DATA CENTERS AS TAXABLE PROPERTY

A feasibility report on taxation schemes on the amount of data kept in data centers

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This paper was written by Gemma Galdon Clavell and the team at Eticas. It is part of a collaboration under Ashoka's Tech & Humanity initiative, a global network of leading social entrepreneurs committed to ensuring tech works for the good of people and planet. This community is concerned about the societal and environmental harms of the data economy and is building innovative frameworks and tools to mitigate these harms.

Table of Contents

Data centers as taxable property

A feasibility report on taxation schemes on the amounts of data kept in data centers

Introduction

Data Centers impacting our daily lives

As the global demand for data continues to rise exponentially, data centers are rapidly expanding around the world. The need for these facilities is driven by the increasing need for data storage and processing to support the growing number of businesses and individuals who rely on the internet for a wide range of tasks. In order to keep pace with this demand, data centers must be able to expand quickly and efficiently, providing the robust and reliable infrastructure that is essential for supporting the ever-increasing amounts of data generated and consumed on a daily basis. While data centers can offer numerous advantages, such as the potential for stimulating investments and job creation, they can also have some disadvantages. For example, data centers can have substantial impacts on the environment, such as through their energy consumption, water footprint and the potential for greenhouse gas emissions. Data centers can also have negative impacts on the socioeconomic aspect of communities, such as through the potential for displacement of local residents or businesses. To gain a complete understanding of data centers and their significance in modern society, it is crucial to consider the challenges, as well as the benefits and drawbacks, they present.

Balancing the pros and cons of data centers can be a difficult challenge, as the benefits and drawbacks of these facilities are often complex and interconnected. In order to address this outstanding challenge, it may be necessary to update taxation policies and other regulations to better reflect the realities of the data center industry. Indeed, taxation on property is still marred by numerous challenges, and environmental taxation remains a relatively immature discipline in many ways. In this study, we will discuss the challenges and opportunities related to property taxation of data centers, as well as the potential for treating data centers as environmental hazards. Through a review of existing literature and case studies, we will explore the various issues and considerations involved in taxing data centers, including the complexity of property tax policies and the lack of comprehensive environmental taxation policies. Additionally, we will introduce some innovative approaches to taxation (compensation through dividend distribution) that could help to pave the way for a rethinking of how data centers can be taxed in the near future. By examining these issues in detail, we hope to provide valuable insights and suggestions for policymakers and other stakeholders who are looking to develop more effective and sustainable approaches to taxing data centers.

Data centers. A growing industry

According to the specialized network and telecommunications industry consultancy Synergy Research Group, in 2021 there were 209 deals closed in 2021 with an added value of more than $48 billion, 41% more than 2020, which itself was a record year. In the first half of 2022, 87 mergers and acquisitions (M&A) deals focused on the DC sector have already been closed, worth $24 billion [1]. These figures illustrate the growth of the data center market as investment interest and growth. What is interesting here is that not only technology firms are interested in investing in the DC sector. Large logistics and real estate players, such as GLP, Prologis, Segro and ESR, are taking positions in the DC market. Prologis, a real estate investment trust, has recently acquired more than 220 acres outside of Austin to build a DC (Swinhoe, 2022). The synergy between the two sectors is increasing, leading to increased competition for land and its resources.

a) Definition and types

Data centers (DCs) are the basic physical infrastructure that houses the necessary computer components (communications, servers, data storage systems, etc.) to enable the basic functioning of cloud computing. ISO standards [2] confirm that data centers should be understood as a kind of infrastructures which are housing and supporting the information technology and network telecommunications equipment and in most of the existing literature (Khan and Zomaya, 2015; Geng, 2021; Huang et al., 2022), the definition of DCs seems to be strongly influenced by the triple classification of its three different purposes:

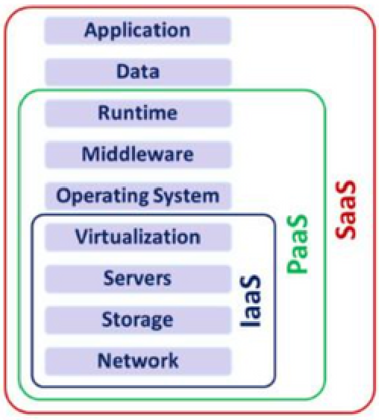
[1] See: https://www.srgresearch.com/articles/private-equity-is-driving-a-boom-in-data-center-ma-deals
[2] See: https://www.iso.org/obp/ui/#iso:std:iso-iec:ts:22237:-6:ed-1:v1:en

data processing (servers), data storage (storage equipment) and communications (network equipment). Thus, DCs are high-power environments that require large amounts of energy to maintain reliability, control environmental equipment, and maintain the proper temperature and humidity for equipment (Harvey, 2017). There are various ways to classify DCs, based on their size, structure, availability time offered, cloud service delivery models and cloud deployment models. One of the most important classification that directly affects the environmental pollution generated is about their availability rate [3], or in other words, the activity time of the systems that are part of the DCs. For companies that base part or all of their IT solutions in the cloud, it is extremely important that DCs have an uninterrupted and secure data supply. This is why service providers are expected to offer much stronger cloud infrastructures to support the high demand for data, ensuring uninterrupted service that can be delivered to the consumer consistently and without delay.

b) Certifications and cloud services

In this sense, to assess the availability of data management services, there are several types of certifications for data centers: NSI/TIA-942, ISO/IEC 24764, ANSI/BICSI-002, and the most used TIER classification [4], created by the UpTime Institute [5] to classify and certify DCs by assigning an expected uptime rate percentage per year into 4 levels. Each level describes the infrastructure required for data center operations based on business functions. It is precisely the configuration of access to the cloud that describes another popular classification method of the services offered by a DC, based on how the service is delivered, depending on the level of outsourcing that the user is interested in delegating to the provider. Based on this characteristic, there are three main types of cloud computing solutions as a service: Software as a Service (SaaS), Platform as a service (PaaS) and Infrastructure as a service (IaaS). The first one, SaaS, is a model designed so that the user completely delegates needed infrastructure and software to the provider, who owns and is responsible for maintaining the entire management environment. End users buy access to software applications through the internet (Geng, 2021). PaaS model is mainly focused on meeting the needs of the developers and programmers. The end customer gets a pre-packaged combination of cloud computing hardware and software, obtaining an environment in which to develop the applications. At the last level in the delegation of services is the IaaS model, in which the service provider handles the storage of the network management and virtualization through the cloud, but the user maintains control and responsibility for managing the system. operation, the applications and the management of the data. The following table is a conceptual model that represents the level of delegation of services in each model, although there are also other multidimensional and other very creative ones:

[3] See: https://en.wikipedia.org/wiki/High_availability
[4] See: https://uptimeinstitute.com/tiers
[5] See: https://uptimeinstitute.com/tiers



Graphic 1: IaaS, PaaS and SaaS Conceptual Model. Source: Oliveira (2015)

Analyzing these three cloud service delivery models is necessary to understand how the storage and processing of data and its subsequent need for access explains why data centers are proliferating and will continue to do so. Beyond these three, there is a latent trend in the cloud computing market to migrate all types of cloud applications to offer them as services. This paradigm, called XaaS (Everything as a Service) is understood as the natural evolution of moving everything to the "cloud" and one of the consequences of cloud computing development.

