WORKING PAPERS

N° 1726

March 2026

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15th March 2026

Abstract

The paper shows that the entry of data centers in the electricity market leads to price and consumption effects observed in the real world that were quite predictable from a simple conceptual modelling exercise. The size of the associated welfare losses is sensitive to specific electricity market characteristics, explaining why they are often not comparable across regions or countries. In general, the historical users are likely to be worse off in the short run. They will recover their losses in the longer run, but only if the entrant finances its own capacity needs and if the data centers do not have excessive bargaining power. The differences in possible outcomes according to context suggests that one-size-fits-all policies to manage the shock across countries or regions will fail to mitigate undesirable effects in some contexts.

JEL codes: D63, L1, L5, L94, 033, Q41, Q48

Références CREFS: Economie de l'énergie; Economie industrielle; Progrès technologique

Key words: Data centers, Electricity, Pricing, Regulation, Incidence

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‡This research was supported by the TSE Energy and Climate Center, the H2020-MSCA-RISE project GEMCLIME-2020 GA No. 681228, and the grant ANR-17-EUR-0010 (Investissements d'Avenir program).

1 Introduction

Since the early 2020s, global observers of the electricity sector have noted an acceleration of demand linked to investments in data centers (DCs) induced by the booming use of artificial intelligence (AI). The International Energy Agency (IEA, 2025) expects that further heavy investment in DCs will bring their share of a global electricity demand to around 4.4% of by 2030, almost three times the 2024 level. In some countries, the share is already significantly higher. In Ireland, for instance, DCs accounted for 21% of total electricity consumption in 2023 and their needs should continue to rise (Central Statistics Office, 2023).

The expected brutal increase boils down to an electricity demand shock rather than a simple increase in the growth trend. The shock is adding to the important investments needs in generation, transmission and distribution capacity and fuels a competition for access between DC and the historical customers of the sector. It also raises many technical issues recently reviewed by Chen et al. (2025). More recently, it has started to raise policy and political concerns. Many of these new concerns are being voiced quite loudly in debates in US political circles. The substance of these debates serves as a leading indicator of the tensions that could spread over countries facing similar demand shocks and deserves a closer look.

One of the main concerns expressed by politicians and business media in the US since 2024 are anchored in an observed apparent link between the growth in the number of DCs and increases in electricity prices in some states.[1] While many of these concerns were quite predictable from a simple conceptualization of the impact of a brutal entry in the electricity market, as this paper will show, most of the debate is for now based on initial partial analytical evidence on reasons to be concered. For instance, Wade et al. (2025) show that data center and cryptocurrency mining growth could lead to an 8% increase in average U.S. electricity generation costs by 2030. Mamkherzi et al. (2025), focusing on the state of Virginia, find that DCs entry significantly increased wholesale power prices by about 7% in their study of the causal effect of DC expansion on wholesale electricity prices between 2015 and 2024. Abecasis and Wei (2026), in a review of the experience of several states, also find already higher electricity prices in areas with higher concentrations of DCs and discuss the associated loss in real disposable income, in particular for lower-income households. Lee and Schmalz (2026) offer an additional insight in a theoretical model showing that borrowing constraints and the costs associated with relocating to different areas limits the margin households have to respond to changes in electricity prices linked to DC demand shock. All this partial evidence does indeed add up to a good reason for politicians to demand a review of regulatory pricing practice in the sector.

So far, however, regulation in the US has not yet been able to deal with these shocks. For instance, Martin and Peskoe (2025) review 50 regulatory proceedings about utility rates for DCs to show that, without changes, rate structures and

[1] The other recurring concern discussed is the environment impact, both in terms of emission and water consumption. de Vries-Gao (2026) offers a useful summary of these concerns.

pricing contracts between DCs owners and utilities allow the entrants to shift some of their energy costs to the historical users.[2] Their survey confirms that there is a need to consider upgrading regulation in many of the US states to ensure a smother integration of DC in electricity markets. It also shows that the same regulatory adjustment may not be needed in all states.

The search for solutions has actually now started to lead to some concrete decisions. The growing vocal publicity around the available evidence in an election year have led President Trump to sign a Ratepayer Protection Pledge on March 4, 2026 with seven major tech firms — Amazon, xAI, Oracle, Microsoft, Meta, Google, and OpenAI.[3] They all commit not to pass on the cost of powering their DCs to the other utility customers. The implementations details are however still unknown at the time of this writing. And it is a solution that will probably only be effective in some contexts as discussed later in the paper.

While the US may be perceived as a leading indicator of the debates to come elsewhere, similar debates are actually already taking place in Europe, Asia and Africa, although the reactions to the potential impact of DC on the electricity market are quite different across countries and regions. While some are indeed concerned with the price effects, others focus more on the potential benefits DC are expected to bring to business.

The European and Latin American countries tend to focus on the same concerns as the US and several countries (Belgium, Brazil, Colombia, France or Ireland for instance) are already discussing possible solutions to protect the historical users. In Asia, in contrast, there seems to be a willingness to actively manage the electricity price to attract DCs. For instance, in many countries across Southeast Asia, DCs enjoy a 7% discount, on average, on their on-grid tariffs relative to a typical industrial user (Wood-MacKenzie, 2025). In Africa, the focus is on ensuring that DCs allow an acceleration of investment in generation capacity and on the idea that it will eventually lead to share infrastructure investment costs with the new entrants and eventually decrease the cost per kilowatt-hour for residential and commercial customers over time and hence the price (Africa Energy Chamber, 2025). While all those debating may not agree on the risks associated with DCs, they all seem to agree the price of electricity is quite central to the sometimes somewhat ideological debates.

Despite the growing volume of empirical and anecdotal evidence to anchor the debates, there are at least three gaps in the literature. The first is that there is so far hardly any theoretical treatment of some of the challenges associated with the shock to be managed.[4] The second is that there is no modelling of the market characteristics explaining why we observe very different impacts of

[2] Hertz-Shargel (2025) offers a useful summary of the regulatory issues countries (and not just the US) will have to address to update regulation to account for any of the deals the authorities may strike with the DC owners

[3] https://www.whitehouse.gov/articles/2026/03/president-trump-secures-historic-commitment-to-keep-electricity-costs-down-amid-data-center-boom/

[4] To our knowledge, Lee and Schmaltz (2026) is a notable exception.

a demand shock across states or across countries. The third is that there is no theoretical analysis of the rationality of the different approaches adopted across states and across countries to mitigate the risks of undesirable effects. Not all US states and not all African, Asian, European or Latin American countries are facing the same impact, nor are they considering the same solutions. A better understanding of the drivers of the differences should help policymakers only starting now the diagnostics of their options and their constraints.

