Digital Territories and energy transition
the limits to growth

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Internet is not magical territory in which flows circulate without any physicality, nothing consumes more space, energy and resources than digital technologies. The cornerstone of the digital technical system, data centers are present everywhere and their construction is accelerating. They are found in city centers, in suburbs, in rural territories, as well as isolated and deserted regions. Whether they are connected to the existing electricity networks, autonomous or incorporated into energy exchange circles with variable perimeters (block, neighborhood, city, territory), they redefine, each time, the energy project of the territories in which they are sited because their electricity consumption is very high. By the yardstick of a pioneering and flourishing American digital industry, but with a weakened energy system, field studies on the West Coast (Oregon, Silicon Valley) and the East Coast (New York) have enabled us to shed light on the challenge of integrating data centers into territorial energy systems in Europe. In this article we propose bringing the energy and spatial excess of the digital world back to the center of the debates on the subject. The article is divided into 3 parts which describe The data center siting strategies and its various location ; 2) How local public authorities grappling with a complex and opaque sector ; 3) The excessive energy consumption of data centers.

Introduction

During the lockdown period faced with Covid-19, working at home and streaming have put digital infrastructures to the test. Google, Amazon and Netflix have opted for a lower resolution to reduce throughput. Despite these efforts, the projections on the evolutions and the growth of online videos, but also all the other digital activities will further increase demand and energy consumption, where the 5G infrastructure is being rolled out. The battle of numbers is constantly trying to lessen or complicate the energy impacts of the digital,[1] even while no serious study has made it possible to demonstrate that the digitizing of the world will permit us to meet the energy transition and environmental goals necessary for our species' survival. As a certain Cédric Price said: "The answer is technical. But what was the question?"

What are the paradigms that founded this technological choice? Paradoxically to the imaginary dimension of dematerialization anchored in the tradition of the cybernetic utopia that made the Internet a sort of magical territory in which flows circulate without any physicality, nothing consumes more space, energy and resources than digital technologies. In 2015, one of the most recognized and cited studies evaluated the consumption of the IT sector (equipment, networks, data centers) at 7% of global electricity. The projections reach a maximum of 13% of global electricity used by the data centers in 2030, and between 20 and 51% for the IT sector[2] in its totality (Andrae and Edler, 2015).

If these energy consumption figures are complex to measure, the spatial impact is more visible. The cornerstone of the digital technical system, data centers[3] are present everywhere and their construction is accelerating. They are found in city centers, in suburbs, in rural territories, as well as isolated and deserted regions (Diguet and Lopez, 2019). Whether they are connected to the existing electricity networks, autonomous or incorporated into energy exchange circles with variable perimeters (block, neighborhood, city, territory), they redefine, each time, the energy project of the territories in which they are sited because their electricity consumption is very high. The corollary of the exponential growth principle of data since the explosion of the digital sector is an increase in space and energy needs. As a new stage of the network urbanism (Dupuy,1991), the digital city has often been analyzed in terms of uses and practices, services and events, the cultural meanings, social effects and environmental impacts (Townsend, 2013) (Picon, 2015) neglecting the materiality and energy consequence of its physical infrastructures on territories.

The data center program raises strategic spatial and energy questions, even though the environmental footprint of the smart city and our digital lives has not been adequately discussed (Tinetti et al. 2016). The data center industry seems to have knowingly maintained an effacement that limits or pushes back questions on the viability of our practices and their energy mirror. We can ask if the unmasking of these storage infrastructures and their energy functioning participates in revealing the untenable character of the digital technical system and its globalized economy, which functions on invisibility and distance. By the yardstick of a pioneering and flourishing American[4] digital industry, but with a weakened energy system, field studies on the West Coast (Oregon, Silicon Valley) and the East Coast (New York) have enabled us to shed light on the challenge of integrating data centers into territorial energy systems in Europe. In this article we propose bringing the energy and spatial excess of the digital world back to the center of the debates on the subject[5].