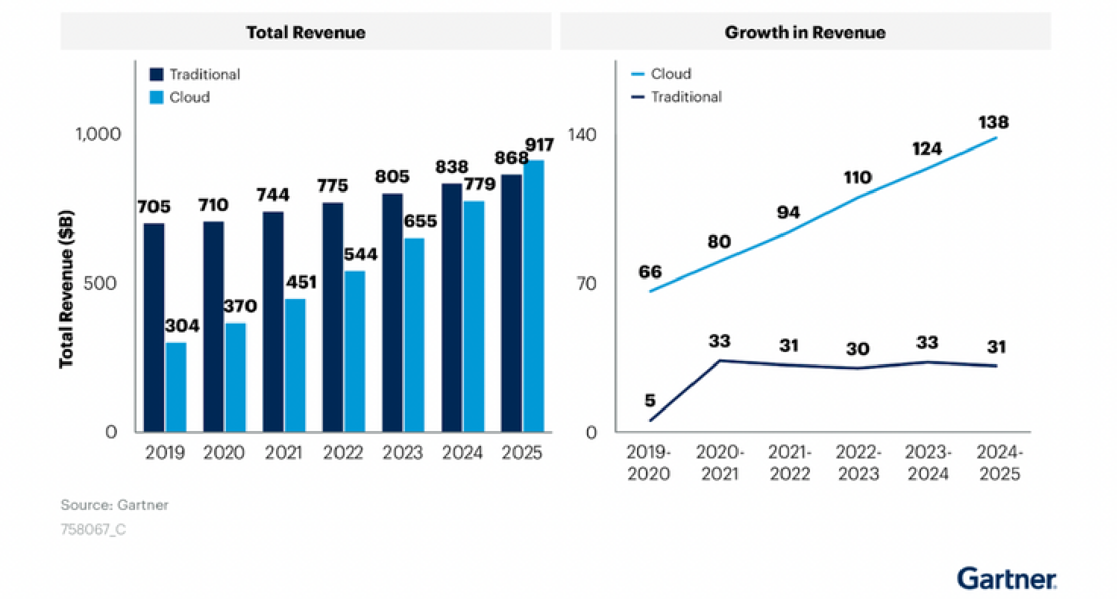
Defenders of this trend assure that it helps to break with the linear consumption models based on the pattern "take, make, discard" to more circular ones based on satisfying needs specific to the moment and the functionality desired by the consumer, since they follow the logic of allowing access to the service instead of ownership: people do not need cars, but mobility; they do not need washing machines, but clean clothes. (Systemiq, 2021). Under the trend towards an adoption of the XaaS model as prevailing due to its scalability, it is possible to understand that the market trend is towards payment for use of cloud services, in which companies will demand very concrete and specific solutions, diversifying their services in multi-cloud environments.

An illustrative example are all the services related to the shared mobility system, in which what is sold is not the vehicle, but the mobility service through a service delivery model in the cloud of the type "Mobility as a service", or MaaS (also known as "Transportation as a Service" or TaaS, which also includes freight transport), which is called to create a disruption in the transport sector, under the paradigm of mobility on demand (MOD) and the sharing of vehicles in replacement of their private property (RethinkX, 2017).

There are also multiple other "aaS" models such as CaaS (Communication as a Service), BPaaS (Business Process as a Service), DBaaS (Database as a Service), VaaS (Video as a Service), BaaS (Backup as a Service), DaaS (Desktop as a service), among many others [6].

[6] See: https://www.auvik.com/franklyit/blog/aas-as-a-service-list/?

Some voices point to the danger that this exponential growth of the XaaS model, in which all kinds of services are migrated to the cloud and sold as remote access applications, warn that more and more resources will be needed and data will have more environmental impact. According to Gartner (2022), accelerated levels of cloud service adoption are expected by 2025. For example, Gartner forecasts that by 2025 business spending on new cloud computing-based technologies will exceed business spending in the traditional cloud computing market. new technologies, driving the continuous shift to the cloud, as illustrated in the figure below:



Graphic 2: Sizing Cloud Shift, Worldwide, 2019 – 2025. Source: Gartner (2022)

In conclusion, the market trend is clear and the demand for data network services will experience exponential growth in the coming years, mainly due to the increasingly widespread adoption of elements that require high data transfer, such as cloud gaming, metaverse, IoT, blockchain, machine learning, and virtual reality, among others. This will cause associated a growth of consumption of electricity and GHG emissions that it generates, an urgent problem to tackle, if we take into account that nowadays the largest element of this kind of pollution within the technology industry are data centers, with an annual consumption estimation that exceeds 200 billion kWh (Xinyuan, 2022).

Environmental impact of Data Centers

A multi-faceted perspective

In 2019 it was estimated that DCs worldwide used more than 2% of the world's electricity and generated the same volume of carbon emissions as the global airline industry (TNW, 2020). Despite the enormous energy expense and associated pollution of data centers, the development of increasingly efficient technologies means that the energy efficiency of the devices is increasing. However, this is slowing down and the effects of the data-intensive demand of the technologies, on the contrary, continues to grow exponentially. This double effect generates a growing concern about the still uncertain general environmental impacts of the sector in the coming decades. (IEA, 2022).

Thus, in order to imagine possible taxation schemes for DCs it is necessary to carry out a multidimensional evaluation of their impact. The consequences of the increase in the demand for massive data processing and storage and the voracious consumption of resources by DCs as the necessary infrastructure for "the cloud" to work, cannot be evaluated, much less corrected, if we exclusively focus on energy consumption and GHG emissions. With all eyes focused on the energy carbon footprint and despite its important contribution to climate change, the water, land, and other footprints of data use have not been well studied (Ristic et al, 2019).

