ZONING PRACTICE JUNE 2022

AMERICAN PLANNING ASSOCIATION

ISSUE NUMBER 6

# PRACTICE DATA CENTERS



# Zoning for Data Centers and Cryptocurrency Mining

By David Morley, AICP

Data centers are the physical facilities where the internet lives. Fundamentally, they consist of networked computer systems used for data storage and processing, along with supporting equipment, such as batteries, back-up power generators, and cooling devices. Modern data centers are the direct descendants of the, so-called, *telecom hotels* that began springing up in downtowns in the late 1990s to accommodate the rapid expansion of the commercial internet and, before that, of automated telephone exchange facilities that made it possible to place landline telephone calls across a city, the nation, or the world (Evans-Cowley 2002).

An emerging segment of the data center market consists of facilities dedicated in whole or part to "mining" cryptocurrency. A cryptocurrency is a decentralized digital currency that uses encrypted data strings to denote individual units, or coins, and a peer-to-peer database known as a blockchain to maintain a secure ledger of transactions. Several of the most popular cryptocurrencies, most notably Bitcoin, require extremely complex computations to verify each transaction and add a record, or block, for that transaction to the blockchain. Whoever verifies a transaction first receives a new cryptocurrency coin as a reward. While, theoretically, anyone with a computer server can "mine" new coins by helping to verify these transactions, large-scale cryptocurrency mining requires a massive amount of computing power.

This article explores the reasons why cities, towns, and counties may wish to define and regulate data centers and cryptocurrency mining as distinct uses in their zoning codes and provides a summary of contemporary approaches. It begins with a brief overview of the factors that drive demand for data centers or cryptocurrency mines in particular locations before examining the key planning issues that may merit special attention through zoning and posing a series of questions to guide code drafting.



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A hyperscale Google data center in Council Bluffs, Iowa.

The article concludes with short profiles of local zoning approaches that may serve as models for others.

## DEMAND DRIVERS

Industry analysts predict sustained growth in data center construction in the coming years (Dunbar and Bonar 2021). This includes demand for larger and larger "hyperscale" data centers as well as more widely distributed "edge" data centers (Sowry et al. 2018). Data center developers (or operators) are attracted to sites with low latency to end users and dependable and affordable electricity.

While data centers have historically been clustered around major internet access points, information technology companies, and government employment centers, the proliferation of cloud computing and the internet of things is pushing demand out to network edges. This means more data centers in smaller metropolitan and nonmetropolitan areas.

Big technology companies are likely to continue looking for sites that can accommodate new, large single-story structures. But operators that specialize in leasing space in the same facility to multiple companies (i.e., collocated data centers) may be more open to infill sites and existing structures, especially if those sites have access to fiber optic infrastructure.

Data centers use a lot of electricity (see below) to power processing and storage hardware and to keep that hardware cool. The amount of electricity (and often water) needed for cooling is higher in warm, humid climates than in cool, dry areas. Consequently, holding other factors equal, developers favor locations with low electricity rates and cooler climates. Furthermore, because these facilities operate continuously, developers are also looking for sites that are less vulnerable to natural hazards.

Cryptocurrency miners are also looking for locations with cheap electricity and low hazard risk; however, dedicated mining facilities are not concerned about proximity to customers and are less likely to invest in backup power. While there seems to be a widespread consensus that data centers are essential to global communications and the global economy, cryptocurrency miners

have a more limited "social license" to operate. Widespread concerns about the energy use of mines and the limited utility of the coins they produce has led some countries, including China, to ban Bitcoin mining. Consequently, many cryptocurrency miners are relocating to the U.S. (Obando 2022).

## PLANNING ISSUES

From the exterior, data centers and cryptocurrency mining facilities may be physically indistinguishable from many commercial or light industrial uses. However, the operational characteristics of these facilities are typically quite distinct from those of surrounding land uses. From a planning perspective, the most noteworthy characteristics relate to their electricity and water use, noise production, enhanced safety and security needs, and low employment densities.

### They Use a Lot of Electricity (and Water)

In 2020, data centers used between 200 and 250 terawatt hours (TWh) of electricity, accounting for approximately one percent of global consumption (IEA 2021). While the total consumption has grown steadily along with global power demand, this ratio has held relatively constant over the past 20 years as efficiency improvements have proportionally offset increased demand from data centers. However, this pattern is unlikely to hold as growth in streaming video, online gaming, cloud computing, machine learning, virtual reality, and the internet of things begins to outstrip efficiency improvements.

