**$5.50**	**$2,766,500**
Marginal Rate			**$5.50**

in Table 3, 12CP charges are billed based on the utility's usage at the time of the ISO/RTO peak each month. Therefore, the marginal cost is the cost per kW at those peaks.

Marginal costs under 1CP and 4CP methodologies are calculated differently. Table 4 demonstrates a 1CP methodology, where the peak occurs on July 28 at 2 pm. In this case, the marginal cost for transmission is $0 for 8,759 hours of the year and $66.00 for each kW used on July 28 at 2:00 pm.

Under a 4CP methodology, the marginal cost is $16.50, or one quarter of the 1CP cost, for each kW used during the four summer transmission peaks.

Whether the utility is billed under a 12CP, 4CP, or 1CP methodology, increased usage at the time of the ISO/RTO peaks would be realized at the marginal rate for each kW added.

Table 4 – Determination of 1CP Marginal Rate

Transmission Peak (Date/Time)	Determination of Monthly Billings (kW)	Formulas
Usage July 28 @ 2PM	50,000	a
Monthly Rate ($/kW)	$ 5.50	b
Monthly Charges	**$ 275,000**	**a * b = c**
Month	**Monthly Charges**	
July	$ 275,000	c
August	275,000	c
September	275,000	c
October	275,000	c
November	275,000	c
December	275,000	c
January	275,000	c
February	275,000	c
March	275,000	c
April	275,000	c
May	275,000	c
June	275,000	c
Total	**$3,300,000**	**c * 12 = d**
Marginal Rate ($/kW)	**$66.00**	**d / a**

Figure 2 – Marginal Cost Using a 1CP Methodology

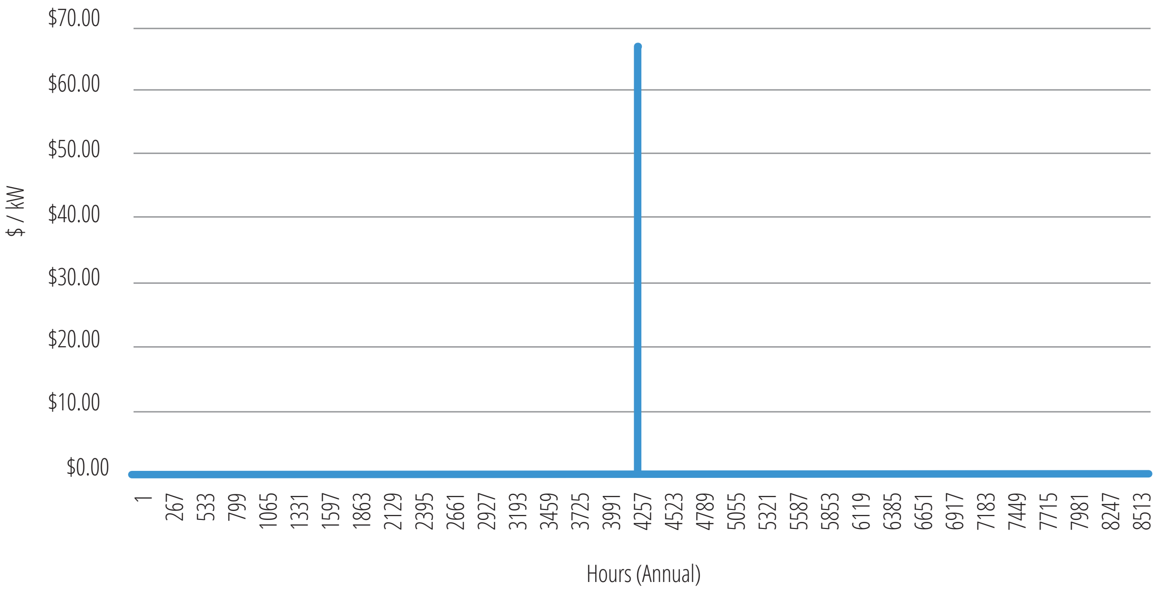


Figure 3 – Marginal Cost Using a 4CP Methodology

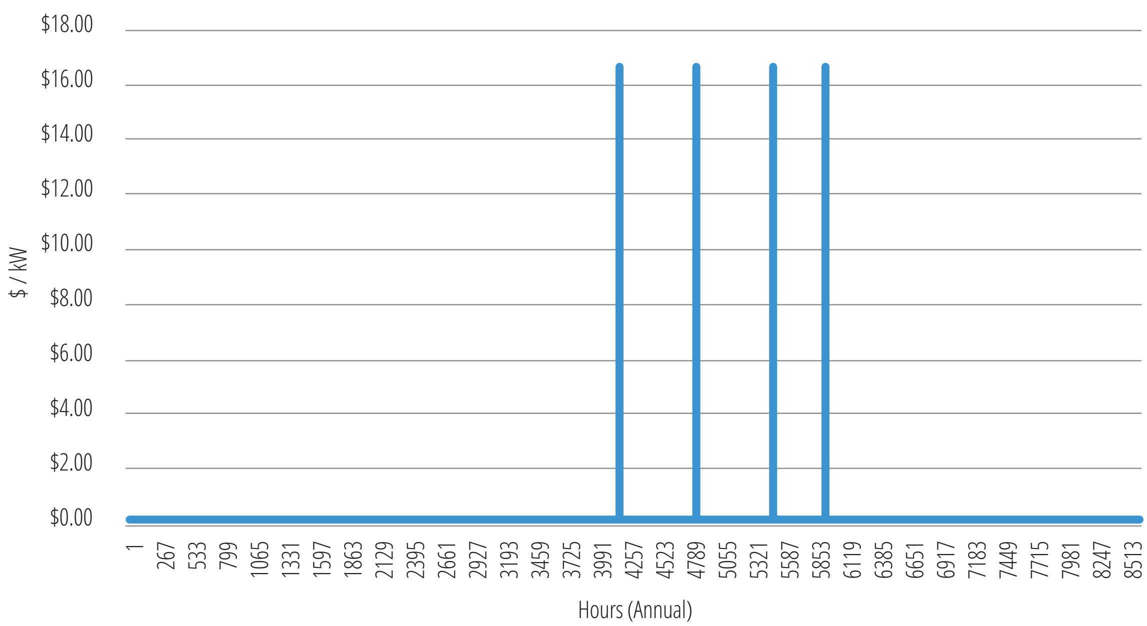


Table 5 – Determination of 4CP Marginal Rate

Transmission Peaks 4CP (Date/Time)	Determination of Monthly Billings (kW)	Formulas
June 25 @ 1PM	55,000	
July 28 @ 2PM	50,000	
August 15 @ 1PM	55,000	
September 3 @2PM	40,000	
Average CP (kW)	50,000	a
Monthly Rate ($/kW)	$5.50	b
Monthly Charges	**$275,000**	**a * b = c**
Month	**Monthly Billings**	
July	$275,000	c
August	275,000	c
September	275,000	c
October	275,000	c
November	275,000	c
December	275,000	c
January	275,000	c
February	275,000	c
March	275,000	c
April	275,000	c
May	275,000	c
June	275,000	c
Total	$3,300,000	c * 12 = d
Marginal Rate ($/kW)	**$ 16.50**	**d / a / 4**

Determining Marginal Transmission Costs

Marginal transmission costs are the change in transmission costs from the addition of the new customer. This can be obtained by estimating a cryptocurrency or grow facility's usage at the time of the transmission peak. The utility will need to review how transmission charges are determined. For example, transmission cost may be based on the utility's usage at the time of the RTO's peak or at the time of the utility's peak demand. Other considerations include reviewing if transmission charges are determined on an annual, seasonal, or monthly basis. When charges are based on a single peak of the year (as shown in Figure 2) and billed over the subsequent 12 months, the marginal cost at that peak hour may be substantially greater than if the utility's transmission is based on monthly peak usages. Working with cryptocurrency, grow facilities, or other new loads to avoid adding to transmission peaks, such as allowing for interruption, will help both the utility and customer benefit from reduced marginal transmission costs.