Impact on electricity demand, greenhouse emissions and water footprint

a) Energy consumption of DCs

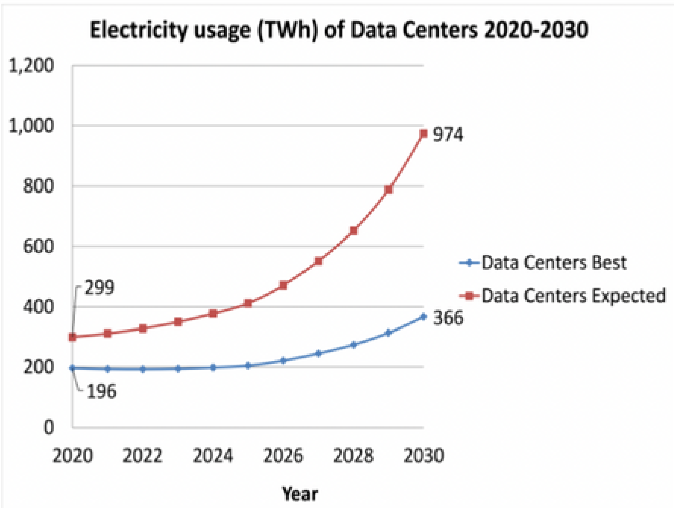
Adopting a multidimensional vision of the environmental impact of DCs does not exempt from starting with what continues to be the main environmental problem of DCs: energy consumption. According to the International Energy Agency (IEA, 2022), data centers and data transmission networks are responsible for nearly 1% of total energy-related GHG emissions, which is about 205 TWh, and their use of electricity in 2021 was 220-320 TWh2, or about 0.9-1.3% of global final electricity demand, excluding energy used for cryptocurrency mining, which was 100-140 TWh. If we look at the impact of the growth of DCs in some of the most industrialized countries, the figures for energy use are huge: in the US, electricity generation is the second largest consumer of water and the main cause of GHG emissions (Siddik et al., 2021); Denmark alone is expected to host several large-scale DCs, whose demand for electricity in 2040 may reach 33% of 2017 national electricity consumption (Petrović et al., 2020); In Ireland, the DC consumption of electricity increased by 144% between 2015 and 2020 (Burke-Kennedy, 2022) according to an analysis from the Central Statistics Office (CSO) and in the country have an average floor area of 20,000 sq.m, and an average site area of approximately 11 hectares (O'Leary, 2022). Also in China the trend is the same: according to the China Academy of Information and Communications Technology (CAICT), by the end of 2021, China's data centers had a combined total of more than five million standard Rack Units (U) (Xinyuan, 2022). These effects are even more evident when hyperscale DCs (more than 10,000U) are installed, which suffer the consequences of a much more intensive energy consumption, since this type consumes 100 million kWh of electricity each year. (Xinyuan, 2022)

b) Main factors that stimulate DCs energy demand

Among all the functionalities that can cause large energy demands in DCs, consumption related to computing power (43%) and cooling systems (32%) stand out. All these figures could be higher, since obtaining the real and up-to-date information on the consumption of DCs is still difficult to obtain due to the rapid expansion and growth of their market share (Obringer et al, 2021), the constant updating of the technology they use and the constant evolution of their infrastructure and locations. That is why the enormous consumption of electricity and emission of GHG remains as the main environmental problem of DCs, but what causes this high energy demand of the DCs? The answer is the need for constant cooling. If we imagine a room with hundreds or thousands of data servers running at full capacity and constantly, we can get an idea of the heat they can give off. This excess heat can affect not only the desired availability of the service and the performance of the equipment (latency, speed,etc.) but it can also be the cause of more important dangers, such as loss of equipment or even fire. These risks are completely incompatible with one of the fundamental characteristics of cloud computing, the need to maintain availability at all times to safeguard, process and allow access to the data contained in the servers.

This reliability of immediate access to information is precisely the key to using the cloud. Eventual interruptions in the service can not only cause frustration due to the interruption of internet services, but also breaches of the law due to data loss, serious exposure of computer or physical security, and even loss of life (Lawrence, 2021). For this, it is essential to have a constant climatic stability in the installation, which maintains an adequate and stable temperature and humidity of the constant data processing and storage components, taking into consideration that the DCs are buildings between 10-40 times more energy intensive than a typical office building and this intensity of energy is completely linked to its energy consumption (ICF, 2009).

The relationship between refrigeration and GHG emission is very high: 40% of the total energy consumed by the DC is dedicated to cooling. Unfortunately, the most widely used system, air cooling, is also the most inefficient, although its maintenance is relatively simple and inexpensive (Zhang et al, 2021). This means that the forecast for the future is in any case of growth in energy demand and therefore in greenhouse gas emissions, although this scenario is difficult to draw. There is a long way to go in terms of efficiency as it appears that 20-30% of servers in typical enterprise data centers use electricity but do nothing useful (Koomey, 2017) (also known as "Zoombie Servers") is expected to improve in parallel with ever-increasing data processing demands, as the following table shows:



Graphic 3: Electricity usage (TWh) of Data Centers 2020-2030. Source: Andrae (2020)

c) Water footprint of DCs

Closely related to the large amount of electricity used to cool the DCs is the huge water footprint of these infrastructures, which spend large amounts of water to function. The water footprint can be associated mainly with two factors. The first one is the amount of water consumed indirectly that, as a primary source, is needed to generate the electricity used by a DC. The second one is the water footprint associated with the water used within the infrastructure, normally used for cooling through cooling towers. Water consumption can become very significant: data centers that have 15 MW of IT capacity can consume between 80 and 130 million gallons per year and it is estimated that the typical water consumption of a DC is 1.8 liters (0.46 gallons) per kWh (Shehabi et al, 2016). Ristic et al. (2015) made general estimates considering this direct and indirect water consumption. More recently, Siddik et al (2021) also made estimates at the US level of what the water footprint was in 2018, in which they estimated an average of 1 MWh of energy consumption by a data center requires 7.1 m3 of water, although it is confirmed that in general, the calculation of a water impact footprint is difficult to estimate and a better understanding of the global water footprint of DCs is necessary to understand its real scope. Among others, one of the main problems is access to data. In the approximation of Siddik et al (2021), problems of access to this information are also highlighted. For example, as noted again by Siddik et al. (2021) in the US, only power plants with generating capacity greater than 100 MWh must report water consumption.

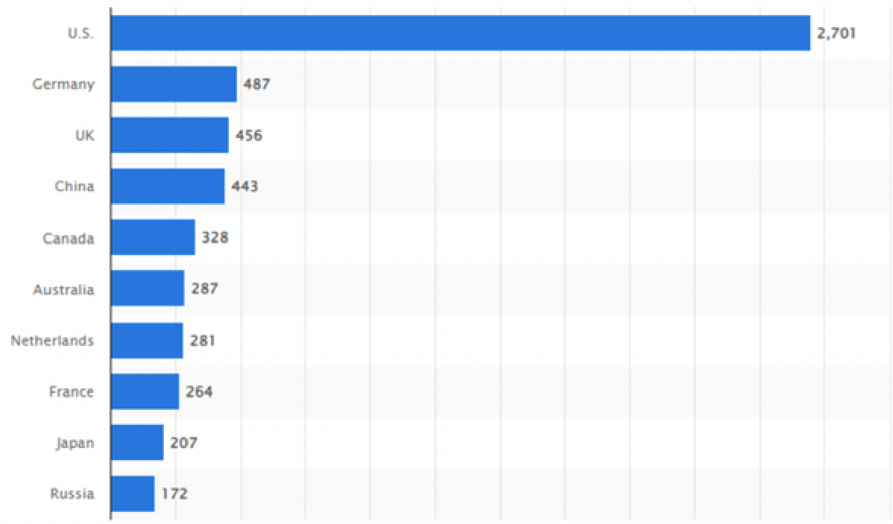
The water footprint can also cause significant impacts on the environment and on water itself, as demonstrated by a rather controversial case in the US panorama. Following the acquisition of an aging coal-fired power plant located in Finger Lakes, New York state by a private equity firm, Atlas Holdings LLC, the plant was converted into a bitcoin mining company named Greenidge Generation Holdings Inc., which continues to arouse much controversy today (Gopalakrishnan, 2022). One of these is the alleged huge water footprint that the plant is causing by the dumping of tens of millions of gallons of hot water into the glacial Seneca Lake (De Chant, 2021) which has led many residents to denounce how the temperature of the lake has significantly increased (Morgenson, 2021). More recently, in a much-anticipated decision, New York's Department of Environmental Conservation has denied the air permit requests to the company claiming that following the previous permit released back in 2016 and 2019, the greenhouse gas emissions from the plant have increased dramatically. The case of the Greenidge Generation plant and its impact on nearby Seneca Lake is one of many that should draw attention to the adverse effects that the mismanagement of data centers can entail on the environment.