To address some these knowledge gaps, the paper develops a conceptual assessment designed to increase the transparency of the likely short run and long run price and consumption effects on the historical users of the entry of large DCs. In particular, the modelling approach helps look into the relevance of the characteristics of the market in which the entry takes place. For instance, it shows why the effects of the entry of a DC in an African country in which some of the population does not yet have access to electricity are unlikely to be the same as in countries with full population coverage.

The conceptual approach consists of a sequence of simple optimization models tracking the effects of competition for electricity consumption for the historical users and the DCs under different market characterizations. The comparison of the different optima helps understand the sources of some of the issues already raised by politicians. They also help assess the extent to which there may be a need for a new financing approach in various contexts. Note that to keep the discussion focused, we do not account for network constraints or public policies or for the externalities associated with the heavy water needs of the DCs. We do not deal either with the important impact of the entry of DCs on the transmission capacity needs.[5]

The main results of the modelling exercise are summarized as follows. Many of the effects on prices observed in various countries or regions were predictable under the prevailing sector pricing and financing rules. Moreover, in the near future, without any regulatory adjustment, the historical users are likely to be losers in terms of price and in terms of access to electricity supply. The extent of the losses will be quite sensitive to the bargaining power of the DC owners in their interactions with the electricity utilities. From a longer run perspective, it will often be rational for authorities to get the DCs to invest and finance their own capacity as recently decided by the Trump administration.[6]

The paper is organized as follows. In section, 2, we present the basic model and its underlying assumptions. We then identify the optimum pricing rule ensuring that competition works in the electricity market. In section 3, we look at the extent to which the optimum changes in the short run and in the long run with the entry of a large DC, maintaining the assumption that the market is competitive. This identifies the extent to which the historical consumers lose from the change

[5] On the transmission challenges; see Annex A of the ENTSO-E position on the need for national connection requirements to ensure EU power system stability, 11 December 2025 https://www.entsoe.eu

[6] See above, footnote 1.

in different market characteristics. In section 4, we consider the impact on the market outcomes of allowing the new entrant to enjoy market power in the short run, accounting for the possibility that the entrant can bargain both with the electricity producer and the regulator. We conclude in section 5.

2 The BAU market *prior* to the entry of data centers

We begin, in subsection 2.1, with a discussion of the assumptions of our reference model. In subsection 2.2 we determine the conditions to be satisfied to reach an optimal organisation of the electricity industry. The quantity to be produced and consumed that maximizes the well-being of local agents is analysed in subsection 2.3, and the price of energy that decentralizes this optimum is derived in 2.4.

2.1 Consumers and producers

To keep the discussion as simple as possible, we rely on a model of the electricity industry in which there is no distinction between final users (households) and intermediary users (from sectors as different as agriculture, industry and services). We label them the historical users. Denoting their consumption of electricity by q, we assume that the gross surplus they enjoy is given by the quadratic function:

$$S(q) = aq - b\frac{q^2}{2} \tag{1}$$

where $a > 0$ and $b > 0$ so that marginal utility $\frac{\partial S(q)}{\partial q} = a - q$ is decreasing in q.

The coefficients a and b have very concrete interpretations relevant to some of the policy debates surrounding the impact of the demand shock. The coefficient a is a measure of the willingness to pay for the first units of electricity ($\frac{\partial S(q=0)}{\partial q} = a$). In this model, it is exogenous for consumers but can be modified by public decisions such as subsidies, taxes or distribution of electrical appliance or electric vehicles for instance. The coefficient b approximates the consumers' sensibility to changes in q. When b is large (resp. small), a slight increase in q provokes a sharp (resp. slight) drop in the electricity marginal valuation. To put it simply, if b is large (resp. small), electricity demand is price inelastic (resp. elastic).[7] This is particularly useful to assess the incidence of price shocks resulting from demand shocks. It can also be influenced by policy interventions, including nudging efforts to change consumption habits for instance.

The modeling of the cost side of the market is also kept as simple as possible. We rely on the standard model of electricity provision when there is one single

[7] Of course, this is only an approximation, since we know that the price elasticity of demand is not constant along a linear function.

technology. The cost to supply the electricity quantity q is given by

$$C_e(q, K) = \begin{cases} c_e q_e + rK & \text{if } q_e \leq K \\ \infty & \text{otherwise} \end{cases} \tag{2}$$

where K is the installed capacity and r its unit cost.

As long as the installed capacity K is not fully used, the unit operating cost c_e is constant. In practice, it essentially corresponds to the cost of the primary energy used (coal, natural gas, uranium, ...) multiplied by the technical coefficient for transforming the primary energy into electric energy. Because electricity cannot be stored at low cost, it is a standard hypothesis that it is impossible to provide electricity beyond the production capacity. Note that the unit cost r covers maintenance costs and financial costs related to investment in production capacity.

2.2 First best under the BAU case

Until the demand shock imposed by the data centers hits the market, the optimum choice of electricity consumption q and production q_e as well as production capacity K is conceptually quite predictable in this initial modeling of the market. Given the balancing requirement $q_e = q$, it is the vector (q, K) that maximizes

$$W(q, K) \overset{def}{=} S(q) - C_e(q, K)$$

Denote μ the multiplier of the constraint $q \leq K$. The associated Lagrange function is

$$L = aq - b\frac{q^2}{2} - c_e q - rK + \mu(K - q)$$

The variable μ is the shadow price of the capacity constraint. It represents the additional net surplus gained by relaxing the constraint by one unit. It is an essential driver of the way changes in the capacity constraint will affect optimization through a policy intervention favouring one or all types of users as discussed later, once the optimal solutions have been identified.

The solution to the constrained optimization problem will be given by :

$$\frac{\partial L}{\partial q} = a - bq - c_e - \mu \leqslant 0, q \geqslant 0, \frac{\partial L}{\partial q} \times q = 0 \tag{3}$$

$$\frac{\partial L}{\partial K} = -r + \mu \leqslant 0, K \geqslant 0, \frac{\partial L}{\partial K} \times K = 0 \tag{4}$$

$$\frac{\partial L}{\partial \mu} = K - q \geq 0, \mu \geqslant 0, \frac{\partial L}{\partial \mu} \times \mu = 0 \tag{5}$$

The measure of the gain in utility achieved by relaxing the capacity constraint by one unit (μ) is provided by condition (4). This condition highlight the relevance of the comparison between the unit cost r, and the marginal utility achieved from a capacity expansion, μ. But this value is also likely to be impacted by the market context in which the change takes place. The specific relevance of this context is given by condition (3) that shows the need to compare the value of μ to the values defining the characteristics of the market defined by a, b and c_e, reflecting the willingness to pay of users, their price elasticity and the operating cost of the producer. This already hints at the need to recognize that any policy assessing the desirability of adjusting the capacity to the needs of a DC should account for these characteristics. Not all markets are equally able to absorb the associated demand shock, as we will see in section 3. Finally, condition (5) highlights the need to have a production capacity able to meet the total demand and the resulting effect on the marginal valuation of capacity measured by μ.