Distribution

Distribution charges are meant to recover costs associated with the delivery of electricity from the transmission system to the customer's meter. These charges are often established using a more traditional method and require a review of the utility's cost-of-service study. If the utility has an unbundled tariff, the distribution rate may be readily available.

When developing a distribution rate, the new customer should be charged for the infrastructure it uses. It is important for utilities to have early discussions with potential customers on the location of their facilities. The utility can suggest locations that require little improvement or minimized line extension costs. Transmission service-level customers locate near transmission lines to receive energy at higher voltages, primary service-level customers own their own transformers and are considered primary metered, secondary service-level customers use all the distribution system components and represent the majority of electric customers. When a larger customer locates near the transmission or the sub-transmission system, due to a need for higher voltage service, it subsequently bypasses lower voltage distribution lines and transformers.

Utilities use a variety of billing methods for distribution cost recovery. The distribution infrastructure located near a customer's premises is sized to handle the customer's potential peak. A common method for recovery is using the customer's monthly peak demand. A potential issue with this methodology is that the infrastructure exists, and an investment was made to provide service, even during months of lower demand. Because the customer is billed for its peak in that month, this rate structure could potentially under-recover for distribution-related investments. Many utilities have moved to a rate structure that bills customers based on their peak demand over the past 12 months or to fixed charges based on the customer's transformer size.

Determining Distribution Rates

The distribution rate should consider both short-term and long-term marginal costs when adding new loads, such as cryptocurrency mining and cannabis grow facilities. Long-term marginal costs quantify the impact on the distribution system over the next several years and consider future capital investments that may be needed, such as new capacity. These costs can be identified through review of the long-term capital plan. When identifying long-term marginal costs, the utility should factor the cryptocurrency miner or grow facility's plans for growth. In the short term, the immediate change in utility cost due to investments in infrastructure should be considered and is discussed in the following section.

Capital Costs to Connect New Customers

Necessary capital investments to connect new customers can be costly, and the utility's line extension or contribution in aid of construction policy identifies how much the utility versus a new customer should pay. Some utilities pay all extension costs to connect a new customer, while others charge the new customer the full extension cost. It is, however, typical for utilities to share the cost of the line extension. Often this cost determination is based on a specific criteria, such as length of extension or a multiple of projected revenues.

To protect existing customers and lower potential cost barriers for the new customer, many utilities review projected contribution margins and the risk of extending services to the new customer.

The Risk of Extension of Service

The determination of risk is subjective but certain guidelines are often considered. Extending service to residential customers tends to have low risk, as once a home is constructed, the utility will often provide electricity for many years to its location, allowing adequate time to recover the extension costs. Extending service to an industrial customer has different considerations of risk, such as customer bankruptcy or relocation outside the community. When an industrial customer ceases production, the building is often vacant for many months and if another company acquires the building, the electricity use may change. The new company might not require the same amount of service or could need additional infrastructure investments to meet its needs. These considerations provide guidance to the utility in developing its extension policies. Assessing the

The utility needs to ensure recovery of its investment to extend service over time. If this does not occur, it will create upward pressure on rates for existing customers.

level of risk will also determine if additional assurances are required, such as deposits, security bonds, or a contract requiring minimum service charges to ensure recovery of the utility's investment.

Understanding Contribution Margins

Contribution margins are the difference between the revenues received from the customer and all variable costs. If rates are unbundled, the contribution margin is often the same as the distribution charge. When rates are established, they include recovery of variable cost and fixed infrastructure cost to fund debt service payments, service crews, administrative costs, or future system replacements. Table 6 shows an example calculation.

If the utility's portion of the line extension cost is $105,000, it would take 3.5 years to payback the initial investment. The longer the payback period, the greater the risk of unrecovered investment from the customer.

Utilities are reviewing and modifying their line extension policies to ensure investments are recovered within a reasonable amount of time. For higher risk customers, the utility may require assurances, such as deposits, minimum charges, security bonds, length of contract, or a true-up mechanism.[ii] Some utilities may require a new customer to pay 100% of extension costs, with the utility reducing the monthly charges for a period of time based on the new customer's actual usage.

[ii] True-up mechanism is a review of the customers usage and fixed cost recovery with the initial investment with differences charged or refunded to customer once the true-up period ends.

Capital Cost Considerations

The cost to extend service to cryptocurrency mining, cannabis grow facilities, or any load from an emerging market, should be examined closely by the utility. For some emerging markets, such as cryptocurrency mining, the volatility due to market pressures can greatly affect operations — causing periods of consistent, high demand and potential periods of low to no use. In periods of extreme market downturn, cryptocurrency miners have gone so far as to issue a bankruptcy warning. The utility must recognize the economies-of-scale benefits these customers bring to the distribution grid while protecting themselves and other ratepayers from the potential of stranded costs. Cannabis grow facilities present a unique opportunity in terms of capital investment as they may be able to retrofit an existing building and service extension. In addition, cannabis grow facilities use systems that require energy, such as lighting and heating ventilating, air conditioning, and dehumidification (HVACD) systems,[2] and size of the infrastructure needed to serve them may be reduced if energy efficiency standards and equipment specification are included in the application process.

Table 6 – Determination of Contribution Margin

	Monthly	Annual	Formulas
Revenues	$10,000	$120,000	a
Less: Variable Costs			
Power Supply	$5,900	$70,800	b
Transmission	$1,000	$12,000	c
City Transfers, Taxes and Other	$600	$7,200	d
Total Variable Costs	$7,500	$90,000	b + c + d = e
Contribution Margin	**$2,500**	**$30,000**	**a - e = f**
Utility Investment		$105,000	g
Payback Period (Years)		3.5	f / g

Contribution to the City and Other Taxes

Many public power communities require their local utility to make transfer payments to the general fund, often referred to as a payment in lieu of taxes, or PILOT. The PILOT is frequently determined as a percent of revenues or a rate per kilowatt-hour of sales. As sales increase, the required transfer increases. New customers that generate high sales may cause a substantial increase in the PILOT transfer. To fully recover PILOT-related costs, the marginal cost rate must be increased by an associated factor. For example, a 5% transfer payment would require marginal costs to be increased by 5.2% or (5.0%*(1+5.0%)). This calculation should also be applied to any changes that occur in taxes or franchise payments.

When examining rate impacts from cryptocurrency miners, cannabis grow facilities, and other new loads, the utility should consider the transfer payments made to the city. These customers can be large users with large annual revenues, and therefore will have a direct effect on transfer payments. Revenues may need to be estimated and a true-up made at the end of the year if the customer is new to the grid.