The figures above exclude cryptocurrency mining. Bitcoin miners alone used an estimated additional 60 to 70 TWh in 2020. According to Cambridge University, if Bitcoin was country, it's annual electricity consumption would be slightly higher than that of Poland or Malaysia (2022).

Data center and cryptocurrency mining equipment also generates a tremendous amount of waste heat, which must be dissipated by fans or absorbed by a cooling medium to avoid hardware damage and ensure efficient operations. Many data centers and cryptocurrency mines use water as a cooling medium. Water is also necessary for most forms of electricity production. In aggregate, a medium-sized data center typically uses more water each year than two 18-hole golf courses (Mytton 2021).

### They Can Be Noisy

Inside a data center or cryptocurrency mine server room, the noise can make it difficult to carry on a conversation at a normal volume. While most data centers and large cryptocurrency mines incorporate construction and soundproofing techniques that ensure this server noise isn't audible outside of the building, air conditioner compressors mounted on the roof or on ground near these facilities can generate noise that carries across property lines.

In some contexts, vegetation or other structures may rapidly attenuate this sound. In others, the sound may travel over long distances. Obviously, the degree to which these sounds constitute nuisance "noise" depends on surrounding land uses and ambient noise levels. The problem is typically most acute when data centers or mines are near residences.

### They Have Enhanced Safety and Security Needs

Data centers typically aim to run continuously, and any outage or downtime can threaten business operations. Furthermore, data centers house expensive, highly specialized hardware, and many handle sensitive data. Consequently, most data centers incorporate enhanced safety and security features, such as gated access points, fencing, or bright lighting, to prevent unauthorized access and to minimize the likelihood of disruption.

Cryptocurrency mines have similar safety and security needs, with two key distinctions. First, miners want to maintain network access, but the stakes are lower than for data centers because an outage wouldn't negatively affect any other services or users. Second, cryptocurrency mines generally aren't receiving any clients and have little incentive to draw attention to themselves with fencing or lighting.

### They Have a Low Employment Density

Data centers typically have far fewer workers per square foot than professional offices or light industrial facilities (Tarczynska 2016). And cryptocurrency mines generally have even lower employment densities than data centers. For some communities, data centers (and potentially cryptocurrency mines) are highly desirable from an economic development perspective because they often generate a large property tax surplus that can subsidize more service-intensive land uses, such as single-family homes. Others, however, are reluctant to devote too much commercial or light industrial space to uses that generate few jobs.

## ZONING CONSIDERATIONS

Any community interested in regulating data centers and cryptocurrency mining through zoning should consider three key questions:

1. Do these uses need new use definitions?
2. Where should these uses be permitted?
3. Do these uses need special development or performance standards?

### Do They Need New Use Definitions?

New land uses don't necessarily require new use definitions in the local zoning code. It depends, in part, on whether the use fits



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The roof of eBay's Topaz data center in South Jordan, Utah.

neatly under a broader use category or is substantially like another defined use. And it depends on whether treating the new use the same as this use category or other similar use would be likely to generate negative effects on nearby properties or the community as a whole.

Many communities have defined data centers (or some closely analogous term) as a distinct use in their zoning codes. These definitions typically reference the general function of the facility and the degree to which it is occupied by computer systems and related equipment. For example, Anne Arundel County, Maryland, defines *data storage center* as "a facility used primarily for the storage, management, processing, and transmission of digital data, which houses computer or network equipment, systems, servers, appliances, and other associated components related to digital data storage and operations" (§18-1-101.(44)).

Comparatively fewer communities have defined cryptocurrency mining as a distinct use. Many of these definitions focus on the specialized purpose of the facility, often with references to other newly defined terms, such as *high density load* or *server farm*, that clarify its distinct characteristics. For example, Moses Lake, Washington, specifies that *cryptocurrency mining* often uses more than 250 kilowatt-hours per square foot each year (§18.03.040).

### Where Should They Be Permitted?

Communities that choose to regulate data centers or cryptocurrency mines as distinct uses may permit these uses either by right or with a discretionary use permit (i.e., conditional, special, or special exception use permits) in one or more existing base or overlay zoning districts. Alternatively, they may elect to establish a new special-purpose base or overlay zoning district for either use.

Many communities permit data centers and cryptocurrency mines either by right or with a discretionary use permit in commercial and industrial districts. While data centers and mines can fit in a wide range of existing commercial or industrial buildings, purpose-built facilities are often single-story structures with large floorplates.