The article is divided into 3 parts which describe

1. The data center siting strategies and its various location (urban, peri-urban and rural)
2. How local public authorities grappling with a complex and opaque sector
3. The excessive energy consumption of data centers

The data center siting strategies

If they are present worldwide, the siting of data centers is concentrated in the United States, Asia and Europe. Amsterdam, Dublin, Frankfurt, London and Paris have a very large number of them. Two location criteria are genuinely structuring for data centers. First, being located near the optical fiber Internet network, notably the principal hubs – the Internet backbones – to connect to Internet Exchange Points, platforms on which all the networks that transmit information throughout the world are connected. Next, sufficient electrical power for its installation and possible development, in a stable and reliable manner, and preferably inexpensively, must be made available. This can be teamed with a nearby substation. An unweighted criterion until now, this could change in the future.[6] We should also mention a certain number of complementary location criteria: security, absence of nearby inhabited zones, reactivity of the local hosting administration in administrative actions, availability of renewable energies and specific rates for data centers, various tax incentives, abundant and affordable land, with the fewest restrictions and easements possible. These siting criteria make it possible to better understand how new digital territories are consolidated. We can distinguish three of them: the rural world, the metropolitan outskirts and city centers

Big Tech out to conquer the rural world

The rural world and the peri-urban territories are of great interest to large data center operator because of their isolated nature, their available land, but also for the tax advantages that the local authorities, in search of a new economic impetus, offer them. In terms of development, the result is often that of territorial sprawl, in a sometimes unbalanced relationship between the operator and the local administration. On the west American coast, Oregon is a prime location for data centers, thanks to its climate, land availability and abundant and inexpensive energy thanks to the hydroelectric dams on the ColumbiaRiver. In Prineville, in a rural and deserted territory in Oregon (US), Facebook built its first data center in 2009 and Apple closely followed in 2011. The two digital giants have continued to develop their installations: a third Apple storage space is being completed and Facebook will soon have a total area of 200,000 m^2. The data centers arrived there concealed. The code name of Facebook was Vatas. The local administration only knew that the project needed 80 to 120 hectares, a great deal of water and a large amount of electricity. It had however no idea of this operator’s activity at startup and until rather late in the project’s progress. The secrecy culture of GAFAM can also work against the territory’s need for anticipation and urban and economic planning. Betty Rope, the mayor of this town of 10,000 inhabitants, estimates however that Facebook “is a good, very good neighbor”[7] that, with Apple, redynamized an economy destroyed by the 2008 crisis and the decline of the timber industry (21% unemployment), first with construction sites that have been ongoing, next with the resulting direct and indirect jobs whose number rose, according to the mayor, to 500 at the end of 2017. Facebook provided a great many services to its employees. Moreover, no one could have imagined a decade earlier that the electrical power needed in the town would rise from 10 to 500 MGW. Consequently, Facebook and Apple co-invested in five solar farms of 15 MGW each, not far from their sites. And each pays annual ‘project expenses’ to install, then develop, and helps invests in local infrastructures (substations, water production plants, sewerage systems). Here, the digital giants are considered above all a godsend, a vector of jobs and economic development.

If this digital rural model does not yet concern all the European countries, Swedish, Irish and Finnish rural territories have dealt with these situations because they propose inexpensive land and energy as well as various tax incentives. GAFAM questions here the European digital strategy in this area, since French professionals have put forward tax dumping techniques in particular.
In France, territories like Saclay, south of Paris, could be concerned by dynamics such as these due to their connectivity (backbone along the A10 highway), the presence of research centers, universities and internationally known higher institutions of learning, a good electricity supply (St. Juste substation, another being built on the Plateau de Saclay), but also real estate opportunities with generous footprints. These territories will be able to draw up, with the energy operators, strategies to make the most of these installations in terms of energy (pooling) and space (preferential occupancies of abandoned spaces, for example).

The outskirts and the digital: planning to be built

Metropolitan outskirts, often industrial in the past, comprise ideal sites for colocation and Cloud data centers, and for local companies that only need low latency. There is a common development model: a formerly industrial territory, often serving the metropolis, offering large areas of land and abundant electrical power, but also good connectivity – data centers then replace factories. Each territory uses their arrival differently. Certain cities have taken hold of the development of these buildings by adopting proactive positionings to attract them and obtain direct benefits from them. In Silicon Valley, the city of Santa Clara concentrates the most data centers on its territory. Fifty or so of them consume 70% of the energy supplied by the municipal public company, Silicon Valley Power, created in 1896, offering the least expensive electricity in all of California. This advantage, undeniable for the data center industry, pushed them to concentrate there starting in the 1990s, transforming former electronics factories then constructing their own buildings. Santa Clara also provides a dark fiber[8] network for companies, completing a perfect offering for the digital world. If it perpetuates in a certain way its role of a territory serving the metropolitan heart and decision-making centers, Santa Clara (just like San José) now hosts many activities: the service sector, company headquarters, universities, offices, large-scale sports and cultural facilities. Today, land is starting to become scarce in Santa Clara and the space dedicated to data centers is competing with housing needs. Whereas they were often in industrial zones, they are now found in office zones, which illustrates their mutation in terms of urban integration (as in Hillsboro in Oregon). The infrastructures are more compact and architectural, like the Vantage campus, built higher on a densified plot on Walsh Boulevard, which now has six data centers.