2.3 Possible efficient outcomes under BAU

For now, we focus on the possible solutions to the maximization problem and on their interpretations prior to the demand shock a DC can induce. These interpretations depend on the context being analyzed. We successively consider corner and interior solutions.

2.3.1 Corner solutions

Consider first the case in which the local user's willingness to pay for the first units of electricity (a) is small. This may be the case for low-income families in developed economies. It also reflects the situation of many families in low-income countries, particularly in rural areas with many households not connected to the grid and not rich enough to pay for independent equipment. These families would derive some utility from the consumption of electricity, but their gain would not be large enough to cover the cost. This should lead to a rejection of a decision to develop capacity with the prevailing technology.

Formally, in the model this corner solution shows up when the value of μ derived from first-order conditions for positive consumption, ($\partial L/\partial q = 0$ when $q > 0$), is so low compared to the unit equipment cost r that (4) leads to ($\partial L/\partial K < 0$). In that case, by the complementary slackness condition ($\frac{\partial L}{\partial K} \times K = 0$), we can conclude that $K = 0$. The surplus that residents could gain from electricity consumption is so small that it would, indeed, be inefficient to install power plants as suggested by the intuitive description of the choices.

2.3.2 Interior solution

We focus next on the most common average situation, one in which there is a production capacity in place and it is the use of this capacity that DCs will want to compete for. Formally, we assume that $K > 0$ so that $\partial L/\partial K = 0$ by (4) and μ can be replaced by r in (3). This assumption allows us to focus on the case in which there is an historical local demand, i.e. $q > 0$ and this implies that capacity has to be positive, i.e. $K = q > 0$ by (5).

In this environment, the optimal consumption solution is given by solving $\partial L/\partial q = 0$ in (3) with $\mu = r$, that is

$$a - bq - c_e - r = 0 \tag{6}$$

and the second order condition

$$\frac{\partial^2 L}{\partial q^2} = -2b < 0. \tag{7}$$

From (6) we have

$$q^* = K^* = \frac{a - c_e - r}{b}. \tag{8}$$

As expected, this optimum will depend on the context defined by the specific value of all the parameters. This is the result that best shows why not all countries or regions within countries should be expected to react in the same way to an increase in demand. Equation (8) makes it quite transparent that the optimal level of capacity and matching demand is sensitive to each of these parameters as well as a few more not picked up in this model. For instance, it explains why in the US or in Europe, it is rational for many regions to focus on the associated economic opportunities while, for others, to emphasize the associated environmental, financial and social burden. The policy challenge is to get a sense of how much of a difference the increase in demand shows up as a shock that needs to be dealt with new policy decisions rather than a simple increase in demand that can be managed as BAU.

2.4 Market implementation

Since we now have a measure of the optimal level of consumption that prevails prior to the demand shock, we also need to have a measure of the associated optimal price. Jointly, these two measures will serve as a benchmark to which the effects of an entry by a data center will be compared. This first best benchmark is quite straightforward to compute if both consumers and producers are price-takers. Given the linearity of the profit function, the supply function is flat for the price

$$p^* = c_e + r \tag{9}$$

With households equating their marginal surpluses to this price, we obviously obtain equation (6). As illustrated in Figure 1, under these market conditions, the full production capacity will be used by consumers and producers will cover their cost.

3 Modeling the effects of the data center entry

Suppose now that the authorities are considering the installation of a large DC in its region or country. This center is assumed to be a non-marginal newcomer

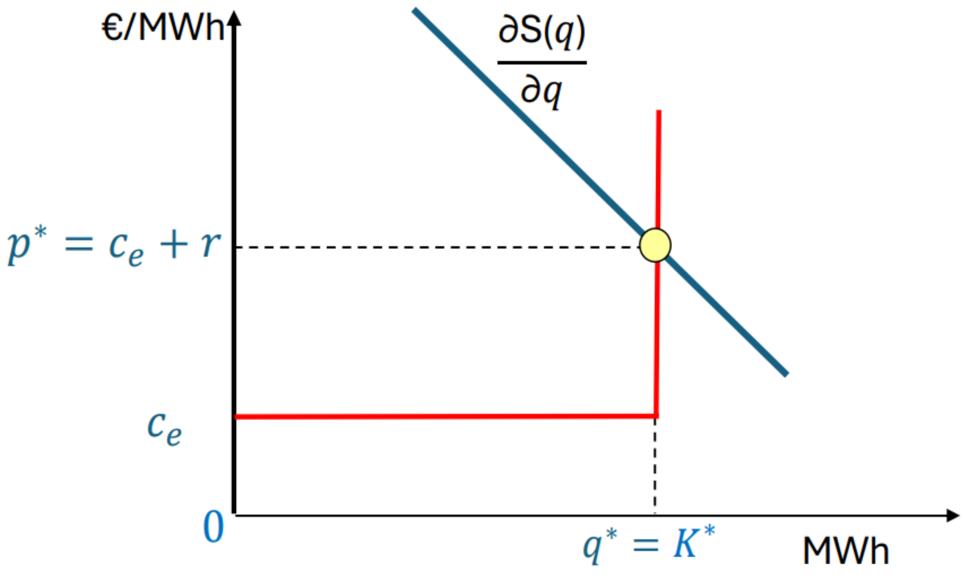

Figure 1: Pre-entry market for electricity

requiring a significant supply of electricity.[8] The fact that it is non-marginal suggests that the analysis needs to consider the change as a shock rather than a simple increase in demand to be tracked by the historical demand trend. This is turn requires a change in the modeling used to track the effect on the outcomes of interest, i.e. optimum price, consumption and capacity.

To do so, we need to introduce a few additional notations and assumptions. These are described in subsection 3.1. Then, in subsection 3.2 we determine the optimal allocation to be compared to the first best outcomes described earlier in subsection 2.3.2. At this stage, we still assume that the installed capacity remains fixed at the value K^* defined in (8), reflecting the optimal capacity under the existing regulatory regime and an environment in which all consumers consume to get the level of electricity they need. In subsection 3.3, we will identify the new optimal capacity that will result from an internalization of the change in demand associated with the data center entry in the market.

3.1 Upgrading the BAU model

The entry of the data center implies that the gross surplus equation needs to be adjusted to account explicitly for the surplus contributed by this entrant. The adjustment needs to be able to internalize the extent to which the local users (residential and non-residential) will be able or not to share the surplus achieved

[8] "A typical AI-focused data centre consumes as much electricity as 100 000 households, but the largest ones under construction today will consume 20 times as much." (IEA, 2025).

by the new entrant rather than being transferred to other regions or countries. The distribution of this surplus is one of the main topics covered by most political speeches mentioned earlier.