Table 7 – Percentage Adder on Marginal Costs for PILOT

Percent of Revenue Contribution	Revenues	Formulas
Revenues	$1,000,000	a
PILOT %	5.0%	b
Increase in PILOT	$50,000	a * b = c
Realized Revenue After PILOT	$950,000	a - c = d
Percentage Adder on Marginal Costs	**5.26%**	**c / d**

RATE TARIFFS APPLICABLE TO NEW LOADS

A utility may offer an existing rate to a cryptocurrency miner, cannabis grow facility, or other new customer or may consider developing a new rate structure if the customer's size or service level does not fit criteria established for the existing rate tariffs. Some customers might have flexibility in their operations, including the ability to be interrupted or curtailed for mutual benefit. When an existing rate tariff is offered to a new customer, the revenue should exceed the calculated marginal costs to avoid upward pressure on electric rates for other customers.

In the past, rates were established with the primary objective of meeting the utility's revenue requirements or recovering costs appropriately from each class of customers. Due to changing usage patterns and technology, electric utilities are moving toward rates that send price signals based on the utility's costs. The implementation of solid-state metering, advancement in database management systems, and improvement in billing system capabilities allow more accurate rate designs and cost recovery. As rate structures better reflect utility costs, customers benefit from greater control over their electric bills while utilities achieve improved financial wellbeing.

Advancement in rate design is not limited to large electricity users but can also benefit small general service and residential customers. Current rate design trends are based on potential utility savings due to customers responding to the price signals and modifying their usage patterns. Table 6 outlines the cost-based rate structures often considered for new loads and current users.

Significant Rate Design Trends

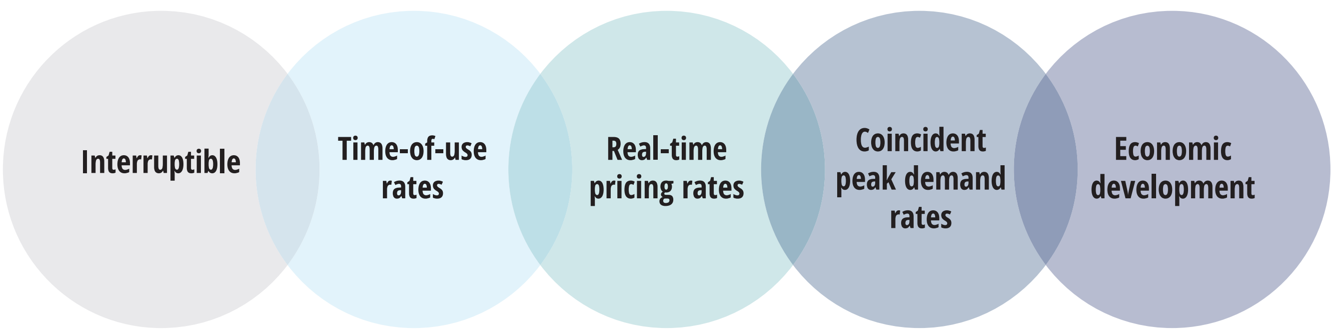


Table 8 – Pros and Cons in Current Rate Design Trends

Trend	Potential Utility Pros	Potential Utility Cons	Customer Profile
Interruptible	Ability to limit utility exposure to RTO coincident peak demand charges, especially if charges are set on a 12CP.	Customer acceptance and ability to be interrupted.	**Crypto –** Well suited to operations. Most can comply, which creates a win-win. **Grow –** Not as well suited. Facilities require well-maintained environments and interrupting service could cause loss of plants. Could potentially interrupt lighting.
Time-of-Use	More accurately reflects cost at varying times of the day.	Administratively burdensome to meter and bill.	**Crypto –** Most are 24-hour operations without the ability to shift operating hours. **Grow –** May have the ability to shift operations during off-peak times. Would be beneficial for lighting.
Real-Time Pricing	Pass through of costs to customer, mitigating utility risk.	Metering and billing may be difficult. This structure is not allowable in all states.	**Crypto –** Unknown costs may be a deterrent to miners. **Grow –** May have the ability to shift operations to low-cost times.
Coincident Peak Demand	Protects the utility against coincident peak charges.	Customers hitting the peak could result in subsequent months charged at maximum CP to the utility even if the customer leaves.	**Crypto –** High load factor would allow for a low energy rate paired with an appropriate CP rate. **Grow –** Customers may be able to limit elements of their operations to save on this rate.
Economic Development	Attracts customers to utility service territory. A rate may be established through a JAA, if applicable.	If not set appropriately, could harm existing ratepayers.	**Crypto –** Potentially attractive to miners, but utility should ensure appropriate costs are recovered within the allotted time. Some facilities may be a flight risk. **Grow –** Facilities would benefit from an economic development rate. Determine if company profile fits community objectives.

CRYPTOCURRENCY MINING

FAST FACTS

JOBS: Few, highly technical positions. Median workforce size of 15 employees in North America[3]

LOAD FACTOR RANGE: High Load Factor

INTERRUPTIBLE / DEMAND RESPONSE: Yes, typically[4]

SCALE: 25 MW – hundreds of MW[5]

TIME FOR CUSTOMER TO COME ONLINE: 9 – 12 months or longer[6]

Background and Characteristics

Cryptocurrency operations validate and confirm new transactions to the blockchain and use electricity for data storage, computing, cooling, and data communications. Cryptocurrencies, such as Bitcoin, are decentralized in that transactions do not need to be verified through a financial institution, such as a bank. Instead, transactions are verified through the blockchain and the blockchain is considered the public ledger. Validation of transactions requires specialized computers that run at a high capacity for the entire day. The miners, or owners of these operations, receive payment via the electronic currency they are mining.

Due to inactivity, or in many cases, fraud, the number of genuine cryptocurrencies is hard to define. As of January 3, 2023, CoinMarketCap identified 22,177 currencies[7] with around 11,000 that are active, however, only 2,233 have been audited by the IRS.[8] Auditing is important as it provides validity of the cryptocurrency and assures that currency is not fraudulent.

The current global market "cap" or amount of cryptocurrency in circulation is $803.4 billion, of which Bitcoin holds 39.9% of the market share. It is important to note that market figures are constantly changing as new transactions and currencies are added to the blockchain. The United States currently hosts over 38% of global Bitcoin activity and a third of global cryptocurrency operations in total.[9]

Electricity is a significant cost to cryptocurrency operations due to the extraordinary amount of computing power necessary to validate transactions to the blockchain, store data, and cool the computers. According to "Climate and Energy Implications of Crypto-Assets in the United States," a September 2022 report published by the White House Office of Science and Technology Policy, the estimated global electricity usage attributed to cryptocurrency falls between 120-240 billion kWh per year. Cryptocurrency facilities typically function with little human labor and oversight, which allows them to operate out of container-based or transient structures, though some will construct or purchase buildings. Since electricity is a large operational expense for cryptocurrency facilities, they will often choose to locate in areas where they can receive the lowest possible electric rates and will permit the utility to interrupt service to keep electric costs lower. Numerous public power utilities have had cryptocurrency mining operators inquire about locating in their service territories. Cryptocurrency miners, like most businesses, aim to run a cost-effective operation with the least amount of upfront costs or potential stranded costs should the facility need to close. Therefore, miners will often shop around for the lowest energy rates and prefer to avoid demand charges where possible.