In France, Saint-Denis and Aubervilliers, just north of Paris, seem to have had this development foisted on them. Gathered in the intermunicipal structure Plaine Commune, the presence of data centers dates back to the late 1990s. The presence of enormous plots of land available at affordable prices in the immediate vicinity of Paris, good electricity availability, the quality of connectivity with the presence of one of the main lines of the Internet network along the A1 highway (which permits the link between the different European data centers) has favored the development of these infrastructures. The data centers present on Plaine Commune are mostly large structures with an average area of 1,000 to 5,000 m². If a slowdown in the number of data center constructions has been observed since 2010,[9] large-scale construction sites are underway: the Interxion data center on the former Eurocopter site[10] in La Courneuve, as well as the Interxion data center extension on the rue Rateau, which should reach 9,000 m² of IT rooms and the Equinix data center in Saint-Denis with 13,000 m² of IT rooms on a plot of over 6 hectares. This therefore amounts to over 88,000 m² that will be dedicated to digital storage with over 360 MGW available. Nonetheless, the Plaine Commune metropolitan area recalls that data centers strongly impact the territory and raise concerns about the durability of the local electricity system; about possible problems raised by citizen groups (noise, danger linked to heating oil storage, electromagnetic waves); and, in a context of competition between uses in the center of the metropolis, and the very large impenetrable zones – the data centers – correspond to a very small number of jobs. Emphasizing the mono-functional character of the territories, similar in terms of landscapes of logistics or commercial zones, these digital activity zones are moving toward urban fragmentation with digital enclaves, often protected by defensive fences without much urbanity.

The hyper-urban Gateways, strategic hubs of the networks

Metropolitan centers, in the United States and Europe, and international cities such as London and New York even more so, are strategic hubs where Internet cables are found and connected; global and centralized decision-making centers where consumed, distributed products of multiple informational contents (cultural, financial, communicational, commercial, etc.) are also found. The former telephone exchanges have often become

Internet Exchange Points, combined with greater or lesser areas dedicated to data storage.
In New York, several buildings in Lower Manhattan are continuing, with the Internet, their communicational destinies and were able to adapt the historic real-estate heritage, formerly the head offices of the major telegraph and telephone companies – 32 Avenue of Americas (headquarters of AT&T) and 60 Hudson Street, (headquarters of Western Union), respectively built in 1914 and 1928. In the late 1990s, the two buildings shifted to the digital and carried out an impressive molting, getting rid of telephone installations to install Internet Exchange Points, data storage spaces and cutting-edge telecommunication infrastructures in them. Starting in 2000 and after the 9/11 terrorist attacks in 2001, data centers began to relocate in nearby New Jersey, more advantageous than New York in terms of the price of energy as well as that of real estate, but also less climate vulnerability. In 2012, Hurricane Sandy shut down several data centers in Manhattan. Many data centers however remain in New York City, like the Sabey tower built by the New York Telephone Company in 1975 at the foot of the Brooklyn Bridge, and subsequently a Verizon telephone exchange. This 32-story building offers 102,000 m^2 of available floor space and has continued to develop.

Three subjects are particularly interesting here: the recycling of existing major service sector building in the heart of the metropolis; the infrastructural compactness of these machine-buildings, containing all the infrastructures to handle their autonomy (heating oil, water, cogeneration, heat storage); the mixed uses in the buildings.
For example, at 32 Avenue of the Americas, offices, radio studios, data centers and 70 telecom operators (30% of the floor space) and the head office of the Tribeca Film Festival coinhabit in 186,000 m^2.
The public authorities are sometimes helpless or lost faced with the arrival of these new space and energy-guzzling infrastructures. Positionings and strategies differ from one country to another.
In France, in Paris, it is above all former industrial buildings with a metal structure built for the textile industry, the press or department stores that have been mobilized for data center use. It is also a part of the telecom real-estate heritage that now hosts data. The Sentier ['garment district'], also once called Silicon Sentier, is the headquarters of several large data centers that were able to be installed in former industrial buildings (Zayo, Telehouse). The Telehouse operator also was installed in the 1990s in a former department store, on the boulevard Voltaire, near the town hall of the 11th arrondissement, with a total floor space of 7,000 m^2 and available power of 5 MGW. The Parisian industrial heritage therefore made it possible to handle large-scale connectivity and a digital hosting capacity in the heart of Paris and in the immediate vicinity of its business districts (central business district and La Défense) in particular. The buildings specifically erected to house data centers in very dense urban fabrics are much rarer, giving the complexity of building in them, and the priority often given to housing and other uses, but especially the ease, in comparison, of developing in better adapted territories, with fewer urban and environmental constraints and those with neighboring homes and businesses.