To address this concern, the gross surplus can now be modeled as follows:

$$\widetilde{S}(q,Q) = S(q) + \rho(AQ - B\frac{Q^2}{2})$$

where $S(q)$ has been defined in (1), $AQ - BQ^2/2$ is the gross surplus created by the entrant when it produces Q (with $A > 0, B > 0$) and $0 \leq \rho \leq 1$ is the fraction of this surplus that benefits the local users, the remaining part being scattered abroad.

On the cost side, we assume that Q and the required electricity input Q_e are related by

$$Q = \delta Q_e \tag{10}$$

where $\delta > 0$, and the production cost of Q is

$$C(Q) = cQ \tag{11}$$

with $c > 0$. The new net welfare function is

$$\widetilde{W}(q,Q) = \widetilde{S}(q,Q) - C_e(q_e, K^*) - C(Q)$$

where electricity demand and supply must be balanced:

$$q + Q_e = q_e. \tag{12}$$

The maximization of $\widetilde{W}(q,Q)$ subject to the capacity constraint $q_e \leq K^*$ will allow us to get the new outcomes indicators we need to assess the impact of the data center entry in the market. Finally, observe that the electricity capacity is still not a decision variable since it is fixed at value K^* in the short run.

3.2 The short run optimum in the enlarged market

The computation of the optimal solutions for price and quantity follows the usual procedure. It simply requires a somewhat more complex optimization process, including somewhat more precise assumptions.

3.2.1 Setting up the model

With μ still denoting the multiplier of the electricity capacity constraint, the associated Lagrange function is

$$\begin{aligned} \widetilde{L} &= aq - b\frac{q^2}{2} + \rho.(A\delta Q_e - B\delta^2\frac{Q_e^2}{2}) \\ &\quad -c_e(q+Q_e) - rK^* - c\delta Q_e + \mu(K^* - q - Q_e) \end{aligned} \tag{13}$$

The solution to the constrained maximisation problem is given by :

$$\frac{\partial \widetilde{L}}{\partial q} = a - bq - c_e - \mu \leqslant 0, q \geqslant 0, \frac{\partial \widetilde{L}}{\partial q} \times q = 0 \tag{14}$$

$$\frac{\partial \widetilde{L}}{\partial Q_e} = \rho(A\delta - B\delta^2 Q_e) - c_e - c\delta - \mu \leqslant 0, Q_e \geqslant 0, \frac{\partial \widetilde{L}}{\partial Q_e} \times Q_e = 0 \tag{15}$$

$$\frac{\partial \widetilde{L}}{\partial \mu} = K^* - q - Q_e \geq 0, \mu \geqslant 0, \frac{\partial \widetilde{L}}{\partial \mu}.\mu = 0 \tag{16}$$

We focus on a context in which the electricity demand of both the historical consumers and the DC is positive, i.e we assume that $q > 0$ and $Q_e > 0$. Given $K^* = q^*$ in (8), by (16) one can accomodate $Q_e > 0$ only if $q < q^*$. This is one major change with respect to the original market situation since it means that the historical electricity consumers need to be rationed to make room for the new entrant in the short run. This rationing can be obtained either by physical limitations or by an increase in prices. For example, $\widetilde{p} = a - bq > a - bq^* = p^*$.

Then, from (14) and (15), given that we now have $Q_e > 0$ in addition to $q > 0$,the additional surplus obtained from relaxing the capacity constraint by one unit becomes

$$\begin{aligned} \mu &= a - bq - c_e && (17)\\ &= \rho\delta(A - B\delta Q_e) - c\delta - c_e && (18) \end{aligned}$$

and

$$q + Q_e = K^* \tag{19}$$

3.2.2 Identifying the optimal level and distribution of consumption

When we solve the system of equations

$$\begin{aligned} \rho\delta(A - B\delta Q_e) - c_e - c\delta &= a - bq - c_e \\ q + Q_e &= K^* \end{aligned}$$

we obtain the new optimum consumption/production levels

$$\begin{aligned} \widetilde{q} &= \frac{1}{b + B\delta^2\rho}\left(a + c\delta - A\delta\rho + B\delta^2\rho K^*\right) && (20)\\ \widetilde{Q}_e &= \frac{1}{b + B\delta^2\rho}\left(A\delta\rho - a - c\delta + bK^*\right) && (21) \end{aligned}$$

With $\widetilde{Q}_e > 0$, the level of optimal local consumption of electricity reported in (20) is clearly lower than the one reported in (8), prior to the entry of the data centers in the electricity market. The historical users are thus losers in terms of their new ability to consume. This highlights the predictable competitive tension between the historical consumers and the newcomer in the short term.

From a policy perspective, it is useful to observe that this market solution is only feasible if the term $A\delta\rho$ is large enough. This implies that the willingness to pay for the data centers outputs A is high enough, the unit consumption of electricity required by this output $\frac{1}{\delta} = \frac{Q_e}{Q}$ is low, while the local users benefit from a high share of the surplus ρ associated with the output.

However, the model suggests that there are two cases in which the most desirable policy choice would be not to allow entry to the newcomer, i.e. $Q_e = 0$. The first is simply in a context opposite to the one just described. If the decision takes place in an environment in which all these parameters are small, we have that

$$\frac{\partial \widetilde{L}(Q_e = 0)}{\partial Q_e} = A\delta\rho - c_e - c\delta - \mu < 0$$

since $\mu \geq 0$. Then by (15) $\widetilde{Q}_e = 0$: the newcomer should not be accepted in an environment in which the local users only benefit from a low share of the surplus associated with the output (low ρ) and the willingness to pay for the data centers outputs is also low (low A). And this can be the case even if δ is large, that is if the consumption of electricity required by this output is low.

The second situation is more subtle. Equation (20) suggests that, if the term $A\delta\rho$ is too large, local historical consumers would be driven out of the market by the arrival of the digital center. In this context, we are therefore faced with a dilemma: the short term first best is not feasible for reasons of extreme unfairness. This would be politically unacceptable in most countries.