Unlike traditional industrial operations, cryptocurrency companies do not necessarily require a large workforce once construction of the facility is completed. The number of full-time employees for cryptocurrency operations in North America ranges from zero to 110, with a median of 18 employees.[10] For the utilities highlighted as case studies in this paper, anywhere from zero to 15 full-time employees were reported for their crypto customers. This limited employment means that large cryptocurrency operations do not necessarily equate to additional residential growth in the community. A smaller workforce may give the utility more influence in the facility's location as the cost of the electric line extension may be of greater consideration for the cryptocurrency miner than proximity to interstates to attract employees.

Additionally, community land use objectives and public ordinances for buildings and noise may create a potential hurdle when cryptocurrency facilities attempt to locate. Some cryptocurrency facilities prefer to operate out of a container-style structure, which is not foundational and may not fit the building criteria outlined in city ordinances. Fan noise can also be an issue if it violates the community's noise ordinances. Due to potential noise complaints, companies will often attempt to locate in rural or industrial areas and away from residents. Noise and vibration disturbances from cooling fans are of utmost concern to those living nearby. Emissions due to high electric use and grid reliability for residents and other businesses are an additional cause of apprehension. Due to these considerations, some communities are questioning if cryptocurrency operations fit with their town's character.

Figure 4 – Single Bitcoin Transaction Footprint

Carbon Footprint	Electrical Energy	Electronic Waste
427.95 kgCO_2	767.27 kWh	428.20 grams
Equivalent to the carbon footprint of **948,491** VISA transactions or **71, 325** hours of watching YouTube.	Equivalent to the power consumption of an average U.S. household **26.30** days.	Equivalent to the weight of **2.61** iPhones **.087** iPads.

Based on research from Digiconomist as of January 2023, a single bitcoin transaction requires 767.27 kWh of electricity and may have significant impacts on carbon dioxide emissions and electronic waste. Figure 4 shows the environmental impact of mining a single Bitcoin.[11]

In total, the electricity needs of cryptocurrency operations are estimated to comprise 0.4%-0.8% of total U.S. greenhouse gas emissions, which is similar to the emissions caused by railway diesel fuel.[12]

Generally, cryptocurrency mining companies want to work with local utilities to minimize environmental impacts and may be willing to shift operations to times when renewable generation, such as wind or solar, is producing and away from times when less efficient generating units are needed. Some companies have considered installation of solar panels to help reduce environmental impacts or onsite generation to participate in demand response programs.

A September 2022 White House report from the Office of Science and Technology Policy outlined key recommendations for cryptocurrency operations to meet federal climate objectives. The report summarized considerations for the Environmental Protection Agency (EPA), Department of Energy (DOE), Congress, and additional departments, which may result in further policy relating to the industry.[13]

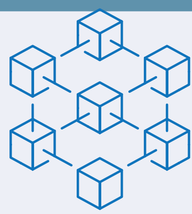
- **Minimize greenhouse gas emissions, environmental justice impacts, and other local impacts from crypto assets.** EPA and DOE to provide technical assistance to states and the crypto industry to develop appropriate standards as they relate to energy intensity, emissions, noise, and other impacts.
- **Ensure energy reliability.** Reliability assessments to be conducted on crypto asset's effects on electric system reliability.
- **Obtain data to understand, monitor, and mitigate impacts.** Collect and analyze data from cryptocurrency operations on energy use, fuel mix, purchase power agreements, environmental justice implications, and demand response participation.
- **Advance energy efficiency standards.** Regularly update energy efficiency standards on a federal level.
- **Encourage transparency and improvements in environmental performance.** Publicly report crypto-industry locations, annual electricity usage, greenhouse gas emissions, and electronic waste recycling performance.
- **Further research to improve understanding and innovation.**

Following this national research into cryptocurrency mining effects on climate and energy, Congress issued a letter to the Electric Reliability Council of Texas (ERCOT) in October 2022, requesting information on electricity usage, associated emissions, projected scale, and contract agreements for cryptocurrency operations in Texas.[14] The letter placed specific focus on ensuring that impacts of mining on energy costs do not cause increases in cost to existing residents and businesses. Although the Anti-Money Laundering Act of 2020 requires that all transactions in "value that substitutes for currency" be subject to reporting requirements, issues created by digital currencies, are generally left to be addressed at the state level.[15] As of June 2022, 37 states have specified legislation for cryptocurrency. Examples include:[16]

- Arizona included Bitcoin as legal tender.
- New York established the allowance for state agencies to accept cryptocurrencies as payment.
- Oklahoma added commercial mining of cryptocurrency to the state revenue and taxation laws.
- Rhode Island enacted the Green Housing Public Private Partnership Act to incentivize the construction of properties, including cryptocurrency mining operations, with climate emissions reduction goals.
- Tennessee authorized county, municipality, or state investment in cryptocurrency, blockchains, and non-fungible tokens.
- Texas recognized virtual currencies in its Uniform Commercial Code, defining them as a digital representation of value used as a medium of exchange.
- West Virginia rewrote the criminal code to include cryptocurrency in unauthorized currency.

The cryptocurrency mining industry has grown substantially and is projected to continue growing at a compound annual growth rate of 12.2% globally between 2022 and 2028.[17] However, future electricity demand from crypto-related operations is difficult to project.[18] Miners respond to cryptocurrency market price signals and will adjust operations accordingly. In addition, they are frequently adopting new technologies and equipment to improve efficiencies. Regardless, due to the size of these facilities and load factors exceeding 90%, utilities may want to protect existing customers from any potential stranded costs should the customer go out of business or relocate. This can be done through review of line extension polices and ensuring the cryptocurrency customer's rates recover costs that are above the marginal cost to serve the load. The utility could receive substantial benefits if the revenue received is above the marginal costs, as additional margins can be used to lower rates or mitigate rate increases.

Benefits, Challenges, and Tips



Cryptocurrency Benefits

- Increase electric revenue
- Improve system load factor
- Reduce average power supply cost
- Mitigate the need for future rate increases
- Potential short-term construction jobs in the community
- Increased utility transfer payment to city governments (benefit to the city)
- Increased city property taxes (benefit to the city)

Cryptocurrency Challenges

- Sensitivity to cryptocurrency market fluctuations
- Transient (mobile) customer risk — stranded infrastructure costs
- Negotiation of electricity tariff and utility contribution toward line extension costs
- Potential for additional federal oversight and regulations
- Potential large customer risk noted by bond rating agencies
- Negotiations with local governing bodies can delay customer coming online
- Community perception and acceptance — fan noise, fit with community "character," grid reliability, and emissions

Tips for Managing Cryptocurrency Load

- Consider an interruptible rate structure
- Review line extension policy
- Locate near a substation with excess capacity/existing infrastructure
- Site in a rural location
- Add risk acknowledgment in financials and cost of service

DENTON MUNICIPAL ELECTRIC

FAST FACTS

LOCATION: Denton, Texas

RTO: Electric Reliability Council of Texas (ERCOT)

SYSTEM PEAK / ANNUAL SALES: 375 MW / 1.6 million MWh Vertically integrated

CURRENT CRYPTO MINING LOAD: 115 MW

EXPECTED FUTURE CRYPTO MINING LOAD: 300 MW, 2.3 million MWh/year

RATE: Seven-year securitized power purchase agreement

EXTENSION POLICY: Customer pays for line extension

CRYPTO MINING LOAD CHARACTERISTICS: >90% load factor, fully interruptible

START DATE: Q1 of 2021

Several cryptocurrency miners contacted DME over the past few years, with negotiations still underway for potential electric service with a few potential parties. A couple of potential operators lost interest when Denton was unable to meet timing needs for the construction of the interconnection. A 115 MW cryptocurrency facility, built in 20-25 MW increments, began operation in February 2021 and operates at a load factor of approximately 96% with development underway to add an additional 185 MW.