Location, inequality, and socioeconomic impacts

There are nearly 8.000 data centers throughout the world

DCs locations

In order to understand the feasibility of a tax on land used by DCs, it is necessary to know where they are currently located and the reasons that have led to such global distribution. There are nearly 8.000 data centers (USITC, 2021) throughout the world, mainly located in the U.S. (2.701) and followed far behind by Germany (487) and the UK (456). In 2022, the distribution of data centers location outlined the following scenario:



Graphic 4: Number of data centers worldwide in 2022, by country. Source: Statista (2022)

Some resources have mapped the location of these DCs, such as Datacenter.rs World Map [7] or Data Center Map [8], but such maps (mostly created for commercial purposes), while they can be quite accurate, may be missing an important part of the smaller and more dispersed DCs. The actual distribution of data centers is also very difficult to pinpoint as data centers can be located in remote locations such as old mines [9], under cathedrals (Williams, 2014), in chapels [10] or (soon) under water (Roach, 2020).

Factors on location leading to inequalities

As we can see from the information discussed above, the current distribution of data centers globally is not the result of chance, but rather responds to the best business strategies. Deciding where to locate a DC site is one of the most critical steps in its design strategy. For the location of a data center, environmental, strategic, logistical, social and geopolitical factors of the country/area where the installation will be carried out are taken into account (Covas et al., 2012).

Although a data center can be housed anywhere, the choice of location plays a critical role in its performance, but there are also other factors that play a key role in the choice of location. Larumbe & Sanso (2012) describe the following as the most relevant:

- the strength of the **telecommunications infrastructure**, including vendor evaluation,
- **the quality of fiber optics** and its latency,
- **the conditions of the geography**, such as infrastructures in the area (airports, highways, train, etc.)
- the type of population,
- the availability of labor,
- the availability of water for cooling,
- the evaluation of issues related to the climate such as the average annual temperature of the region,
- environmental hazards such as earthquakes or tornadoes,
- everything related to **energy and its cost**, cost per kWh, energy consumption, etc.
- the ease with which energy is available,
- the ease of obtaining permits to connect to the energy supply network or its price (and/or the incentives that the government is willing to grant for its implementation)

Furthermore, all of these factors become more important when it comes to hyperscale data centers as they need extremely high reliability in power and data supply to function properly.

As we can see, the decisions about the location of the DCs are mainly commercial. Added to this, the lack of regulation, effective taxes, variability in the price of energy and the tax

[7] See: https://datacente.rs/
[8] See: https://www.datacentermap.com/
[9] See: https://www.lefdalmine.com/
[10] See: https://aql.com/about/salem-chapel-heritage/

benefits of some local governments for their installation, has closed a scenario in which the global distribution of DCs is not equitable and is far from being uniform. For example, there are areas of the planet that, due to their social, political and environmental characteristics, present a higher concentration of DCs. An illustrative example is found in Loudoun County, also known as "Data Center Alley" (VA), which, although it is not the area with the most DCs in the United States (118), does have a special density of DCs and in which It is estimated that 70% of the total network traffic circulates. Global companies like Facebook, Amazon, Google, and Apple have DCs installed here. This area is also paradigmatic due to the causes of this concentration of DCs: economic energy, 28% more than the national average [11]; a moderate cost of land; availability of water for cooling, since it is located near the Potomac River; academically prepared local population, counting 60% of the population with a bachelor's degree; abundant services, since it has business services prepared to meet the demand of DCs. As a consequence, the concentration of DCs directly affects the demand for energy consumption in the area, which it is projected that the demand for energy is expected to increase by 15% in the next 15 years (Gong et al, 2022).

"Data Center Alley" is not only an example of unequal energy use concentrated in a certain area, it is also an example of unequal and inequitable land use, as we can see in the following image:

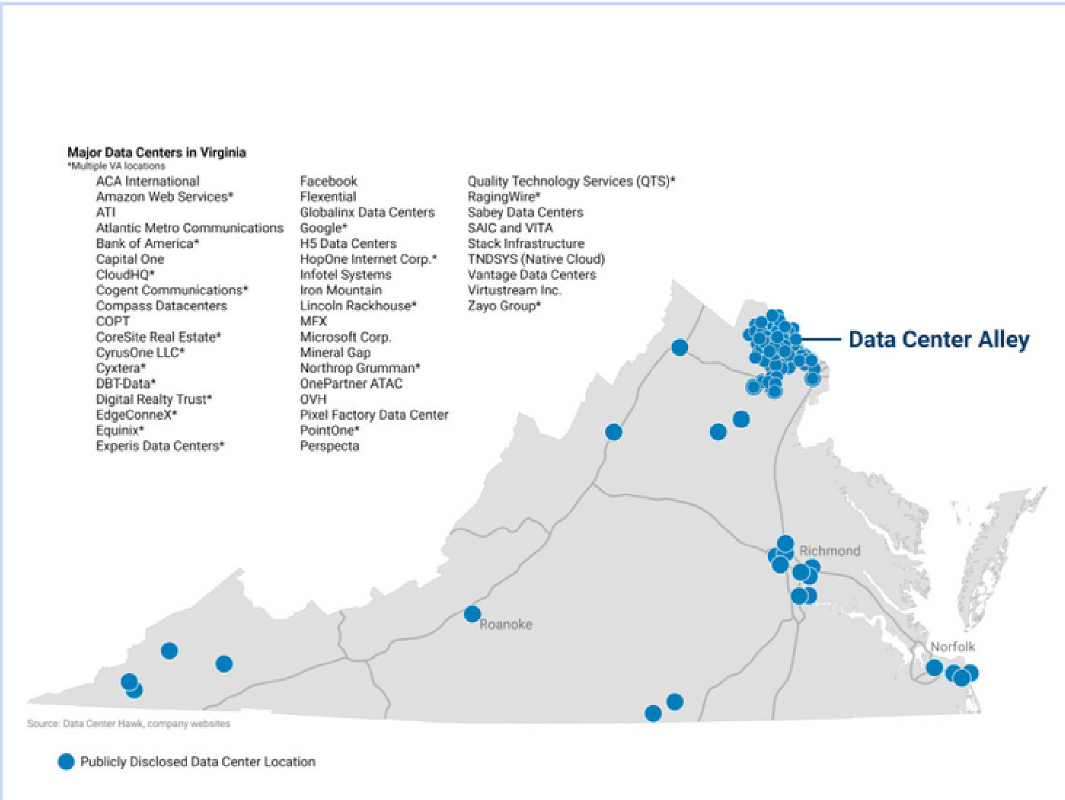


Image 1: Major Data Centers in Virginia. Source: VDEP (2022).