3.2.3 Getting to the optimal prices

Let's focus now on the prices that implement this short run first best. Under competition, the price paid by the local historical consumer will be her or his marginal surplus, then

$$\begin{aligned} \widetilde{p} &= a - b\widetilde{q} \\ &= a - b\frac{1}{b + B\delta^2\rho}\left(a + c\delta - A\delta\rho + B\delta^2\rho K^*\right) \\ &= \delta\frac{b\left(A\rho - c\right) + B\delta\rho\left(a - bK^*\right)}{B\rho\delta^2 + b} \end{aligned} \tag{22}$$

It is higher than the pre-entry price p^* since with the supply to the entrant and unchanged capacity K_e^*, the (short run) marginal cost is above the long run marginal cost $c_e + r$. As was shown by Boiteux (1960) and illustrated in Figure 2, the electricity price paid by the househod is determined by the intercept of

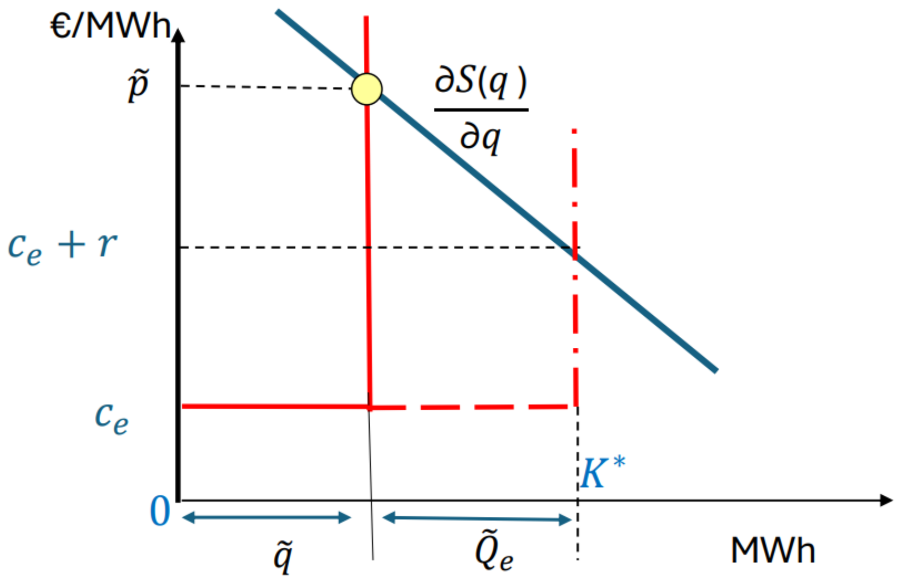

Figure 2: Post-entry market for electricity

his marginal surplus with the vertical part of the short run marginal cost, after substracting the quantity $\widetilde{Q}_e$ supplied to the DC.

As for the unit price paid by the data center, it is determined similarly:

$$\begin{aligned} \widetilde{P} &= \rho\delta(A - B\delta\widetilde{Q}_e) - c\delta \\ &= \delta\frac{b\,(A\rho - c) + B\delta\rho\,(a - bK^*)}{B\rho\delta^2 + b} \end{aligned} \tag{23}$$

Despite the disruption caused by its entry, the data center will have to pay the same unit price as local consumers.

The associated political challenge is that this price is now higher for the historical users when compared to the pre-entry condition. These users not only lose in terms of their consumption capacity, they also lose in terms of price. This is precisely the concern that has been voiced by many politicians in the US and that resulted in the Trump administration to react early March 2026.[9]

3.3 The long run optimal allocation

In a sector characterized by long lived assets and a long run increasing demand trend, time should be expected to matter. Equations (22) and (23) hint at the potential payoffs to increase capacity to deal with the differences in prices before and after entry. Indeed, the two prices are obviously decreasing in K^*. An

[9]See above, footnote 1.

investment would thus mitigate the price surge experienced by the historical local consumers. In this section, we consider this longer-term situation.

To be able to conduct this assessment, we need, once again, to improve the welfare function. With a longer run perspective, the optimal capacity post entry is the solution to

$$\max_K \widetilde{W}(q(K), Q(K)) = \widetilde{S}(q(K), Q(K)) - C_e(q(K) + Q_e(K), K) - C(Q(K))$$

subject to

$$q(K) + Q_e(K) \leq K$$

where $q(K)$ and $Q_e(K)$ are given by the functions (20) and (21) respectively.

By the envelop theorem, we can use the Lagrange function (13) and apply $\frac{d\widetilde{L}}{dK} = \frac{\partial \widetilde{L}}{\partial K}$. Consequently, to conditions (14), (15) and (16), we add

$$\frac{\partial \widetilde{L}}{\partial K} = -r + \mu \leqslant 0, K \geqslant 0, \frac{\partial L}{\partial K} \times K = 0 \tag{24}$$

Then, for $K > 0$, we have $\mu = r > 0$ and the system to solve for $q > 0$, $Q_e > 0$ and $K > 0$ is

$$\frac{\partial \widetilde{L}}{\partial q} = a - bq - c_e - r = 0 \tag{25}$$

$$\frac{\partial \widetilde{L}}{\partial Q_e} = \rho(A\delta - B\delta^2 Q_e) - c_e - c\delta - r = 0 \tag{26}$$

$$\frac{\partial \widetilde{L}}{\partial \mu} = K - q - Q_e = 0 \tag{27}$$

The solution to this system provides the new optimum consumption for both historical and new consumers as well as the optimal long run production capacity:

$$\begin{aligned} \widehat{q} &= \frac{a - (c_e + r)}{b} \\ \widehat{Q}_e &= \frac{A\delta\rho - (c_e + c\delta + r)}{B\delta^2\rho} \\ \widehat{K} &= \frac{Ab\delta\rho + B\delta^2\rho\,(a - c_e - r) - b\,(c_e + r + c\delta)}{Bb\delta^2\rho} \end{aligned} \tag{28}$$

In this long term optimum, we see that local consumers return to their pre-entry level $\widehat{q} = q^* = \frac{a - c_e - r}{b}$ and the capacity increase just covers the consumption of the DC: $\widehat{K} - K^* = \widehat{Q}_e$. Here, efficiency and fairness go hand in hand: in order not to disadvantage local consumers, the Data Center must finance the increase in capacity needed to power it at a price equal to the long run marginal cost $c_e + r$.

In practice, this what an increasing number of DCs are offering to do in some countries. In the US, some of the major DCs owners are committed to cover new generation resources and transmission upgrades to ensure the historical electricity users are protected from any associated cost increase. This may include investments in on-site generation such as micro-grids or batteries to minimize the burden on local grids during peak times.[10] This approach is also being adopted in European countries such as Italy, Portugal or Spain with easy access to renewable energy sources.[11]

The willingness to minimize the burden on local grids is quite important since, in many cases, investments in data centers can be implemented within a couple of years while the development of additional grid capacity can take twice to four times as long. During the transition, the historical users are likely to end up paying higher prices to internalize the short-term congestion issues.