Given that they generally have few employees and visitors, these uses may not be appropriate in ground-floor street-frontage spaces in pedestrian-oriented commercial areas. Wenatchee, Washington, addresses this issue by permitting data centers and cryptocurrency mines by right in multiple pedestrian-oriented commercial districts, with a simple stipulation that they cannot occupy "grade level commercial street frontage" (§10.10.020).

A new special-purpose zoning district can help steer data centers or cryptocurrency mines toward corridors or other subareas that have suitable utility infrastructure. When adopted as floating zones, special districts can also provide an extra layer of review for large projects that may cover dozens or hundreds of acres.

Prince William County, Virginia, added a Data Center Opportunity Zone Overlay District to its zoning code in 2016 (§32-509). The county has mapped this overlay to more than 70 percent of its industrially zoned land. The overlay permits data centers and includes design standards for these facilities; however, it does not otherwise modify the existing use permissions for underlying districts.

### Do They Need Special Development or Performance Standards?

Communities that decide to regulate data centers or cryptocurrency mines as distinct uses may choose to adopt use-specific standards that modify or supplement other relevant universal or district-specific development or performance standards. This approach can help communities target standards to the distinct features of these uses to address specific community concerns.

Use-specific standards can help minimize reliance on discretionary approvals and improve the consistency of local decisions. Without these standards, local officials may be more likely to require all data centers and cryptocurrency mines to obtain a discretionary use permit, and they may be more likely to adopt wildly varying conditions of approval for substantially similar proposals.

Communities that have adopted use-specific standards for data centers and cryptocurrency mines often establish building design and buffering or screening requirements to minimize the visibility or improve the appearance of these facilities from public streets or nearby properties. Other common standards address environmental performance, including noise and light pollution, and evidence of electric utility approval.

## EXAMPLES OF DEFINED USES

| Jurisdiction | Defined Uses |
|---|---|
| Alpharetta, GA | Data center (§1.4.2) |
| Anne Arundel County, MD | Data storage center (§18-1-101.(44)) |
| Fairfax County, VA | Data center (§9103) |
| Frederick County, MD | Critical digital infrastructure facility (§1-19-11.100) |
| Moses Lake, WA | Cryptocurrency mining; Data center/server farm/cluster (§18.03.040) |
| Pitt County, NC | Data processing facility (large scale) (§15) |
| Plattsburgh, NY | Commercial cryptocurrency mining; Server farm; High density load service (LL 6-2018) |
| Prince George's County, MD | Qualified data center (§27-2500) |
| Prince William County, VA | Data center (§32-100) |
| Somerville, MA | Data center (§9.8.b) |
| Vernal, UT | Data center (§16.04.173) |
| Wenatchee, WA | Cryptocurrency mining; Data center (§10.08) |

## POTENTIAL MODEL APPROACHES

It would be difficult to find a community with more experience with data centers than Loudon County, Virginia. And the county's approach to zoning for data centers serves as a potential model for other communities with suitable sites and sufficient infrastructure to accommodate data center development. In contrast, Missoula County, Montana, was one of the first local jurisdictions to craft zoning regulations for cryptocurrency mining operations. And its emphasis on mitigating the potential climate impacts represents a different type of potential model.

### Loudon County, Virginia

Northern Virginia's Data Center Alley, primarily clustered around Routes 7 and 267 in Loudon and Fairfax Counties is the largest data center market in the world (Fray and Koutsaris 2022). Its combined power consumption capacity is more than 1.6 gigawatts (GW), nearly twice as much as the next largest market. And within Data Center Alley, Loudon County has the highest concentration of data centers. As of October 2021, data centers occupied more than 25 million square feet, with another 4 million square feet in development (LCDED 2022).

Several important factors have driven demand for data center development in Loudon County. It is home to the Equinix internet exchange, one of the largest internet access points in the world and a successor to Metropolitan Area Exchange, East, the first U.S. exchange. The county has abundant (and redundant) fiber optic infrastructure, relatively cheap power, and sufficient water. Additionally, it has a high concentration of skilled technology workers and businesses that support the data center industry.

By the year 2000, there was already an emerging data center cluster in Loudon County. However, the county did not define and regulate data centers as a distinct use in its zoning code until 2014 (ZOAM 2013-0003). According to Acting Planning & Zoning Director James David, prior to this, the county defined data centers as commercial offices.