[11] See: https://biz.loudoun.gov/key-business-sectors/data-centers/

Due to the concentration of infrastructure, the conditions in the area attract more and more companies that want to install a DC there. Therefore, the price of building in the area is climbing (Miller, 2022) and the real estate business in the area profits from it. But the extension of the DCs in the United States does not only happen in this area. In Northern California, where the largest location of data-intensive firms such as Google, Facebook, Uber, Twitter, Yelp, for example, are concentrated, Dallas currently has the highest number of data centers (149). This is followed by the Bay Area (147), and Los Angeles (139) (Daigle, 2021). On the other hand, if we focus on the occupied land area, it is necessary to turn our eyes towards hyperscale DCs. As we have pointed out before, hyperscale DCs need extreme high reliability in power and data supply, affecting the locality where they are installed. The world's largest data center is the China Telecom-Inner Mongolia Information Park [12]. It occupies 1M square meters (10,763,910 square feet) and consumes 150MW across six data halls. In the United States is the "Citadel Campus", with 1.4 million sq ft and 130 megawatts of power capacity (Moss, 2022).

a) Socioeconomic impacts

Despite the fact that governments think of incentive packages to attract the installation of DCs in their territories, with the promise of economic and labor activation near their urban centers, the reality is that more rural areas, uninhabited or far from urban centers, have better connectivity conditions (fiber optics, electrical network) that allow data centers to be located in these areas at a lower cost, especially in the cost of land. As a consequence, there are many doubts about the socioeconomic impact on the territory where they are implemented, and growing concern about negative social effects caused by the possible relocations and impermanence of DC facilities, on which more academic research will be necessary (Bast et al., 2022).

A paradigmatic example of this tendency towards physical impermanence is the Ericsson data center in Vaudreuil-Dorion (Canada), which was built in 2016. This data center produced a great involvement of the government and a great promise about the local socio-economic development, generating great optimism in the population. In less than a year after its inauguration, it was closed due to commercial decisions of the company and currently the infrastructure is still waiting for a new buyer and employs the minimum of necessary maintenance and security professionals to keep it standing, in a kind of 'cloud ruins' that has consequences on the land, the landscape, the environment and, most [previous discussion] worryingly, on the development of the local community (Brodie & Velkova, 2021).

Another of the socioeconomic impacts on the territory where DCs are implemented is the lack of supplies, and specifically energy resources, that it can cause to the local population. For example, in the Netherlands, which is in a drought context, it discovered that Microsoft's DC was spending five times more water than it had promised and jeopardizing the water supply for the consumption of the local population.

[11] See: https://fidic.org/node/8747

But not only efforts in local protection and achieving the transition to clean energy are necessary. Data centers can also have a big impact on shaping territory and local growth expectations. When the construction of a DC project is announced in a locality, both the local government and the media send messages that emphasize the possibilities of local growth, its monumentality and its spectacularity hides the real impermanence of decisions made according to the needs of a very volatile market (Libertson et al., 2019).

Once built, DCs can also be a factor in changing the configuration of cities Carr et al (2022) carried out an interesting study in which they created maps of Luxembourg, Amsterdam, Seattle and Washington, with the aim of evidencing the sociopolitical changes caused by the various hyperscale DC installations in each of the cities and the impacts in its residents and their environments. The findings of this study include changes in the distribution of energy supply, the installation of DCs near local water sources, the configuration of urban accesses and communication routes. Perhaps Amazon, Google or Facebook have more influence in the organization of cities than we can imagine.

Another aspect that has been shortly studied and that remains to be explored is the impact that data transfer cables have on the places where they pass. The infrastructure related to data is not only located in or around DCs, but also extends to the cables that make up the extensive data transmission networks globally. One of the parts with an environmental impact are the submarine optical cables, with large extensions of wiring that cross seas and oceans and that have exceeded one million kilometers in length, they can cause pollution or harmful changes in the marine environment when they are built, when their maintenance is carried out, simply by their presence or when they are abandoned without use (Jurdana et al, 2014).

Mitigation measures

Data processing demand criteria and the evolution of data center structures is changing their locations

Compensation through dividend distribution

A compensation scheme for residents following a reallocation of economic resources can be also seen as a mitigation measure for the socioeconomic harms as in the case of the Alaska Permanent Fund. The fund, established by the state of Alaska in 1976 through a constitutional amendment, is intended to provide a stable source of income for the state and its residents, and to help protect the state's economy from the volatile nature of the oil industry. The fund is managed by the Alaska Permanent Fund Corporation, which invests the fund's assets in a diversified portfolio of stocks, bonds, and other investments. Each year, a portion of the fund's earnings are distributed to eligible residents of Alaska in the form of a dividend payment. The amount of the dividend payment varies from year to year, depending on the actual performance of the fund's investments.

Since the first distribution in 1982, the total amount of PFDs paid out has exceeded $18.38 billion, and an Alaskan who received the 29 annual PFDs paid through 2010 would have received a total of $32,191 with the highest dividend in 2008 ($2,069.00) and the lowest amount in 1984 of around $331.29 (Widerquist and Howard, 2012:43) In 2022, payments (Permanent Fund Dividend or PFD) directly received by each Alaska resident totaled $2,622 plus $662 in one-time energy relief (DeMarban, 2022). Alaska's experiment of paying cash dividends directly to the citizens of a given territory or community (those who "own" the land) can ultimately be seen as a political measure that mitigates through economic compensation individuals from possible damages or socio-economic inequalities. The Alaska model, for Widerquist and Howard (2014) is a powerful idea that could be employed on a much larger scale in many more places for, at least, six key reasons. First, resource dividend schemes work successfully; secondly, those models do not assume that a state is wealthy; third, dividends are an excellent choice of political opportunity; fourth, people must see themselves as owners of the commons, not only as owners but also as monopolists. Fifth, a successful policy builds an electoral college and, finally, a policy is safer the fewer people it harms (2012a, pp. 8-12).

Edge computing

While we think about the impact that the installation of a DC will have on a territory and a possible taxation on the exploitation of the land on which it is installed, it is essential to take into consideration that the evolution of data processing demand criteria and the evolution of data center structures is changing their locations. When we think of building infrastructures that support data-related processes, we think of infrastructures conceived for the long term, because we understand that data is the future. Beyond that, designers are increasingly thinking about creating DCs with an impermanent configuration, so that DCs have easily relocated structures if market conditions require it. (Libertson et al., 2019).

This enables another factor that comes into play in the decision on the location of the DC that is the emergence of data infrastructures based on Edge computing [13] and Fog computing [14]. The architecture of this type of DCs is based on the proximity of the "end points" of the end user's network. The "matrix" module of the DC may be located kilometers from the end points, but the whole assembly is part of the same network. By locating the ends of the networks close to where the application is resolved, it is possible to reduce the response latency and solve a high demand for data transfer and most importantly, that vast amount of data can be processed and filtered locally.

[13] See: https://en.wikipedia.org/wiki/Edge_computing
[14] See: https://en.wikipedia.org/wiki/Fog_computing

The market size of edge computing was estimated at USD 7.43 billion in 2021 and is expected to reach USD 11.24 billion by 2022, experiencing a market growth of 38.9% from today until 2023 [15]. The architecture of Edge and Fog computing is possible thanks to the deployment of 5G networks and increasingly occupies a more central place in the location strategies of DCs developers, that respond to services that require large amounts of data simultaneously, such as, for example, virtual reality, augmented reality, IoT, among others (Forbes, 2022) and it seems that it could modify the whole panorama of the location of the DC.