4 What if the data center has bargaining power?

A critical dimension that needs to be addressed in this conceptual analysis of the impact of DCs in the electricity market is that their owners often have much more bargaining and lobbying power than the historical customers. This is a recurring component of the political speeches on the risks associated with DCs. Moreover, in their review of regulatory utility rates proceedings, Martin and Peskoe (2025) mention the possibility of hidden subsidies and secret contracts between utilities and data centers to allow a transfer of some of their energy costs to the other users. Bargaining at that level thus seems to be a possibility to consider in the assessment of the possible outcomes of DC entry. In some context, this bargaining will take place only between the DC and the electricity producer. In some others, it can also involve the regulator. We deal next with these two possibilities in turn. In subsection 4.1, we assume that the government or regulatory agency is powerful enough to fully protect historical consumers and allows the entrant and the electricity producer to negotiate an energy supply contract. Subsection 4.2 is dedicated to the more complex case where the local authority representing historical consumers participates in the negotiation round without having the power to fully impose its point of view.

4.1 The DC facing the electricity producer

In this sub-section, we focus on bargaining between the entrant and the utility company. To keep the discussion as simple as possible, we assume that the

[10]See Goldman Sachs (2025a), Bloomenergy (2025), Martucci,B.(2026).

[11]See Energetico (2025), Iberdrola Espana (2025), Lightbox (2025), Rollinson Urquhart and Thomson (2025).

control exercised over the electricity producer by the sector's regulatory authority is sufficient to prevent any manipulation of its selling price to historical users (households and local businesses). This means that these users are not affected by the entry: they still consume the BAU quantity $q^* = (a - c_e - r)/b$ and they pay the unit price $p^* = c_e + r$.. This rules out one of the most predictable distributional effects of market power but it allows us to focus on the less predictable yet very concrete negotiation that takes place between the electricity producer and the powerful new entrant. More concretely, it opens a window on the bargaining taking place between the Big Techs, key players in the DCs business and the utilities owners in the regions or countries in which they are interested in setting up their infrastructure.

In this specific environment, the two components of the contract negotiated between the DC and the electricity seller are i) the additional capacity to install K_i to accomodate the entry and ii) the unit price p_i of the electricity delivered to the DC.

As shown in the Appendix 6.2, given the price charged to the local consumers, the net profit of the electricity producer is

$$\pi_e = (P_i - c_e - r)K_i. \tag{29}$$

As for the data center, since the electricity it will consume Q_e, cannot be larger than the additional capacity to install, K_i, and it has no interest in asking for an investment that it will not fully use, we can argue that $Q_e = K_i$. Consequently, its profit is:

$$\Pi = \left[\rho(A\delta - B\frac{\delta^2 K_i}{2}) - \delta c - P_i\right] K_i \tag{30}$$

To keep the discussion as simple as possible, we also assume that the DC has no alternative solution to feed its computers[12] and the electricity producer has no potential new client. This implies that they both have a zero profit if they disagree on K_i and P_i.

Next, we need to be able to account for the differences in bargaining power between these two firms and to assess how it influences the total surplus/profit. Let σ represent the bargaining power of the DC. When the DC has the full bargaining power $\sigma = 1$; when it has none, $\sigma = 0$. Then, following Nash (1950), the outcome of the bargaining process accounting for the relative bargaining power of the two firms is the solution to:

$$\max_{K_i, p_i} \pi_D^{\sigma} \times \pi_e^{1-\sigma}$$

As shown in Appendix 6.2, the solution is

[12]In practice, data centers use self-generation (see Ambec and Crampes (2025), Crampes and Estache (2026)). It can therefore be a fallback solution in negotiations with the electricity producer. This additional feature is introduced in subsection 4.2.

$$K_i^N = \frac{A\delta\rho - (c_e + c\delta + r)}{B\delta^2\rho}$$
$$P_i^N = \frac{(A\delta\rho - c\delta)(1-\sigma) + (1+\sigma)(r + c_e)}{2}$$

As expected in this game of cooperative bargaining, the two players agree on the capacity to install, calibrated to maximize the joint surplus of the transaction, that is $\pi_e + \pi_D$. It results $K_i^N = \widehat{Q}_e$ defined in (28). By contrast, the choice of the price p_i that determines the distribution of this surplus is a subject of intense negotiations. Obviously, it is a decreasing function of the DC's bargaining power σ.

Consider first the most likely scenario in which $0 < \sigma < 1$, that is one in which both stakeholders enjoy some bargaining power and hence both only manage to capture part of the surplus generated by the sale of electricity to the DC. In this context, it is likely that an agreement will be reached and hence the entry of the DC will be supported by the utility company. The relative values of the bargaining power will define the share of surplus each of these two stakeholders will get.

It may not totally eliminate some of the risks for the historical consumers of corruption or of secret agreements with an impact on their prices or consumption as suggested by Martin and Peskoe (2025) for instance. But in the context defined in this subsection, we ruled out these risks when we assumed that the regulator could protect the historical users from undesirable price and consumption effects. In the next subsection, we release that assumption in getting the regulator involved in the bargaining rather than imposing a full protection of the historical consumers.

Note that when the DC has the full bargaining power (i.e. $\sigma = 1$), it would enjoy the full surplus generated by its purchase of electricity and only pay the long run marginal cost of electricity. For a government keen on hosting a DC, this can lead to a major problem. Indeed, an independent utility company may then not wish to make any effort to cater to the needs of this new entrant. Actually, the optimal choice for the utility company is to reject the request of entry by the DC.

There are at least two exceptions to this reluctance. First, some countries or regions in emerging economies consider that the business opportunities that the DC will bring locally are more important than a concession on the price of electricity. This may be what drives the debate in Asia and in Africa for instance. Second, once more, weak governance contexts may ease deals. Corrupt regulators or governments may impose on the utilities to cater to the DC needs. In other words, bribes may lead to a DC entry that is not in the interest of society and in particular historical consumers and/or taxpayers.

4.2 Intervention by the regulatory authority

This subsection considers the contexts in which the assumption that the benevolent regulator can afford to stay out of the negotiation is unrealistic. To see how much accounting for the possibility that the regulator is an active participant in the negotiation changes the outcomes, we thus need to move to a more complex three-player negotiation in which this benevolent regulator represents the interest of the historical consumers. So we now need to consider explicitly the respective bargaining powers of the DC, the utility company producing electricity, and the authority representing the historical local consumers. These are measured respectively by α, β, and $1-\alpha-\beta$.

The following is the identification of the unique combination of prices and consumptions that would maximize the gains for all the stakeholders relative to what they would get if negotiations break down (a Nash bargaining solution as in the previous subsection). Each of these stakeholders knows that if negotiations fail, each can count on a fall-back gain equal to $\underline{\Pi}$ for the DC, $\underline{\pi_e}$ for the electricity producer and $\underline{S}$ for historical customers. Moreover, we assume that the total capacity will be able to cater to the needs of both the historical consumers and the DC, i.e. $K = q + Q_e$.