Local public authorities grappling with a complex and opaque sector

Faced with the creation of these digital territories, several positionings have been observed. The great autonomy of American cities has permitted them to regulate and locally profit from the data center industry, which is the case for Santa Clara, whereas in the rural zone, the town of Prineville in Oregon illustrates the imbalance between the municipality and Big Tech.
In France, north of Paris, development took place without any urban planning and without technicians or local elected officials being able to anticipate what came next, or not having the determination or desire to better integrate data centers. In Europe, the case of the Netherlands is unique where the cities of Amsterdam and Haarlemmermeer took the lead with a moratorium whose aim was to stop their construction for a while in order to better think about their development.

Putting up with but promoting: Prineville (Oregon), a small rural town faced with Big Tech

If the GAFAM data centers in particular often replace aluminum foundries and sawmills, which also needed a great deal of electrical power, the power consumed by data centers is much greater and as are the potential imbalances on the territories. Furthermore, the secrecy surrounded the siting of data centers and which does not differ much from what usually concerns military installations or national security, makes it difficult if not impossible to control the development and planning of a territory.
This imbalance in information does not permit local administrations to sufficiently anticipate a positioning on the data center question, to consolidate expertise on the subject, on the alternatives in terms of urban and architectural siting and energy integration, for example. This is all the truer in rural territories like Prineville or nearby Umatilla, where some of the technical departments are not necessary equipped to deal with these subjects, where the political or demographic weight of the territories is not of the sort to

offset the power of GAFAM in particular and, lastly, where the often very difficult economic situation in terms of employment pushes the territory to favor job creation, even at a minimal level. Likewise, these departments are not prepared to deal with urban, energy, environmental or economic questions in the long term.

Welcoming and regulating: the 'one-stop shop' of Santa Clara in California

In the early 1990s, data centers, first small ones, in existing buildings notably those of the telecoms, were installed in Santa Clara. Then, and notably with the development of environmental labels and energy performance requirements, new larger and larger buildings were erected. Whereas the city initially approved these projects without too many technical studies, especially focusing on water consumption for cooling (and the sizing of the sewerage networks), it quickly decided to organize to develop a one-stop shop for data centers and consequently to anticipate and administer the development of these digital infrastructures proactively[11] by setting up a one-stop shop.

This one-stop shop brings together:

- Silicon Valley Power (SVP), the municipal electricity company created in 1896. One person is specifically in charge of the data center clients (which represent 80% of the company's revenues). The company also developed and manages an optical fiber network (and free Wi-Fi in the city) and is responsible for managing the water and sewerage networks.
- The firefighters: Santa Clara is a rare exception in Silicon Valley – the city's firefighters are not dependent on the county, but are a municipal corps. This makes it possible to more easily find consensual solutions with the data centers, more in terms of an obligation of results rather than that of means.
- The urban planning and environmental departments.

Technical reviews of the projects are therefore done in three to four weeks, after which the permits are granted or rejected. All the partners, in particular Silicon Valley Power, are involved as much as possible upstream in order to rapidly incorporate all the technical constraints.
Moreover, the benefits Silicon Valley Power accrues through the large electricity consumptions of the data centers are reinvested by the Santa Clara municipality in the city's public facilities. One example is the imposing football stadium built in the northern part of the city, but more largely the quality of the public spaces, parks and local facilities. We can note here the interest in pooling certain departments for an integrated and connected approach to siting complex facilities – the data centers – but also to make use locally of the benefits derived from them.