The location of the existing crypto mining operation is adjacent to DME's gas fired peaking plant in an area that is zoned for heavy industry. To address concerns of residents relative to additional crypto mining facilities, the City Council of Denton approved a zoning restriction that prevents cryptocurrency operations from locating near residential homes. The current cryptocurrency facility has a footprint of 31 acres and is configured with air-cooled cathedral buildings on leased property adjacent to the Denton Energy Center, a 225 MW reciprocating engine peaking plant, a new distribution substation with adequate capacity, and a 138 kV interconnection with the ERCOT transmission grid. The operation is supplied at both the 138 kV transmission voltage level and at DME's distribution voltage. The substation, which was constructed contemporaneously with the Denton Energy Center had sufficient available transmission capacity to meet the needs of the proposed approximately 300 MW cryptocurrency mining operation without any distribution or transmission upgrades.

What DME did to limit the risk from the customer's potential financial instability and to ensure new load growth does not harm existing customers:

1. Modified its line extension policy, requiring the customer to pay 100% of the interconnection cost;
2. Obtained a seven-year fully securitized power purchase agreement; and
3. Required advance payment for purchases to third-party power suppliers, a letter of credit, and increased billing frequency to protect against revenue instability, which could occur if the cryptocurrency operation were to default on any payment obligation.

Due to the size of the current cryptocurrency facility and its potential to more than double DME's retail kWh sales coupled with the unique load profile and operational flexibility, DME negotiated a power purchase agreement (PPA) in lieu of using its standard General Service Large rate tariff. DME's PPA is structured to achieve the following benefits to the City of Denton:

- Ensure that in the event of default, the other ratepayers of DME are left with no liability.
- Allow the cryptocurrency miner to access wholesale electricity from the ERCOT grid while ensuring that the City of Denton and DME receive adequate compensation for the use of DME's transmission and distribution capacity.

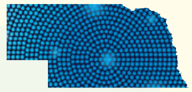
Control the dispatch of the cryptocurrency mining operations during emergency and market scarcity periods.

Permit the cryptocurrency mining operations to participate in selling ancillary services to ERCOT, which enhances to reliability and resiliency of the ERCOT grid.

The margins achieved by DME through the provision of power and services to the cryptocurrency miner are anticipated to offset needed revenue increase and associated rate increased that would have otherwise been required. If the contribution margin is lost, it would likely cause rate increases for the other classes of electric service. The structure of the PPA provides a risk profile that negates traditional revenue concentration concerns by rating agencies associated with such a large annual revenue stream from a single large customer. DME's latest bond rating moved from a negative to stable outlook.

Additional benefits the community is receiving include the addition of 150 short-term jobs during the one-year construction of the facility and the addition of 15 long-term, highly paid, technical positions.

STANTON COUNTY PUBLIC POWER DISTRICT



FAST FACTS

LOCATION: Stanton, Nebraska

RTO/ISO: SPP (NPPD full requirements)

SYSTEM PEAK / ANNUAL SALES: 30 MW, 160 million kWh/year

EXPECTED FUTURE CRYPTO MINING LOAD: 70 MW

RATES: economic development rate with fixed rate for power supply and transmission for first 5 years

EXTENSION POLICY: Customer pays all extension costs upfront; utility reimburses its portion over five years

LOAD CHARACTERISTICS: >95% Load Factor, fully interruptible

START DATE: Under Construction

Stanton County Public Power District (SCPPD) in Nebraska is a full requirements wholesale customer of the Nebraska Public Power District. With revenues of $13 million, SCPPD services 2,800 customers in the city of Stanton and surrounding rural areas. Its peak demand is approximately 30 MW, of which 15 MW is attributed to a pumping station to service irrigation customers.

SCPPD agreed to supply electricity to a cryptocurrency facility under construction. Prior to this agreement, SCPPD had been contacted by several other cryptocurrency miners who were interested in installing portable "pods" (for mobile data storage) near transmission lines. SCPPD initially considered allowing some pods, but had concerns over the flight risk of such customers, which could leave SCPPD with unrecovered cost. Instead, SCPPD wanted an operator that was willing to construct its facilities.

Electric rates were a significant consideration for the cryptocurrency operators. SCPPD, in conjunction with NPPD, offered two rate options to the customer:

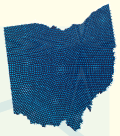
1. A fixed rate for both power supply and transmission offered under an economic development rider from NPPD, lasting five years.
2. A coincident peak demand rate allowing the customer to interrupt operations and avoid demand charges for power supply and transmission.

The economic development rate was the lower cost option and chosen by the customer. After the rate expires, the customer will move to the interruptible rate offered by SCPPD. Additional charges include grid access charges, which are under a sub-transmission service rate rider.

The SCPPD Board of Directors had several concerns that the utility mitigated by:

1. Requiring a large deposit equal to two times the estimated monthly billing to address the timing difference between SCPPD's payment to NPPD and the need for additional working capital.
2. Requiring the customer to get approval through the zoning process. This facility is in a rural area where noise from the machines would not be a major concern. The building was designed to reduce noise and since the machines were located inside a facility, the projected noise was greatly reduced.
3. Applying the established line extension policy that required the customer to pay all extension costs upfront. SCPPD would then reimburse its contribution over a five-year period equal to the contract of the economic development rate. This protects the investment by ensuring full investment recovery would only come if the customer kept service for the five full years.

CITY OF HAMILTON



FAST FACTS

LOCATION: Hamilton, OH

RTO/ISO: PJM

SYSTEM PEAK/ANNUAL SALES: 136 MW, 562,007 MWh/year

EXPECTED FUTURE CRYPTOCURRENCY-RELATED LOAD: 20 MW

RATE: Fixed price until 10 MW, then standard industrial rate, including a power cost adjustment, with a discount on demand for avoiding transmission peaks

EXTENSION POLICY: Negotiated on a per customer basis

LOAD CHARACTERISTICS: >98% Load Factor, fully interruptible

START DATE: operational since 2019

The City of Hamilton, Ohio, is a member of American Municipal Power (AMP), a JAA. Its electric system has been operational since 1893 and has grown to serve approximately 30,000 customers. The city has been contacted by several cryptocurrency mining operations and has negotiated one successful contract. Due to the loss of several large customers in 2008 and the implementation of energy efficiency programs, the city had excess generation capacity available to serve cryptocurrency load. The miners who made initial outreach to the city were interested in power supply costs close to $0.03 / kWh. The city was not interested in selling energy at a loss or for less than market value and did not enter into contracts with those entities.

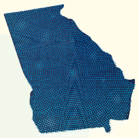
It successfully negotiated a contract with a container-based cryptocurrency operation that has been in operation since 2019. The customer has a current base load of 5 MW with the potential to grow to 20 MW. The city set milestones for customer growth throughout the term of the contract. It negotiated several items into the contract to help minimize the impact on the city's transmission and capacity costs:

1. The customer is interruptible and can be curtailed up to 30 times per year for a maximum of six hours. This allows the facility to avoid capacity and transmission peaks in the PJM market. In addition, since PJM costs are set on a 1 and 5 CP, this protects the utility from being charged for the customer's capacity and transmission peak if the customer discontinues operations. To successfully curtail, a team at the utility monitors PJM peaks and provides a 24-hour notice to the customer prior to curtailment. Since the utility does not have advanced metering infrastructure, the facility must send an employee out to ensure the load had been curtailed. The customer consistently curtailed and never missed the PJM peaks. The facility has been asked to curtail 10 times in 2022 and have met all requests.
2. To determine the proper rate schedule, the utility reviewed its all-in cost to secure the energy from the market and this became the starting point for negotiation. The city and cryptocurrency facility agreed to a fixed price through September of 2023 for up to a specified load. All excess load will be billed at the city's industrial rate and will include a demand

discount for curtailing during the PJM peaks. After September 2023, the entire load will be billed at the city's industrial rate through the term of the agreement.