More formally, in this setting, the bargaining game will determine the consumption level and the price paid by the historical consumers and the DC (q, Q_e, p, P) to maximize

$$(\Pi(Q_e, P) - \underline{\Pi})^{\alpha} \times \left(\pi_e(q, Q_e, p, P) - \underline{\pi_e}\right)^{\beta} \times (U(q,p) - \underline{S})^{1-\alpha-\beta} \tag{31}$$

where

$$\begin{aligned}
\Pi(Q_e, P) &= \rho(A\delta Q_e - B\frac{\delta^2 Q_e^2}{2}) - c\delta Q_e - PQ_e = \Pi_G(\delta Q_e) - PQ_e \geq \underline{\Pi} \\
\pi_e(q, Q_e, p, P) &= pq + PQ_e - (c_e + r)(q + Q_e) = pq + PQ_e - C_e(q + Q_e) \geq \underline{\pi_e} \\
U(q,p) &= aq - b\frac{q^2}{2} - pq = S(q) - pq \geq \underline{S}
\end{aligned}$$

with $S(q)$ defined in (1) and $\Pi_G(\delta Q_e)$ representing the gross surplus of the DC, i.e. before paying the electricity bill.

As seen in the previous subsection, quantities maximize the total surplus

$$\begin{aligned}
TS &= U(q,p) - \underline{S} + \Pi(Q_e, P) - \underline{\Pi} + \pi_e(q, Q_e, p, P) - \underline{\pi_e} \\
&= S(q) + \Pi_G(\delta Q_e) - C_e(q + Q_e) - \left(\underline{\Pi} + \underline{\pi_e} + \underline{S}\right)
\end{aligned}$$

This problem is similar to the one in section 3.3. Consequently, the solution is the first best quantities given by (28):

$$q^N = \frac{a - c_e - r}{b} \tag{32}$$

$$Q_e^N = \frac{A\rho\delta - c\delta - c_e - r}{B\rho\delta^2} \tag{33}$$

The difference with section 3.3 lies in the way in which prices will distribute the total surplus obtained with these quantities among the three agents. As shown in Appendix 4.2, the two prices are

$$P^N = \frac{\left(\Pi_G(Q_e^N) - \underline{\Pi}\right)(1-\alpha) - \alpha\left[S(q^N) - \underline{S} - C_e(q^N + Q_e^N) - \underline{\pi_e}\right]}{Q_e^N}$$

for the DC and

$$p^N = \frac{(\alpha+\beta)\left(S(q^N) - \underline{S}\right) - (1-\alpha-\beta)\left[\Pi_G(Q_e^N) - C_e(q^N + Q_e^N) - \left(\underline{\Pi} + \underline{\pi_e}\right)\right]}{q^N}$$

for historical consumers.

Let us first consider the two extremes of possibilities regarding bargaining power.

■ If the regulator, i.e.the representative of the historical consumers, is very strict, $\alpha = \beta = 0$, then

$$\begin{aligned} \Pi_G(Q_e^N) - \underline{\Pi} - P^N Q_e^N &= 0 \\ p^N q^N + P^N Q_e^N - (c_e + r)(q^N + Q_e^N) - \underline{\pi_e} &= 0 \end{aligned}$$

that is, both the entrant and the electricity producer receive just enough to accept the deal. All the gains TS^N go to the historical consumers who are rewarded instead of having to pay:

$$p^N q^N = -\left[\Pi_G(Q_e^N) - C_e(q^N + Q_e^N) - \left(\underline{\Pi} + \underline{\pi_e}\right)\right] < 0$$

■ By contrast, if the regulator has no power (or is corrupt) $\alpha + \beta = 1$, the bill local consumers must pay is

$$p^N q^N = S(q^N) - \underline{S}$$

that is a net gain $S(q^N) - p^N q^N = \underline{S}$ just enough not to reject the agreement. As shown by Lee and Schmalz (2026), the value of $\underline{S}$ depends on the capacity of business and households to relocate to different areas, which is costly—or even impossible—for many of them.

The model thus shows that the entry of a data center is not necessarily bad for historical consumers if the regulatory authority has sufficient power to prevent the DC and the electricity producer from sharing the rent created by the DC's activity. Between the two extremes identified above, there is room for negotiation leading to a net gain for all three parties involved.

5 Conclusion

The most obvious insight of this paper may be that many of the concerns expressed by the politicians, the media and the consulting firms based on partial initial evidence collected from early experiences with DC entry in the electricity market were reasonably predictable from theory. The sequence of the conceptual models discussed here produces theoretical results that match in many ways this early somewhat heterogeneous evidence. While some of the results explain quite well the observed short run evidence, others hint at possible longer term effects not yet observable.

The main interest of this predictability is that it could help policymakers anticipate much earlier the social and political challenges they need to be able to avoid by adapting regulation. For both short term and long term horizons, the analysis shows that there are ways to minimize or avoid the political and social costs of the demand shocks associated with the entry of DCs. But the solutions will depend on the market characteristics and may include a decision not to allow the entry of DCs in some contexts. More specifically, the short and long term risks and solution options are as follows.

In the short run, the conceptual model shows the necessity of distinguishing between the entry in a competitive electricity market and the entry into a non-competitive market. Not all countries rely on the same market structure and hence it would seem reasonable to expect that they will not all react in the same way to the DC demand shock.

In a competitive market, the entry of DCs should be expected to increase electricity prices and reduce the share of total capacity allocated to the historical users. The politicians expressing concerns are right. But in practice, the effects should be transitional and last until DC owners have developed or contributed their own capacity or have managed to improve significantly the energy efficiency of the DCs. In many cases–but not all!–entry will prove to be desirable. In particular, if the governments or the authorities can find a way to protect the historical users during the transition—e.g maybe with direct or cross-subsidies or if the DC owner cover the transition and capital costs—as long as environmental and other risks are under control.[13] However, the analysis also suggests that, despite the commitments of many DC owners to finance the added costs associated with their entry, in some contexts, it will be rational for a regulator not to authorize them to access to the electricity market even if they have decided to build up their own capacity. This is likely to be the case when a solid share of the consumers has a limited capacity to pay (e.g. households in poor regions or small businesses) or when the access to electricity is unavailable to some potential historical users (e.g. rural households in many African countries).

In a non-competitive electricity market in which DCs enjoy some market power in their interaction with the electricity producers, they are likely to end up agree-

[13] For a discussion of options available to protect the users from the social costs of transitions, see chapter 9 on the social concerns of regulation in Auriol et al. (2021)

ing on the size of the capacity to install but they will have conflicting interests when it comes to the price charged. In countries in which the DC and the electricity utility engage in a bilateral negotiation and the regulator has only required a full protection of the historical users, the final price for the DC will be a decreasing function of its negotiation power. When the DC has the full bargaining power, it will just pay the long run marginal cost of electricity. To avoid this extreme case, there is a growing interest in getting large-load customers to sign long-term contracts to get them to cover on their own the cost of the electricity infrastructure they need. In practice, there is, however, the risks that poor contract design could still expose the historical users to the risk that the DC owner may decide to leave. An unanticipated early departure would leave the local utilities with stranded assets costs that will eventually be passed on to the historical users.