Putting up with: the example of Plaine Commune north of Paris, a rapid and uncoordinated development

On the Plaine Commune territory, north of Paris, the first data center arrived in 1999 (Interxion), then, in about 10 years, the territory became a major digital hub for data centers. This new corporate real estate, still little known, consequently developed on the Saint-Denis plain, and notably in La Courneuve. The subject did not seem strategic and was only questioned when the ALEC (local energy agency) published a study in 2013, whereas numerous installations had already been built. However, in the absence of strong political support on the subject, an alliance between the communes concerned and the metropolitan area and the creation of expertise on data centers, no authority or strategy on the subject existed. The conclusions of the ALEC study therefore were not followed by actions, notably on heat recovery.
Most of the sites have of course received an ICPE[12] authorization delivered by the state, but this does not constitute a lever for genuine negotiations. Moreover, only Enedis (but not the communes or the metropolitan area), which manages the electricity network in France, has a real vision of the electricity consumption of data centers and reserve capacity or queue management. This lack of knowledge is a major problem for treating projects and urbanism authorizations with a global vision while the energy consumption of these newcomers sometimes disturbs the territories.

Controlling and planning: Haarlemmermeer and Amsterdam's moratorium

Data centers in the European Big 4 – London, Amsterdam, Frankfurt and Paris – continue to develop, but the Dutch capital is the first to have stopped this growth in 2019 with a moratorium prohibiting the siting of data centers for one year. At the moment when the growth of data centers reached a peak in electrical power, the cities of Amsterdam and Haarlemmermeer stopped the development of this industry. It was a one-year shutdown to rethink the siting policy for the next three decades. The startup will be done in the framework of a reworked planning with all the actors concerned.
Today, 75% of all the country's data centers are in the region around Amsterdam.[13] Nearly 2 million square meters of floor space for data centers are likely to be dedicated to digital storage in the years to come, which would almost double the current capacity according the Dutch association dedicated to this industry. In total, the metropolitan area

houses 47 colocation data centers and 53 installations with a sole user. They are located in Amsterdam, Almere, Aalsmeer, Haarlem, Hoofddorp/Schiphol (Haarlemmermeer municipality) and Purmerend. In June-July 2019, the cities of Haarlemmermeer and Amsterdam decided to temporarily prohibit, for 12 months, the construction of new data centers on their territory. Aiming at the long term, a new data center policy is being drawn up for Amsterdam and for Haarlemmermeer.[14] The Data Center Spatial Strategy, Roadmap 2030 (REOS) presented a new national spatialization of data centers in three illustrated scenarios: metropolitan concentration, regional clusters and decentralization throughout the territory (Ruimtelijke, 2019). The goal of the moratorium was not to prohibit data centers, but to obtain more rational regulation through an urban siting policy better in order to facilitate their growth in the long term. Before modifying the zoning plan or totally prohibiting construction through this tool, the objective is to stabilize a policy capable of issuing mandatory conditions when the building permit is filed. The flexibility of the conditions applicable to certain zones in the municipalities is under discussion.[15] In Haarlemmermeer, it seems that the problem of energy availability prevails over the other aspects. Nonetheless, the desire to better control data centers in terms of durability and to further restrict their placement is strong.[16] What is happening in the Netherlands illustrates the spatial and energy tension caused by the digital industry on the territory. It could prefigure a European trend in the densest sectors.

The excessive energy consumption of data centers

Data centers will be one of the largest consumers of electricity in the 21st century, buoyed by a multiplication of Internet traffic, the explosion of data exchanges, the growth of the Cloud and the projections of 100 billion connected objects by 2030 (Cisco, 2016). Their frenzied and irrational growth questions the programmed obsolescence of their IT systems as well as the squandering of energy linked to the globalized digital economy.
A large amount of electricity is necessary not only for their functioning but also to air-condition the machine rooms and racks. In terms of equipment, each data center – generally connected for security reasons to two electrical power supplies – is equipped with backup generators and battery rooms providing autonomy in the event of a cutoff on the network. As these are relatively rare, this infrastructure multiplication creates a redundancy whose usefulness raises questions today.
Whereas the search for energy restraint is put forward to reduce CO_2 emissions, the growing electricity consumption of data centers is excellent news for the energy actors. Data centers are perfect customers for the electricity companies: no peaks to manage, a large stable consumption day and night, all year long, and constantly increasing…