The latest version of the county's zoning ordinance permits data centers by right in Planned Office Park, Research and Development Park, Industrial Park, and General Industrial districts and as a special exception use in Commercial Light Industry districts. New data centers (without vested rights) must comply with a set of use-specific standards governing façade design, screening of mechanical equipment, exterior lighting, pedestrian and bicycle facilities, and landscaping, buffering, and screening (§5-664).

According to David, these standards are intended to improve the aesthetics of data centers, minimize visibility from nearby residential areas, and ensure continuous sidewalk and trail networks. Overall, they represent a light-touch approach that has, so far, worked well for a county with enormous demand for data centers and relatively modest competition for space from other commercial and industrial uses.

However, in February 2022, county officials directed staff to research regulatory options to prevent new data centers in the

## EXAMPLES OF USE-SPECIFIC STANDARDS FOR DATA CENTERS AND CRYPTOCURRENCY MINING

| Jurisdiction | Use-Specific Standards |
|---|---|
| Alpharetta, GA | Requires evidence of compliance with noise standards; specifies exterior lighting fixture design; establishes minimum building height; requires building façade design elements; establishes other fencing, screening, and landscaping requirements to minimize visibility from adjacent roads and properties (§2.7.2.1) |
| Anne Arundel County, MD | Establishes minimum lot size and setbacks; prohibits residences on the same lot; establishes limit on outdoor storage (§18-10-119) |
| Fairfax County, VA | Requires all equipment to be enclosed within a building; establishes maximum floor area by zoning district (§4102.6.A) |
| Frederick County, MD | Establishes criteria for reducing setbacks; specifies building design standards; specifies landscaping, screening, and buffering requirements; clarifies parking, loading, signage, and lighting standards; establishes criteria for private roads; establishes noise and vibration standards (§1-19-8.402) |
| Moses Lake, WA | Clarifies review process for business license; prohibits container storage; requires evidence of electrical utility approval; requires evidence of electrical permit and inspection; establishes environmental performance standards, addressing noise, heat, and electric and magnetic fields; limits amount of exposed equipment on facades (§18.74) |
| Pitt County, NC | Limits height; requires separation from sensitive uses; requires noise study and compliance with noise standards; requires underground wiring; requires security fencing and vegetative screening; requires evidence of electrical utility approval; clarifies signage standards; requires notification of abandonment (§8(UUUU)) |
| Plattsburgh, NY | Requires fire suppression and mitigation techniques; limits internal ambient temperature and the direct release of heat on colder days; establishes permissible noise levels (LL 6-2018) |
| Prince George's County, VA | Requires building façade design elements; specifies exterior lighting fixture design; requires screening for security fencing and limits fence height; requires compliance with landscape manual; clarifies applicable off-street parking standard; clarifies signage standards; requires an acoustical study; specifies additional site, locational, and noticing requirements for facilities in rural residential districts (§27-5102(e)(4)(B)) |
| Somerville, MA | Establishes special review criteria related to aesthetic impacts and employment opportunities (§9.8.b) |
| Vernal, UT | Requires fencing and structural screening for electrical generators; requires noise mitigation plan for facilities near residential zones or existing hotels or motels (§16.20.250) |
| Wenatchee, WA | Clarifies review process for business license; prohibits container storage; requires evidence of electrical utility approval; requires evidence of electrical permit and inspection; clarifies blank wall limitation standards; requires an affidavit verifying operating sound levels (§18.48.310) |

Route 7 corridor. While data center demand remains high in this area, the county's comprehensive plan designates most of this corridor as Suburban Mixed Use, which envisions a compact, pedestrian-friendly mix of commercial, residential, cultural, and recreational uses. Furthermore, the existing electricity network infrastructure is insufficient to accommodate the existing demand for new data centers (LCDED 2022).

The county is working on its first complete overhaul of its zoning code since 1993. And it intends to incorporate any new regulations for data centers into the new code, which officials hope to adopt by the end of 2022.



Google Earth

The heart of Northern Virginia's Data Center Alley in Ashburn, Virginia.



Google Earth

The former Bonner sawmill in Missoula County, Montana, was once home to the HyperBlock cryptocurrency mine.

### Missoula County, Montana

In April 2019, Missoula County, Montana, adopted an interim zoning resolution that established a cryptocurrency mining overlay (Resolution No. 2019-026). The county had one large cryptocurrency mine already, and its low electricity rates and cool climate made it an attractive area for prospective miners. While a few other jurisdictions had already defined cryptocurrency mining in their zoning codes, Missoula County appears to be the first to explicitly position its zoning approach as a response to climate change.