[15] See: https://www.grandviewresearch.com/industry-analysis/edge-computing-market

Exploring the Rationale behind Property Taxation

The property tax is an important part of the total collection of some countries

OECD guidelines

The Organization for Economic Co-operation and Development (OECD) defines property taxes as "recurring and non-recurring taxes on the use, ownership or transfer of property" and includes taxes on real estate, net worth, inheritance, donations and capital and financial transactions [16]. Different types of property taxes are also distinguished in the OECD Interpretative Guide on taxes: Recurrent taxes on real property, recurrent taxes on net wealth, taxes on inheritance and donations, taxes on financial transactions and capital [17]. Other recurring and non-recurring property taxes are also included. The revenue impact of the tax is usually measured in comparison with GDP (Tax-to-GDP Ratio) [18]. The following table illustrates the proportion of income obtained by the property tax over the total GDP of the G7 countries. As we can see, the property tax is an important part of the total collection of some countries, especially high in Canada, France, United Kingdom and United States if we compare it with the average of the OECD.

[16] See: https://data.oecd.org/tax/tax-on-property.htm
[17] See: https://read.oecd-ilibrary.org/taxation/revenue-statistics-2016/the-oecd-classification-of-taxes-and-interpretative-guide_rev_stats-2016-9-en-fr#page1
[18] See: https://data.oecd.org/tax/tax-revenue.htm

Location	Latest
Canada	4.154
France	3.976
United Kingdom	3.855
United States	3.048
Japan	2.631
Italy	2.458
OECD - Average	1.808
Germany	1.260

Table 1: Tax on property (Tax-to-GDP Ratio). Source: OECD (2022)

Property Taxes as a domestic strategy

Property taxes are usually managed as a local tax. This means that they are frequently used as an instrument to promote decentralized government policies, adapting to the realities of the local environment where they are applied. Being a local tax, the complexity of its application is high, presenting a high variability both between countries and in different areas of the same country. Despite this variability, it has the advantage that the object to be taxed is easily identifiable and evaluable, just as the taxpayer is easy to identify, making it a difficult tax to avoid. Special attention must be paid to the fact that this tax has a great local variability of assessment: each country/locality taxes properties in a different way. The categories on which the types of properties are usually distinguished are: distinctions between land and buildings, between property destined for housing or non-housing and if it is located whether in urban or rural areas.

This variability will be even more pronounced in states with federal systems, where each state or locality enforces the standard internally (Bird & Slack, 2002). Thus, the property tax tends to become a powerful political instrument since, in addition to being an important source of income, local governments often enjoy many possibilities for exemption from it. As discussed in later points, these packages of tax exemptions are frequently used politically to attract business projects, under the promise that they can generate wealth and employment in the territory. These types of promises present dilemmas of social impact when we talk about facilities related to data storage and processing. Although it seems that these tax exemptions are beginning to not work as expected and countries are going backwards.

Two concrete examples illustrate this: Ireland and Singapore. In Ireland many tax exemptions were made as a policy to attract the installation of DCs, but as a result of their high energy costs. In November 2021, the Commission for Regulation of Utilities (CRO), with the aim of maintaining a secure and stable national electricity supply, imposed on data center operators the urgent implementation of a set of evaluation criteria for processing center grid connection applications. In addition, it reserved the right to impose a moratorium on data center connections if necessary.

Although this moratorium was demanded by several Irish political parties, it would end up not being executed and, in return, the Irish government recently reformulated the role of data centers in Ireland's business strategy, with the aim of promoting its sustainability. Singapore's Ministry of Trade and Industry recognised a similar trend, saying there was a "rapid increase" in the development of data centers [19]. Singapore built 14 data centers in the last five years, compared to building 12 centers in the 5 years before that. Since 2019, the country has decided to pause any plans to build new data centers while it looks for a way to make them more environmentally friendly and implemented a three-year moratorium on the construction of new data centers. The Singapore government is currently lifting this moratorium, but will implement new measures for the construction of new infrastructure,incorporating new criteria on efficiency and sustainability for the construction of new data centers.

Focusing on our area of interest, land property taxes are presented in most OECD countries, which levy recurring taxes on real property, that is, on land and improvements implemented by human beings on it. her (buildings, industry...). These taxes are mostly used to guarantee the efficient use of land and have a direct impact on the financing of local social welfare services. Usually, the object of appraisal is divided into two main dimensions: appraisal only on the value of the land, regardless of the improvements that have been made on it, or appraisal on the value of the sum of the land and its improvements. (Bird & Slack, 2005). The following table compares the object of valuation applied in some countries, depending on whether only the land or land and its improvements are valued together.

[19] See, https://www.mti.gov.sg/Newsroom/Parliamentary-Replies/2021/01/Written-reply-to-PQ-on-new-data-centres

	TAX BASE	BASIS OF ASSESSMENT
OECD		
Australia	Land or land and improvements	Market value or rental value or combination
Canada	Land and improvements (sometimes machinery included)	Market value
Germany	Land and improvements; farm properties also include machinery and livestock	Market value (rental income/construction costs); area in former GDR
Japan	Land, houses, buildings and tangible business assets	Market value
United Kingdom	Land and improvements; some plant and machinery	Market value for residential; rental value for non-residential
Central & Eastern Europe		
Hungary	Unimproved value (plot tax); buildings (building tax)	Area or adjusted market value
Latvia	Land and buildings	Market value
Poland	Land, buildings and structures	Area
Russia	Land for land tax; structures for property tax; assets for enterprise property tax	Area; inventory value of structures; value of assets
Ukraine	Land	Area
Latin America		
Argentina	Land and buildings	Market value
Chile	Land and improvements	Area by location for land; construction value for buildings
Colombia	Land and buildings	Market value
Mexico	Land and buildings	Market value
Nicaragua	Land, buildings and permanent improvements	Cadastral value
Asia		
China	Occupied land; land and improvements	Area; market value or rental value
India	Land and improvements	Mostly annual rental value; limited use of area and market value
Indonesia	Land and buildings	Market value
Philippines	Land, buildings, improvements and machinery	Market value
Thailand	Land and improvements (buildings and land tax); land (land development tax)	Rental value; market value
Africa		
Guinea	Land and buildings	Rental value
Kenya	Land (but can use land and improvements)	Area; market value; or a combination
South Africa	Land and/or improvements	Market value
Tanzania	Buildings, structures or limited development[a]	Market value (or replacement cost, if market value not available)
Tunisia	Land and improvements (rental housing tax); land only (tax on unbuilt land)	Area; rental value

[a]Land belongs to the state and is not taxed; land rents are paid to the national government.

Table 2: Tax and assessment bases. Source: Bird & Slack (2005)

Property taxation of Data Centers

Challenges and implications

Taxing data centers as property

DCs are the point where the physical and digital worlds meet. And that generates questions with difficult answers about the nature that the taxation of these infrastructures and their tax obligations should adopt. Bearing in mind that DCs are the sites where data is stored, processed and transacted, but not necessarily a commercial activity per se, the complexity of establishing the best formula for taxing DCs increases. The components of the so-called digital infrastructure (cabling, DCs, networks) are generally considered real estate or property, the provision of services related to these physical infrastructures or that use these physical infrastructures are not necessarily considered as services related to real estate. To apply a tax to the property of DCs, we must see if the DCs are simply properties such as infrastructure or buildings, or if they are locations where services are provided to determine their fair market value (Schastok and Lenio, 2014).