Energy and digital operators: dependency and disruptions

The American energy market and the history of its deregulation varies from one state to another and is very different from the European situation. However, it can be noted that on both sides of the Atlantic, common characteristics regarding the requirements of the energy transition and the resistance of the utilities that see their markets disrupted and their activities transformed in depth. In the United States, in 2014, data centers consumed about 70 TWh, which represented 1.8% of the country's total energy consumption. Their consumption had increased by 4% between 2010 and 2014 (Shehabi et al. 2016). In the United States, in a general manner, the condition of the electricity transmission networks was not as good as in Europe where the electricity transmission and distribution companies has heavily invest in infrastructure. In the three American areas studied (California, Oregon and New York), the energy territories are unquestionably specific but the production of renewable energies in large quantities is a constant.
In California, in Silicon Valley, where despite high electricity prices (except in Santa Clara), there are a great many data centers and they take part in the development of renewable energies (27% of the electricity production).
In Oregon, a territory that serves California, which welcomed the first large Google data center in 2006, the climate is cooler and electricity less expensive, thanks to the dams on the Columbia River, and where there are strong land purchase possibilities (71% of Oregon's electricity production is generated by traditional hydroelectric power plants and other renewable energy resources).
The urban density of the city of New York and the gradual transformation of emblematic telecom buildings into data centers, in a post-Hurricane Sandy context, favored very strong energy resilience policies, notably on renewable energies and micro-networks (23% of New York State's electricity production comes from renewable sources).
For Gary Cook of Greenpeace, author of the Clicking Clean report,[17] if GAFAM makes efforts in using renewable energies, notably by promoting commitments to be supplied by 100% renewable energies, there is still a long row to hoe because this energy is not local, additional or really used by their data centers: it is partially bought from the electricity companies through certificates (RECS in the United States, GO in Europe). GAFAM is increasingly particular and demanding

and has gone as far as forcing the energy transition from certain old utilities with a very high-carbon energy mix. This is notably the case in certain American states where land is inexpensive and the energy mix high in fossil fuels (with coal-fired power plants whose industrial lobby has remained very strong). In Wyoming, Microsoft bought over 230 MW of electricity from a wind farm from a local utility. In Virginia, Microsoft negotiated an agreement with Dominion Virginia Power and the state government for the production of a 20 MW solar power plant. The company is doing the same in Europe where it signed a contract to reserve all the electricity production of a General Electric wind farm, which had just been started up in Kerry County in southwestern Ireland. This purchase aims at greening the energy mix of its large data center west of Dublin dedicated to Cloud services for all it European corporate clientele. On the other hand, the most recent Clicking Clean report (2019) very specifically targets the leader of the Cloud, Amazon Web Services, all of whose new data centers built in the Ashburn cluster, near Washington, DC, are supplied by coal. The author therefore stresses that the exceptional growth of data centers on this enormous site justifies, for Dominion, the local electricity company, supporting the development of the Atlantic Coast pipeline whose environmental effects are considered devastating on the Appalachian Mountains and regarding CO_2 emissions and pollution.

On the West Coast, GAFAM seems to exert strong pression on the energy system to move toward the use of renewable energies, and would like to end the monopolies of electricity companies that it considers an obstacle to reaching this goal because the utilities first want to make their current installations profitable before investing in new, cleaner ones. Apple consequently created its subsidiary Apple Energy, which enables it to sell the surplus energy produced by four of its American installations, including the Newark wind farm in California. These renewable energy productions (solar, hydraulic, wind and biogas fuel cells) enable the company to claim "100% renewable energy for 100% of these installations"[18], notably for its data centers. In Oregon, Apple bought the 45-Mile hydroelectric dam to supply its Prineville data center. Certain GAFAM companies are also increasingly envisaging developing their energy autonomy and their own infrastructures either onsite or nearby.

The autonomy aspirations of data center operators

In France, the weak presence of GAFAM limits a form of competition on the electricity market, moreover locked up by the Enedis monopoly for transmission. However, the capital resources of the major colocation data center operators permit them to invest in the construction of electricity infrastructures and dark fiber networks. They then replace, in a certain way, the historic electricity and telecom transmission operators.

The large data centers follow the geography of the transmission stations and keep a large quantity of electricity in reserve. They have three options for transmission. The first is to locate near the existing transmission stations. The second is to ask Enedis to build new ones. The third is to build them themselves. In Île-de-France, for Enedis, the data center projects that are known correspond to a doubling of the network capacity north of Paris over the next five years. For data center industrialists, there is a great deal at stake concerning transmission (that is, the moment, when the level of the voltage is lowered from 250,000 V à 20,000 V). Access to a substation is a major element of the business model of these industrialists. Historically, the construction of a substation by Enedis took five to seven years. The data center industry is trying to exert pressure to lower this period to three years and sometimes doesn't hesitate to circumvent Enedis to turn to the RTE (transmission system operator) directly, when the power of the buildings exceeds 50 MW (regulatory ceiling above which this is possible). They will therefore directly connect to a RTE high-voltage line. This is consequently a new siting criterion. This is notably the case for Interxion. Thus, Fabrice Coquio, president of the France group states: "We already began in Frankfurt where we had a 100 MW substation built and we are in the process of building one in Stockholm. I will soon file a permit in Marseille because I grabbed everything that was left: 90 MW, there isn't any more. […]. You have to be a real expert in energy management and infrastructure management to know how to work a substation and you have to have the means. For 73 MW in Frankfurt, it cost 25 million euros. That will immediately thin out the ranks of who can do what"[19]. Moreover, data centers must now pay 100% of the cost of the connection to the substation whereas it used to be Enedis who incurred this cost.