Originally, the cryptocurrency facility was located near a substation with excess capacity but was close to some rural residential areas. Due to the fan noise, the city encountered some customer complaints. A sound study was done and though the noise was below standard ordinances for residential areas, the cryptocurrency facility agreed to relocate. The facility is now located next to the power generating station where adequate land and system capacity exists without the potential to disrupt residential areas. In the initial extension of service, the customer provided all transformer equipment, executed all site improvements, and under both locations, were close to an existing substation. The utility covered the cost to extend service to the customer's transformer, which consisted of dropping a pole and a line.

ELECTRIC CITIES OF GEORGIA



FAST FACTS

LOCATION: Georgia

RTO/ISO: None

MEMBERSHIP SYSTEM PEAK/ANNUAL SALES: Approx. 2,000 MW

CURRENT CRYPTOCURRENCY-RELATED LOAD: 234 MW

EXPECTED FUTURE CRYPTOCURRENCY-RELATED LOAD: 560 MW awaiting construction

RATES: based on marginal costs, interruptible

EXTENSION POLICIES: Cryptocurrency customers are encouraged to find a location adjacent to an existing substation with excess capacity. Alternatively, new and existing customers may qualify for a new substation if they meet specified criteria. New and existing customers will be primary metered and therefore pay for and own the transformer

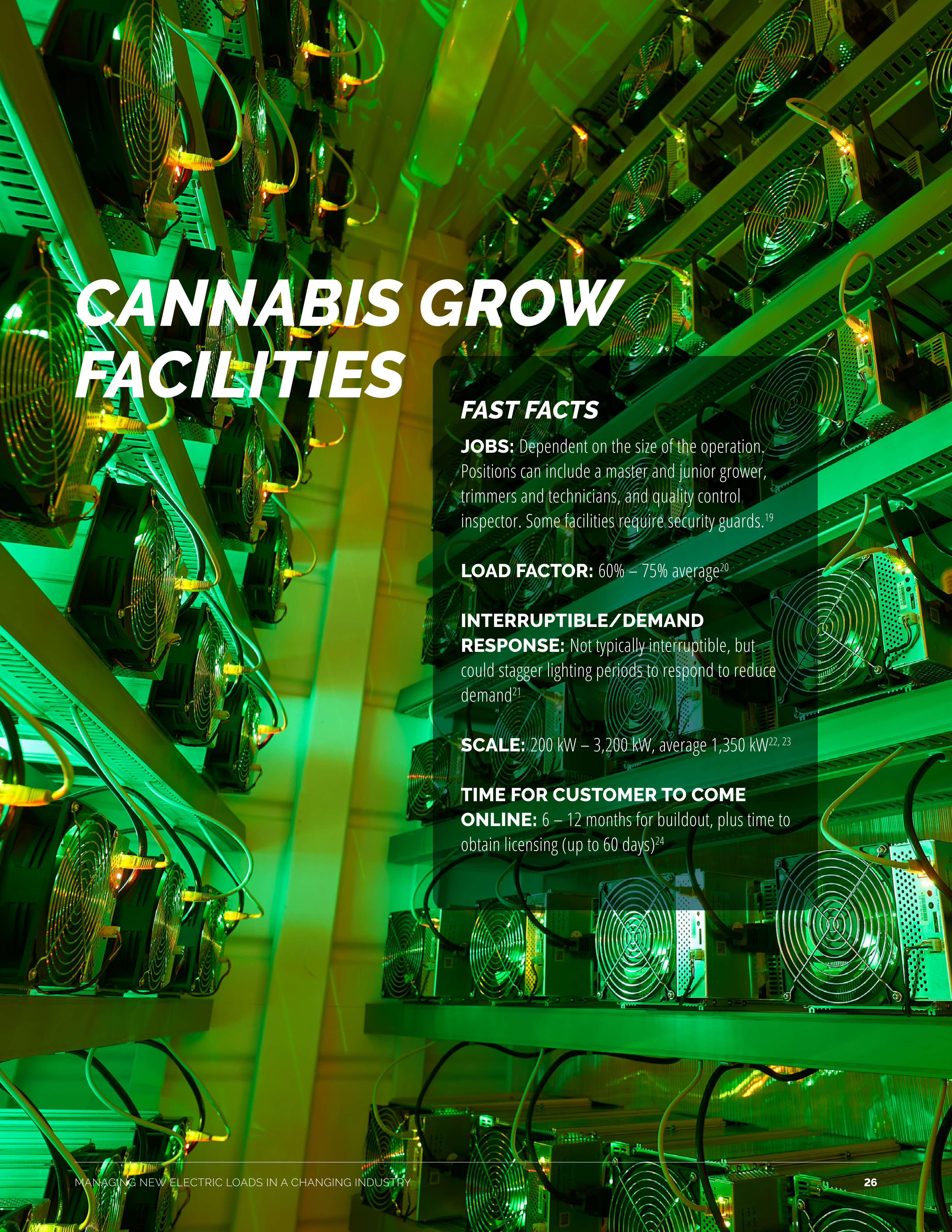
LOAD CHARACTERISTICS: >90% Load Factor, fully interruptible

START DATE: Varies, ECG has numerous members that serve cryptocurrency facilities

Electric Cities of Georgia (ECG) is a state association serving 52 member utilities in Georgia within the Southeast Reliability Corporation. The services ECG provides to its members include pole attachment assistance, legislative and regulatory review, joint purchasing, hosted solutions, aggregated contracting, analytical services (includes cost-of-service & rate studies, key account and national accounts, data analytics), economic and community development, engineering and energy efficiency support, and training and safety. Within its analytical services, ECG helps members on customized pricing incentives and proposals for new or existing major accounts. ECG assisted various members that were contacted by prospective cryptocurrency companies. ECG members with a large amount of excess capacity at existing substations and with excess generation were very appealing to crypto miners that wanted to get going quickly. For expansion, members can provide a new substation with the customer's commitment to pay a feeder charge for 10 years. In fact, any new or existing customers could qualify for the substation if the incremental load exceeds a certain threshold. Members then extend service to the pole outside of the customer's premise with the customer being responsible for its transformers and associated maintenance.

In addition, ECG assists members with developing new contract rates based on marginal cost. Under this rate, the expected load for the cryptocurrency facility noted above is 200-300 MW. The member utility also has the capability to interrupt facility operations both on a voluntary and involuntary basis. Since the utility maintains the ability to interrupt during peak times, the utility can keep power costs low and benefit from the economies of scale from large kWh sales. This has helped the utility keep rates stable for existing customers.