All these circumstances test the concept of Permanent Establishment (PE), which has historically been used as a tax model to apply to infrastructures that meet the requirements of a "fixed place of business" by the Organization for Economic Cooperation and Development (OECD), which is currently under great pressure due to the development of the digital economy (Cabrera, 2021). Decades after the digital revolution, the national and international debate on the introduction of a virtual PE continues to grapple with the elusive nature of digital activities. (Stoner, 2019). Added to this, some appraisers prefer to attribute DCs to the category of properties with a special purpose, due to the specificity of the activity for which they have been designed, since they present unique characteristics that restrict their usefulness to the use for which they were intended and originally built. While DCs include physical space, they also often include services and resources, such as access to batteries, generators, or cooling systems. Stoner (2019) proposes some relevant questions that would have to be answered to find the best way to price a DC as infrastructure.

Is it because, in its focus on the consumer or user, it is anchored to the wrong physical presence in this virtual world? Is there a more viable and palatable solution? And perhaps the groundwork has already been laid for such an alternative international solution?

Nonetheless, data centers are typically subject to property tax, just like any other type of real estate, and are treated as real property for the purposes of property tax. In fact, data centers are becoming an ever more important and larger commercial real estate asset class as businesses expand their digital infrastructure (CBRE, 2022). Taxing data centers as property, however, still remains a contentious issue as demonstrated by the European Court of Justice (ECJ) in the case C-215/19 A Oy [20]. Even if the ruling was made for the scope of value added tax (VAT), it offers several hints on how to consider data centers in a more holistic way and therefore also for the purpose of property taxation. The company A Oy, a tax resident in Finland, offered computing center services to its customers established in Finland and in other Member States of the European Union. These services included providing a server cabinet with a lockable door, power supply, and services ensuring the best possible operating environment for servers, such as temperature and humidity control, cooling protection, power supply interruptions monitoring, fire alarm, electronic access control, and others. The server cabinets were bolted to the floor in a building rented by A Oy, and the users placed their own devices in the cabinets, which were also screwed into the cabinets and could be removed in a matter of minutes. Customers did not have a key to the server cabinets, but after verification of their identity, they could receive it from the security service. A Oy was not entitled to access its customers' server cabinets.

[20] See: https://curia.europa.eu/juris/document/document.jsf;jsessionid=6C5BA788A73BD3ACE8A182D510E0A196?text=&docid=228041&pageIndex=0&doclang=en&mode=lst&dir=&occ=first&part=1&cid=66310

The tax office was of the opinion that the computing center services should be considered as services connected with immovable property as the rental of the technical space for the hosting of customers' servers was a major and necessary element of the package of services provided by A Oy. The Court found that the service did not amount to an immovable property since the customers did not enjoy an exclusive right of use of the part of the building in which the equipment cabinets were installed. Data center services were not services relating to real property according to the Court [21].

a) Challenges on applying property taxes to data centers

It is challenging to apply property taxation to data centers for a number of reasons. For one, data centers are not traditional physical buildings, and as such it can be difficult to determine their value for the purposes of taxation. Additionally, data centers often contain a large amount of expensive equipment, which can also make it difficult to accurately assess their value. Furthermore, the constantly changing nature of the technology used in data centers can make it challenging to determine their value on an ongoing basis. As a result, it can be difficult for governments to determine the appropriate level of property taxation for data centers.

One argument against applying property taxation to data centers is that not all jurisdictions consider them to be physical entities. Because data centers do not have a physical presence in the same way that a traditional building does, some jurisdictions may not consider them to be taxable property. This can create confusion and inconsistency in how data centers are taxed, and may lead to some data centers being taxed at a higher rate than others. Additionally, because the value of a data center can be difficult to determine, it can be challenging for governments to establish a fair and consistent method for taxing them. As a result, property taxation of data centers may not be feasible in some cases. Another argument against applying property taxation to data centers is that different jurisdictions can apply different tax rates, which can create competition and an unfair market. If one jurisdiction has a lower property tax rate for data centers than another, companies may be incentivized to locate their data centers in the lower-tax jurisdiction. This can lead to an uneven playing field, and may result in some data centers being taxed at a higher rate than others. Additionally, the competition for data centers among jurisdictions can create uncertainty and instability in the market, which can be detrimental to both companies and governments. Property tax abatements are an example of how different jurisdictions can create an unfair competition in attracting data centers.

[21] See: https://wts.com/global/publishing-article/20210223-datacenter-services~publishing-article?language=en

b) Property tax abatements

Property tax abatements have been used by states as a tool to attract data centers. A property tax abatement is a reduction in property taxes that is granted to a data center in order to incentivize the company to locate their facility in a particular jurisdiction. These abatements are intended to make it more financially attractive for companies to build data centers in a given state, and can be a powerful tool for economic development. Tax breaks for data centers are motivated by the several advantages that data centers can bring to a jurisdiction. These advantages can include an increase in investments and job creation. Data centers require a large amount of infrastructure and equipment, and the construction and operation of a data center can create a significant number of jobs. Additionally, data centers can attract other businesses and investments to an area, which can have a positive economic impact. As a result, governments may be willing to offer tax breaks to data centers in order to encourage their development and bring these benefits to their jurisdictions. However, property tax abatements have also raised concerns about fairness and competition among states.

This competition for DCs is an example of the race to the bottom in the granting of very profitable tax exemptions for companies, derived from high competition between territories to attract projects that in some cases have been clearly excessive, as in the case from North Carolina's $6.4 million subsidy to Apple to encourage employment (Tarczynska, 2016). Interestingly, tax abatements for data centers have been particularly used by US states as a tool to attract data centers to their jurisdictions. In the United States, eleven states do not automatically assess property taxes on equipment and furniture, and 19 US states offer some form of property tax abatements for data centers. These states include Delaware, Illinois, Iowa, Kansas, Minnesota, New Jersey, New York, North Dakota, Ohio, Pennsylvania, and South Dakota. Data centers can attempt to gain these property tax abatements through a corporate site location process [22]. The state of Nevada, for example, offers data centers a 75% personal property tax break that spans 10 to 20 years when the business meets three requirements within the first 5 years of operation. A 10-year tax break is granted if the data center employs 10 full-time state residents in its first 5 years of operation, pays 100% of the average state wage, and invests at least $25 million of capital expenditures. On the other hand, a 20-year tax break is recognized for data centers that employ 50 full-time state residents and invests at least $100 million of capital expenditures [23].

As mentioned above, tax abatements for data centers are often justified by the positive benefits that they can have on job creation. However, a study conducted by Forbes found that tax incentives were largely disproportionate to the jobs promised by some big companies (Jeans, 2021).