The situation is the same in the United States. The Sabey data center heavily invested in offsite infrastructure for its Intergate Manhattan site, with the construction of four electrical substations ($25 million), which ensures it a lower energy price over the long term (currently 14 cents per kW/h[20]). Sabey uses an ESCO[21] to buy energy – Constellation Energy – and only pays Con Ed for transmission. The maximum power available is 40 MW, but only 18 MW are actually consumed. The company has not positioned itself on renewable energies.
On the West Coast, the GAFAM companies also increasingly envisage developing their own energy autonomy and their own

production infrastructures or ones that are nearby via electricity micro-networks. This is the case for Microsoft, heavily committed in the development of autonomous micro-networks, and Apple, which created its subsidiary Apple Energy.
Actors like Interxion and Equinix area also creating their own telecom installation to replace operators that, according to them, no longer have the money to do so. “When you’re a telecom operator, to make a hole in a sidewalk to connect to a data center, it costs €1,000 the meter. Then, to install a PoP, a point of presence, an active telecom element to deliver services, it’s an investment of between €500,000 and €1,700,000. So with prices that are decreasing by 30% each year you ask yourself how many meters you have to do. If you have 30 km of networks to create, which however on the country-wide scale is nothing, you’re not going to do it”[22]. Consequently, Interxion is building its considerable capacities that are sold to telecom operators – SFR and Orange, among others. There is a substitution game that is created between the historic operators and the data center operators that without having infrastructure licenses can install them since it is a matter of connecting buildings belonging to the same data center operator.

The organization of the territory and the disrupted network

Everywhere in Europe, urban planning departments and electrical transmission and transmission operators have observed that the demands of data centers can block the territories development. Electricity demand can be summed up as follows: electricity is allotted on a first come/first served basis, so queues are created on different sites. The reserve capacity (60 MW for 5 years, 10 years) blocks other customers even though this power corresponds to a maximal consumption hypothesis (when the data center is full, which sometimes takes several years).
In France, the ALEC study already raised questions on this subject in 2013. An example of this is Marseille, where the mayor Jean-Claude Gaudin had to negotiate with Interxion to recover 7 MW “because they had forgotten to reserve them for their electric buses.”[23]
The colocation market disturbs readability and calculations. It must be recalled that many colocation data centers are charged on average at 30-40%, some at less than 20%, and colocation is 30% of the market. This is somewhat like a headlong rush, the operators having built data centers in anticipation of the clientele.

The territories are all the more disrupted as they now must participate in the investment in electricity infrastructures. The law on Solidarity and Urban Renewal modified investment conditions in these infrastructures, for all electricity transmission. The developer and the local authority must participate financially, whereas before, EDF strived to structure its network and reinforce it. How can data centers be pushed to play more collectively? Could the local authority, transmission system operator, even distribution system operator, in the name of the general interest, force them and impose installation sites, as is the case for the city of Stockholm? The Stockholm Data Parks Initiative requires data centers to set up on campuses where the heat produced must be reused. This program was launched in partnership with the urban cooling and heating operator Exergi, the electricity operator Ellevio and that of dark fiber Stokab. This experimentation and engagement of the city of Stockholm seems relatively unique. As David Rinard, sustainable development director of Equinix[24] recalls, whether it is in the United States or in France, any increase in energy efficiency and any new capacity in captured renewable energy makes it possible above all to consume more and at a more stable price. This is the rebound effect, otherwise called the Jevons paradox. As technological improvements increase the efficiency with which a resource is used, total consumption of this resource can increase instead of decreasing. In other words, the use of technologies that are more efficient in the use of energy and emit less CO_2 does not guarantee a drop in total energy consumption, on the contrary…

A part of the world of architecture and urban planning still tends to minimize, today, the energy and spatial impact of the digital world on cities, the territory and climate. The digital sector does not increase, it transforms. It is not an urban exoskeleton that can be worn and taken off as one wishes, but a pervasive system the is gradually modifying urban forms, using an infrastructure that increasingly mobilizes resources and space (energy production units, storage centers, underwater cables, land-based networks, but also electronic equipment production plants, digital waste disposal, etc.). If the materiality of the digital technical system and its environmental impact (on energy as well as on rare minerals) has begun to be mentioned more often, the frenzied race to achieve never-ending technological innovation continues to limit the urban digital imagination to a single discourse that makes the digital, progress, extremely sophisticated technology and ‘green growth’ inseparable, whereas many alternatives exist.