According to county planner Jennie Dixon, AICP, local officials originally took an interest in regulating cryptocurrency mining as a distinct use after multiple complaints of noise from cooling fans at an existing Bitcoin mine operating out of a former sawmill in unincorporated Bonner. Soon, though, the county expanded its focus to include energy consumption and electronic waste.

Montana law only authorizes interim zoning in the case of an emergency involving "public health, safety, morals, or general welfare" (§76-2-206). Dixon says the Intergovernmental Panel on Climate Change's 2018 Special Report on *Global Warming of 1.5° C* helped justify climate change as a local emergency that warranted interim zoning to mitigate greenhouse gas emissions (and other potential environmental impacts) from cryptocurrency mining.

The interim zoning regulations defined cryptocurrency mining as a distinct use and created a Cryptocurrency Mining Overlay Zone, mapped to the entire unincorporated geographic extent of the county (which includes some un-zoned areas). The overlay restricted cryptocurrency mining operations to industrial districts and required operators to obtain a discretionary use permit if the mine was adjacent to a residential district or within 500 feet of a residential property boundary. These regulations also required all mining operations to verify that all electronic waste be handled by a licensed recycling firm and that all electricity use be offset by new renewable energy production.

Caroline Lauer, the county's Sustainability Program Manager, stresses the importance of this last requirement. If cryptocurrency miners purchased existing supplies of renewable energy, it could actually displace existing utility customers to dirtier sources. While most of the county's electricity comes from hydropower, coal accounts for much of the remainder.

Missoula County's 2016 *Growth Policy* plan includes an objective to "reduce the county's contribution to climate change" (4.1) and lists policies that promote alternative energy development (4.1.3) and reduce energy use and waste generation as implementation actions (4.1.6). A day before it adopted the interim cryptocurrency mining regulations, the county further strengthened its policy rationale by adopting a joint commitment with the City of Missoula to achieve 100 percent clean electricity use by 2030.

County officials extended the interim zoning for another year in 2020 before adopting the same regulations as a permanent zoning amendment in March 2021 (§1.04

& §5.05). According to Dixon, the Bonner mine ceased operations during the interim zoning period, but not because of the county's zoning. It declared bankruptcy two days after the "Black Thursday" Bitcoin crash in March 2020, leaving the tribal-owned independent power producer that provided its electricity with a $3.7 million unpaid bill (Rozen 2020).

## CONCLUSIONS

The rapid rise in data center development has coincided with dramatic decreases in the costs of producing solar and wind power. This, in combination with a growing trend toward clean power commitments among technology companies, has blunted some of the climate impacts of an increased demand for data storage and processing.

The increased digitalization of life virtually guarantees that data centers will continue proliferating in strategic locations across the country (Gomez and DeAngelis 2022). Soon, communities may start seeing a sharp increase in interest in very small edge data centers that could fit in underutilized commercial spaces or even be collocated with other telecommunications infrastructure, such as small cell facilities, in public rights-of-way (Sowry et al. 2018).

The future of cryptocurrency mining facilities is less certain. Bitcoin and other energy-intensive cryptocurrencies are facing social pressure to transition to more energy-efficient transaction verification methods, and several existing cryptocurrencies already use these methods. However, we are still at the very beginning of the cryptocurrency story. While this form of currency currently exists primarily as a speculative investment vehicle, this could change rapidly if valuations stabilize and large numbers of goods and service providers accept cryptocurrencies for payment.

Not every community will see the value in defining data centers or cryptocurrency mines as distinct uses in their zoning codes. Nevertheless, doing so can give local jurisdictions a leg up when it comes to signaling preferences to developers and operators and minimizing or mitigating potential adverse impacts.

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**VOL. 39, NO. 6**

**The American Planning Association will lead the way to equitable, thriving communities by creating unique insights, as well as innovative and practical approaches that enable the planning community to anticipate and successfully adapt to the needs of a rapidly changing world.**

***Zoning Practice* (ISSN 1548–0135) is a monthly publication of the American Planning Association. Joel Albizo, FASAE, CAE, Chief Executive Officer; Petra Hurtado, PHD, Research Director; David Morley, AICP, Editor.**

**Subscriptions are available for $95 (U.S.) and $120 (foreign). Missing and damaged print issues: Contact APA Customer Service (312-431-9100) within 90 days of the publication date.**



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# HOW DOES YOUR ZONING TREAT DATA CENTERS AND CRYPTOCURRENCY MINES?

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