Though fan noise with existing cryptocurrency facilities has been an issue for some of its member communities, ECG notes that acceptance is more readily obtained if the customer locates in an industrial area. On average, only a few jobs are created through these facilities, so they do not cause rapid residential growth after commencement. Due to the high electric costs for cryptocurrency facilities, ECG encourages members to require a bank draft and letter of credit to ensure payment.



CANNABIS GROW FACILITIES

FAST FACTS

JOBS: Dependent on the size of the operation. Positions can include a master and junior grower, trimmers and technicians, and quality control inspector. Some facilities require security guards.[19]

LOAD FACTOR: 60% – 75% average[20]

INTERRUPTIBLE/DEMAND RESPONSE: Not typically interruptible, but could stagger lighting periods to respond to reduce demand[21]

SCALE: 200 kW – 3,200 kW, average 1,350 kW[22, 23]

TIME FOR CUSTOMER TO COME ONLINE: 6 – 12 months for buildout, plus time to obtain licensing (up to 60 days)[24]

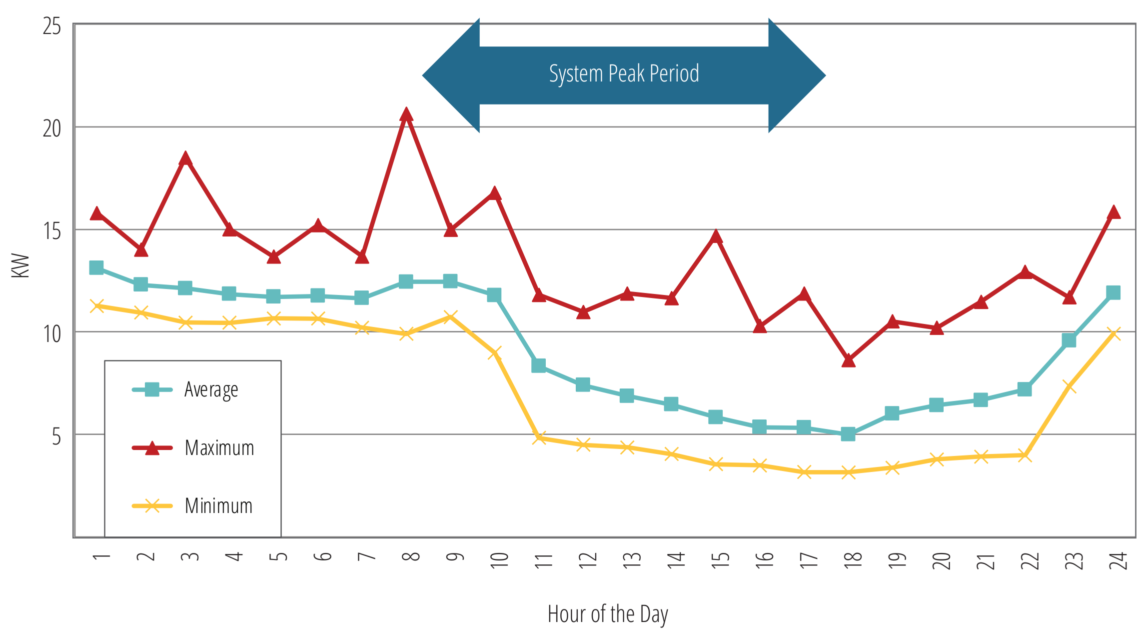
Background and Characteristics

There are three areas of the cannabis industry that require facilities: grow and cultivation, extraction, and dispensaries. Cannabis grow and cultivation facilities farm marijuana plants in regulated conditions. Extraction facilities process the plants once they are harvested from the grow facilities and dispensaries sell the processed products to individuals. The legality of these facilities varies from state-to-state and require a license due to regulation of the market. This report focuses on electricity use specifically for grow and cultivation facilities.

Within this sector, there are three main types of operations: outdoor, greenhouse, and indoor cultivation. Outdoor cultivation makes use of natural water sources, land, and sunlight, allowing growers to lower capital spend and use little to no electricity. A drawback to outdoor cultivation is the exposure of plants to natural and uncontrolled elements, which is why some growers have chosen to operate indoors. Greenhouse cultivation utilizes natural elements but allows for some regulation of light and climate. Hoop houses are a type of greenhouse that are less foundational and often emit more scent than traditional greenhouses or warehouses. Odor is a top concern among communities and city governments will often implement ordinances to limit odor related to the plants. Hoop houses may not hold up in the case of strong wind or inclement weather and would not provide the structure necessary to protect the plants in the winter.

Indoor grow facilities allow for control and consistency over outdoor elements such as temperature, humidity, hygiene, and light. Regulating these elements allows growers to nurture and cultivate the plants more successfully. Commercial growers often require indoor warehouse-style structures that are fitted to their needs. If a customer purchases a building with existing infrastructure, extension of service is quicker and less costly for the utility. According to the State of the Cannabis

Figure 5 – Winter Hourly Load Shape



Cultivation Industry Report published in 2021, 54% of growers operate indoors only, with upwards of 80% operating an indoor facility in conjunction with an outdoor or greenhouse. The report also notes that though the average facility is 33,900 square feet, 39% of facilities are less than 5,000 square feet. Relating this to energy use, approximately 150 kWh are used annually per square foot in an indoor grow facility.[25] This equates to less than 750,000 kWh of annual energy use for small facilities and over 5 million kWh for large users.

Despite being potentially large energy usages, indoor cannabis grow facilities may share load characteristics and usage patterns with the general service rate class. Figure 5, from a presentation of the Northwest Power and Conservation Council, shows a sample hourly load shape of an indoor grower in the winter season.[26]

Due to the sensitive nature of high-quality plant growth, the loads are often not interruptible, and have the potential to contribute to the utility's peak. They also tend to accommodate traditional working hours, which may result in on-peak usage.

Lighting is a large contributor to the high electricity use of commercial growers, as the plants require 12 – 24 hours of lighting a day depending on the growth stage. In addition, standard practice is to use metal halide and high-pressure sodium fixtures, which use 30% – 50% more electricity than comparable light-emitting diode (LED) lamps.[27] Despite a higher upfront fixture cost, LED lighting has proven very effective in cannabis plant growth and offers long-run cost savings though a longer lifespan and energy efficiency. In addition, staggering the lighting schedules helps improve customer load factor. Figure 6, from a study conducted by Boulder County in Colorado, shows the average daily load factor of 11 indoor grow facilities in Colorado.[28] Facility D in the figure improved its load factor to 85% after responding to utility price signals to stagger its lighting load.

There is a lot of focus on improving the industry's carbon footprint in cultivation. Indoor facilities currently result in carbon emissions between 2,283 kg-5,184 kg per dried flower,[29] larger than the carbon footprint of mining a single Bitcoin (1,089 kg). A study conducted by Dartmouth engineering students in conjunction with the Sustainable Cannabis Coalition found there is an additional 50% of energy and greenhouse gas reduction potential after installing LED lighting, using a displacement ventilation approach to humidity control, and using outdoor air cooling to reduce mechanical cooling needs (depending on facility location).[30] The study also suggests that when the above factors are taken in account, facilities can potentially reduce their electricity usage by 50%-66%.[31] Due to the current legal landscape

Figure 6 – Average Daily Load Factor

in the United States, building regulations for indoor grow facilities have yet to be seen, but have the potential to reduce grid impacts if adopted.