Support of the territories in accessing a free and open Internet is as indispensable as a broader reflection on the data center object and the associated digital system: to better measure the environmental impact of the technical choices regarding the expected social added value; and to move toward more reasoned and restrained digital practices that stress degrowth.

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Note

[1] In March 2020, Carbon Brief attempted to show that the carbon footprint of viewing videos via streaming on Netflix was as much as 57 times lower than the conclusions of the report written in 2019 by the celebrated French think tank The Shift Project.
[2] In this study, electricity consumption in 2013 was estimated at 21,000 TWh (7% represents 1,470 TWh) and the projections for 2030 reach 61,000 TWh. An annual production of 7 TWh for a nuclear reactor is the basis of these projections.
[3] A data center is a hosting building that holds a group of digital infrastructures (data computing, storage and transport equipment). It is equipped with cooling and heat recovery systems as well as backup equipment: batteries, undulators, generators.There are different types of data centers and uses can vary. There are two categories. First, that of company or administration data centers, which host and manage their own data servers in a building reserved for them. Second, that of colocation data centers, in which different uses are possible: hosting of client company digital equipment hosting (the operator provides the space and electricity); the availability of the host's IT servers and equipment for its clients (the clients can make temporary physical reservations for the server, the disk rack and network equipment in order to benefit from a guarantee and unshared use of the infrastructures); Cloud reservation (the clients can reserve virtual machines on data center servers).
[4] United States is the first country in terms of data center installations.
[5] Diguet C., Lopez F. 2019, From the Cloud to the Ground, L'enjeu éco-systémique des infrastructures numériques, Report Ademe.
[6] Microsoft's unexpected experiment in Clondalkin, near Dublin, shows that GAFAM can also take on their own energy production. Faced with the incapacity of the transmission network to incorporate the enormous rise in load of the hyperscale data centers, the company has been building, over the last three years, its own installation equipped with 16 gas-powered generators, for a total power of 18 MW.
[7] Interview with Betty Rope, mayor of Prineville, in Prineville, Oregon, October 27, 2017.
[8] Dark fiber designates an optical fiber infrastructure (cables and repeaters) installed but not yet used.
[9] Three principal reasons: land is no longer as available or inexpensive as before; the colocation sector has been consolidated (purchases of companies and existing buildings); the operators had anticipated the growth of the market by building enormous spaces, a part of them are still waiting to be filled by clients.
[10] Today, the metropolitan area would like to improve the insertion of the data center into the city (fences, entrances, planting, urban façade with windows), but the complicated and few exchanges with Interxion, which has already completed its architectural project according to its own interests, does not let any major change to the benefit of the community be envisaged.
[11] Interview with Yen Chen, urban project planner of the city Santa Clara, Santa Clara, November 2017.
[12] ICPE: Installation Classified for the Protection of the Environment
[13] Interview with the city of Amsterdam, urban planning department, Amsterdam, October 2020.
[14] A roadmap is also expected on the scale of the metropolitan region with specificities for each municipality.
[15] For the port or the industrial zones that are not in the immediate vicinity of urban transformation sectors.
[16] Until now, the city could better control the data centers located in the activity zones of the Schiphol Area Development Company, 25% of which is owned by the city. The data centers that are located in it are considered more satisfactory than those outside it. For the municipality, this explains the necessity of extending control.
[17] http://www.greenpeace.org/usa/global-warming/click-clean/
[18] https://www.apple.com/fr/environment/climate-change/
[19] Interview with Fabrice Coquio, president of the Interxion group France, Paris, March 2018.
[20] Compared, for example, with 22 cents per kW/h by 365 data centers, also located in Manhattan. Interview with Jim Grady, January 2018.
[21] ESCO: Energy service company
[22] Interview with Fabrice Coquio, op.cit.
[23] Ibidem.
[24] Interview with David Rinard, San José, California, October 2017.