[22] See: https://montrosegroupllc.com/2021/01/data-center-growth-continues-in-2021-triggered-by-e-commerce-tax-incentives/
[23] See: https://goed.nv.gov/wp-content/uploads/2020/02/Data-Center-2019.pdf

The study analyzed the tax breaks and incentives offered to companies in exchange for job creation, and found that in many cases the jobs promised by the companies did not materialize. This raised concerns about the effectiveness of using tax incentives as a tool for economic development, and highlighted the need for governments to carefully evaluate the benefits and drawbacks of offering tax breaks to companies.

Parent Company (Project Name/LLC)	City, State	Deal Size ($M)	Tax Incentive ($M)	Permanent Jobs Committed
Apple (Project Morgan)	Waukee, Iowa	1,300	208	50
Facebook (Project Woolhawk)	Gallatin, Tennessee	800	19.5	100
Facebook (Starbelt)	Huntsville, Alabama	750	6.6	50
Facebook (Sidecat)	New Albany, Ohio	750	37.1	50
Facebook (Stadion LLC)	Eagle Mountain, Utah	750	150	50
Facebook (Morning Hornet LLC)	Stanton Springs, Georgia	750	71.1	100
Facebook (Baymare LLC)	Stanton Springs, Georgia	750	71	50
Google (Project Pine)	Sherburne County, Minnesota	600	14	50
Google (Montauk Innovations LLC)	New Albany, Ohio	600	43.5	50
Google (Project Zebra/Project Spike)	Jackson County, Alabama	600	81	100
Google (Jasmine LLC/Design LLC)	Henderson, Nevada	600	25.2	50
Google (Sharka LLC)	Midlothian, Texas	500	10	40
Microsoft (Project Fulton)	Fulton County, Georgia	420	14.5	20
Microsoft (Project Osmium)	West Des Moines, Iowa	417.7	4.7	57
Google (Magellan Enterprises LLC)	Columbus, Ohio	300	54.3	20

Table 3: Paying a big price for data center jobs - Source: Jeans (2021)

Taxing DCs as environmental hazards

Taxing data centers as environmental hazards is critical because it is not easy to measure the environmental and socioeconomic impacts of these facilities in monetary terms. Data centers are known to consume large amounts of energy, and their operations often generate significant amounts of waste and greenhouse gas emissions. These impacts can have negative effects on the environment and the people living nearby, but it is difficult to put a precise dollar value on them. As we have seen for data pollution [24], the application of environmental taxation, like carbon taxes or cap-and-trade schemes, to the ICT industry remains controversial because, among other things, there is no uniform methodology in measuring the environmental impact of data. This is especially true for socio-economic impacts.

Indeed, the effects of the energy used by ICTs are diverse and range from those caused by the direct consumption of technological components (electricity, water), second-order effects derived from changes in their processes (efficiency, location) and effects of third order due to changes in human behavior (market, economic trends) (Horner et al, 2016). Because the environmental impacts of ICTs have been studied for decades, uncertainty persists about their environmental impact and net energy effects, since their high complexity and variability of implementation schemes added to the lack of empirical data on how human users interact with ICT systems is very high. Since many digital firms, such as Facebook, Google, and Apple, have already committed to powering their digital infrastructure exclusively with renewable energy and implementing more efficient components and infrastructure (Greenpeace, 2019), an environmental tax on data centers may not be as effective as it could be. These companies have already demonstrated a willingness to invest in sustainable practices, and an environmental tax may not provide much additional incentive for them to further reduce their environmental impact. Additionally, the tax may not be significant enough to encourage other companies to invest in renewable energy and more efficient infrastructure if they are not already doing so. In this case, it may be more effective for governments to develop other policies and incentives that can help to drive the adoption of sustainable practices across the industry.

This creates a general context of tension between the contribution of ICTs to the fight against climate change and their own carbon footprint. An illustrative figure of this phenomenon is that the increase in the total use of electricity by energy operators increased by 5% globally, as opposed to an increase in the demand for global data traffic of 40-50% in 2020 (year of confinement due to the global pandemic) and 31% in 2021, according to GSMA members (IEA, 2022). Some voices point out that technological innovation is precisely the key to the decarbonisation of other much more polluting sectors, exempting and justifying the environmental footprint of ICTs themselves. 5G development is an example, it will enable the connection of people, machines, objects and devices, thanks to its higher capacity, enabling smarter use of resources and reducing GHG emissions in a variety of ways, but the traffic load on the networks will be considerably higher (CERRE, 2021).

[24] See Deliverable 1.

Conclusions

Data centers are booming due to the rise of digital businesses. As more and more companies rely on the internet and digital technology to conduct their operations and serve their customers, the demand for data centers has increased significantly. These facilities provide the infrastructure and support services that enable businesses to store, process, and access large amounts of data, and they are critical to the success of many modern companies. It follows that the growth of digital businesses has driven a significant increase in the construction and operation of data centers, and this trend is likely to continue in the coming years. In the first half of 2022, the data center industry was worth approximately $24 billion in new deals. At the same time, the rising data center industry involves both pros and cons. On one hand, modern data centers are essential to the functioning of many digital businesses and can contribute to increased investment and job creation. On the other hand, data centers also have a number of drawbacks, including some significant environmental and socioeconomic impacts. Data centers can generate, among other things, substantial amounts of waste and greenhouse gas emissions, which can contribute to climate change.

Applying the ideal tax regime to data centers is complicated because, first and foremost, it requires a proper balancing of the pros and cons of these facilities. Despite the negative externalities associated with data centers, many modern states fail to adequately account for them and instead focus on the positive implications, such as the creation of jobs and investment. For example, many states offer tax breaks and other incentives to attract data centers to their jurisdictions. However, as an investigation by Forbes (2021) has shown, these incentives do not always lead to the desired outcomes. In order to properly address the environmental and socioeconomic impacts of data centers, it is important for states to carefully consider the pros and cons of these facilities and develop tax regimes that can help to balance their potential benefits and drawbacks. Applying a property tax to data centers is still a challenge for several reasons. First, not all jurisdictions treat data centers as actual physical entities that may be subject to a property tax. Moreover, property taxes can vary from state to state and create competition and an unfair market. Favoring a pure property taxation regime on data centers, also, carries the risk of not properly accounting for the environmental and socioeconomic impacts associated with their operations. From another perspective, taxing data centers as environmental hazards is also complicated because there are no reliable methods for measuring environmental and socioeconomic impacts of these facilities in monetary terms.

Conclusions

One way to approach the issue of taxing data centers is to view them as both physical property and polluters. By considering data centers both as tangible assets and sources of pollution, governments can develop some innovative tax regimes. The compensation scheme based on the distribution of dividends developed by the state of Alaska could be an excellent idea where different jurisdictions can take inspiration from. In the absence of a clear agreement on how to view data centers as physical units and a reliable method for measuring their negative externalities, the Alaska model could inspire legislators to find a different and more innovative way to compensate residents of a given community for the socio-economic harms that are not yet accounted for.

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About the author

Eticas is a non-profit organization with a mission to protect people and the environment in technology processes, while also ensuring that all people have the right to benefit from technological advances without fear of discrimination or unfair treatment. We work to translate the principles that guide our societies (fairness, transparency, or non-discrimination) into technical specifications, and to strike a balance between evolving social values, technical possibilities and legal frameworks.

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