According to the National Conference of State Legislatures, as of February 2022, 37 states have legalized marijuana for medical use, 19 of which have additionally legalized or recreational growing.[32] State legalization is a leading limitation for grow facilities when deciding where to set up operations, as marijuana use is allowable on a state-by-state basis. In 2018, the Justice Department issued a memo specifying the prohibition of cultivation, distribution, and possession of marijuana.[33] Under the Controlled Substances Act, cannabis is categorized as a Schedule I substance, considered to have high potential for dependency. This discrepancy between state and federal legalization causes complexities for business law relating to the cannabis industry. For example, state and federally chartered banks are subject to federal regulatory oversight. Therefore, banks may be subject to liability under the Controlled Substances Act. This risk has inhibited financial intuitions from serving the cannabis industry, specifically for banks that operate across state lines.

Federal prohibition has also caused complexities for regulatory bodies, such as the Food and Drug Administration (FDA), which holds regulatory authority over drugs. Forty-seven states have legalized the use of CBD products; however the FDA maintains that marketing CBD-infused products as dietary supplements remain unlawful.[34] In addition, federal prohibition of marijuana has hindered federal research in the industry, relying on state-led and independent studies to consider industry impacts in the environmental and energy space.

Benefits, Challenges, and Tips

Grow Facility Benefits

- Increased electricity sales
- Potential to use existing commercial infrastructure as opposed to extending new service
- Potential to put customer on an existing rate structure
- Potential for job creation (community benefit)
- Increased utility transfer payment to city governments (benefit to the city)
- Increased city property taxes (benefit to the city)

Grow Facility Challenges

- Payment and banking challenges
- Little regulation on building requirements for energy efficiency
- Inconsistency between state and federal legality
- Often non-interruptible load
- Potentially moveable structures (hoop houses)
- Utility contribution toward line extension costs
- Traditional working hours without ability to interrupt may add to utility peak
- Community perception and acceptance — odor and fit with community "character"

Tips for Managing New Load

- Consider if load factor (typically mid-high range) fits with general service rate tariff
- Encourage foundational structures — limit smell
- Request the ability to interrupt lighting or stagger lighting schedules
- Encourage installation of LEDs
- Set an energy efficiency standard for grow facility buildings

CITY OF SHASTA LAKE

FAST FACTS

LOCATION: Shasta Lake, CA

RTO: Balancing Authority of Northern California (BANC)

CURRENT CANNABIS LOAD: 3 MW, largest grow facility: >1 MW

RATE: Existing industrial rate

EXTENSION POLICY: A fixed contribution by customer class

EXPECTED FUTURE LOAD: None planned

AVERAGE LOAD FACTOR OF GROW FACILITIES: 40% – 50%

START DATE: 2019

Shasta Lake's all-time peak demand is 38.16 MW, annual revenues are $21 million, energy sales are 220 million kWh, and the utility serves 4,600 customers. The utility is home to four cultivation facility operations, with the largest load exceeding 1 MW. All four grow facilities appear to keep traditional working hours and have annual load factors ranging between 40% – 50%.

These customers are served under an existing industrial service rate tariff and may request an economic development discount if the facility exceeds a certain annual load factor. However, none of the existing facilities meet the load factor required under the economic development rate. Interruptible rates were not considered since the facilities need to maintain strict humidity control for plant health. Having said that, one customer was able to voluntarily adjust lighting schedules to reduce load by approximately one-third for a few days during the September 2022 heat storm event when State regulators were "dialing for megawatts." Shasta Lake is considering time-varying rates as an option for growers to respond to price signals and manage usage in the future.

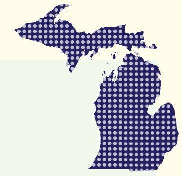
Shasta Lake's line extension policy establishes an "allowable construction credit" provided by the electric department for new electric customers, which is specific to rate class. Line extension costs in excess of this credit are funded by the customer as an "in-aid-to-construction" contribution. For one proposed facility, estimated connection costs exceeded $2 million; under the policy, the utility would contribute about 20%-25% of the cost.

In addition, Shasta Lake provides water to the grow facilities through its city-owned water department. Water supplied to these customers is limited because the growers filter, recycle, and reuse their own water.

The community has been generally accepting of these businesses in the area. A major community concern centered on potential odor emissions, which was addressed by an ordinance. Operators must capture odor in ventilation systems (e.g., carbon filters) and operations must be housed in structural buildings, as opposed to allowing temporary hoop houses, which are a type of greenhouse, usually constructed with tubes and covered in heavy-duty, UV-resistant plastic. Having foundational structures helps to contain odors and reduce the potential for theft. Odor has not been an issue except when the doors are opened for shipping the product.

Payment of utility invoices was initially a challenge, as the growers would pay cash for taxes and utility bills. The amount of cash collected by the utility created internal control issues, requiring the city to install a cash counting machine and cameras. It also consumed significant staff time. The transfer of cash to the local bank was also challenging as many armored car transports refused to transfer the cash. Eventually, the growers moved to pay utility bills using electronic funds transfers, which has eliminated these challenges.

MICHIGAN UTILITY



FAST FACTS

LOCATION: Midsize city in Michigan

RTO: MISO

CURRENT CANNABIS LOAD: 1,326 kW

RATE: existing general service demand rate

EXTENSION POLICY: shared between customer and utility

EXPECTED FUTURE LOAD: none planned

AVERAGE LOAD FACTOR OF GROW FACILITY: 57%

START DATE: Q1 of 2021

In 2018, Michigan voters approved legal recreational use of marijuana, which led to an increase in grow facilities in the state. A mid-sized public power utility that is part of the Michigan Public Power Agency came to agreement with a grow facility in 2019. The facility began operations in 2021 and has a load of 1,326 kW. Though the customer's anticipated load factor was 70%, the actual realized load factor averages 57%.

Initially, the grow facility was put on a general service demand rate. After being on the system for a few months, the utility ran a rate analysis to determine if the customer would benefit from its existing general service time-of-use rate. The rate analysis found the general service demand rate to be a better fit due to the facility's load characteristics, which are 39% on-peak usage and 61% off-peak. In discussions with the utility, the customer indicated it was unable to shift load or be interrupted due to the fragile nature of the plants.

When extending service to the grow facility, the cost was estimated at $42,000. The utility's line extension policy considered the potential load of the facility and margins generated. This resulted in the utility contributing about 50% of the connection costs. In addition, the customer located in an existing building that previously had electric service, which helped to minimize infrastructure needs.

The grow facility is in an industrial area, and though some odor is emitted, the community is generally accepting of the facility. In addition, the facility employs 10 individuals at competitive wages. The utility is not having issues with payment and feels the facility is a stable customer.

CONCLUSION

One of the most powerful ways utilities can maintain financial stability is through proper rate setting. As the electric industry adapts to serving customers with atypical load patterns, cost causation analysis can help ensure new growth will not result in higher rates for existing customers. Adopting cost-based rate structures and formal policies will help to protect the utility and existing ratepayers against potential changes in a new customer's load pattern or upon loss of the customer. Utilizing a marginal cost recovery approach to rate design, requesting the ability to interrupt service, and putting in place a formal line extension or contribution margin policy are tools for electric utilities to manage cryptocurrency miners, cannabis grow facilities, and other emerging loads. As individual utilities strive for growth, resiliency, and reliability, work at the state and federal levels is being done to better understand the effects of cryptocurrency mining and cannabis grow facilities on the electric grid. Even with new loads and progression toward the "grid of the future," the goal of utilities remains to maintain reliable and affordable electricity for the communities they serve.

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