In sum, in the short run, under most scenarios, ignoring the potential business payoffs of a DC entry, the historical electricity users are likely to lose from the entry both in terms of consumption capacity and in terms of price if there is no explicit commitment by a regulator to protect them. This may only be a transitional effect of the demand shock but it is too politically sensitive to be ignored. And the promise of a stimulation of local business activities thanks to the new DC may not be convincing enough since in many cases these payoffs are shared with other regions or countries. The Asian and African authorities seem to be much more optimistic than the many regional or local European or American politicians at least in the predictable horizon. They seem to be betting on the long term predictions of the model, i.e. that an increase in capacity would mitigate the short-term price surge experienced by the historical local consumers. Their challenge will be not to underestimate the possibility of having to deal with the financing of stranded assets if the DC decides to leave the market. However, well-designed contracts should be able to deal with stranded assets concerns and comparable regulatory challenges.

From a process oriented perspective, the main message of this paper is that to make the most of the opportunities allowed by the DCs, it makes sense to conduct location specific assessments of the risks early on. Context matters indeed and understanding the context is a good starting point to decide whether the net surplus generated by the centers will be positive locally. It is also useful to adopt early on policies to minimize the local burden linked to the decision to allow a DC to invest locally. For instance, getting the DC to commit to finance the added electricity capacity production and transmission needs will often be a no-brainer. But this commitment is not risk free. A significant share of the financing will come from private equity investors. They tend to have relatively short horizons as they often bet on exits within 5-7 years. Even more relevant is the fact that they tend to try to concentrate ownership of DC, building quite diversified DC portfolios. This is turn implies increasing their bargaining power in any negotiation.

Ultimately, the fact that the effects of the demand shocks linked to the entry of data centers seems to have come as a surprise to many politicians and regulators leads to two additional more subtle policy conclusions.

The first is linked to the governance of the sector. The authorities may need to invest much more in building expertise on DCs to avoid both the risks of stranded assets and those linked to overestimation of the economic valuation of the generating capacity controlled by grid operators to maintain system reliability in real-time to minimize the probability of outages. This, in turn, requires hiring trading specialists in addition to the engineers, lawyers, and accountants who currently staff the agencies. This is necessary to allow the authorities to strengthen their bargaining position with the utilities as well as the owners of the DC. Better knowledge will allow the regulators to lead the negotiation rather than suffer it and being forced to catch up with only partial information that limits their ability to fine tune the pricing and financing of the sector. It will also allow a collaboration with other regulators anchored in shared common independent reliable information rather than partial or biased data.

The second is the need to recognize that we have a collective knowledge gap related to the pricing and financing complexity associated with the DC entry shocks as well as the challenges associated with the enforcement of good intentions. Closing this gap requires additional research, conceptual and empirical as well as trials of possible solutions conducted through regulatory sandboxes.[14] Decision-makers and researchers still fail to fully understand many policy relevant details driving the bargaining surrounding the entry of DCs. Yet, there is little time left to come up with an upgrade of the BAU approach to regulation in view of the speed at which electricity needs continue to grow with DCs and the explosive use of AI.

[14] For a detailed discussion of the use of sandboxes in regulatory settings, see Crampes and Estache (2025).

6 Appendix

6.1 Appendix A: Notations

q consumption of electricity by local household and business

$S(q)$ gross surplus from the consumption of q.

$S(q) = aq - b\frac{q^2}{2}$ quadratic specification: with $a > 0$ and $b > 0$.

p unit price charged to local household and business

$U(q,p) = S(q) - pq$ net surplus of local consumers

$\underline{S} \geq 0$ fallback value for local consumers during a round of negotiations.

$C_e(q_e, K)$ cost to produce the quantity of electricity q_e with the capacity K.

c_e unit operating cost

r unit capacity cost
$q_e = q$ pre-entry balancing constraint

$W(q,K) \stackrel{def}{=} S(q) - C_e(q,K)$ net social welfare before the entry of a DC

μ dual variable associated to the capacity constraint

L Lagrange function

Q output of the data center

Q_e electricity consumption of the DC: $Q = \delta Q_e$ with $\delta > 0$

$q_e = q + Q_e$ post-entry balancing constraint

P unit electricity price charged to the DC

$C(Q) = cQ$ production cost of Q with $c > 0$

$\Pi_G(Q)$ gross benefit from Q.

$\Pi_G(Q) = \rho(AQ - B\frac{Q^2}{2}) - cQ$ quadratic specification: with $A > 0$, $B > 0$

$0 \leq \rho \leq 1$ local social benefits of DC activity.

$\Pi(Q_e, P) = \Pi_G(\delta Q_e) - PQ_e$. Net benefit of the DC operator

$\underline{\Pi} \geq 0$ fallback value for the DC during a round of negotiations.

$\pi_e(q, Q_e, p, P) = pq + PQ_e - C_e(q + Q_e)$ benefit of the electricity producer

$\underline{\pi_e} \geq 0$ fallback value for the electricity producer during a round of negotiations.

$*$ identifies optimal values before DC entry

$\sim$ identifies optimal values after DC entry

N identifies the outcome of Nash bargaining

σ bargaining power of the DC in the two-player game

α bargaining power of the DC in the three-player game

β bargaining power of the electricity producer in the three-player game

6.2 Appendix B: Two-player game

The net profit of the electricity producer is

$$\begin{aligned}
\pi_e &= p_i Q_e + p^* q^* - c_e q_e - rK \\
&= p_i Q_e + p^* q^* - c_e(Q_e + q^*) - r(K^* + K_i) \\
&= p_i Q_e + p^* K^* - c_e(Q_e + K^*) - r(K^* + K_i) \\
&= p_i Q_e - c_e Q_e - rK_i \\
&= (p_i - c_e - r)\, K_i
\end{aligned} \tag{34}$$

and the data center profit is:

$$\begin{aligned}
\pi_D &= \rho(A\delta Q_e - B\frac{\delta^2 Q_e^2}{2}) - \delta c Q_e - p_i Q_e \\
&= \left[\rho(A\delta - B\frac{\delta^2 K_a}{2}) - \delta c - p_i\right] K_i
\end{aligned} \tag{35}$$

since Q_e cannot be larger than K_i and the DC has no interest in asking for an investment that it will not fully use. Consequently $Q_e = K_i$.

Since both the DC and the electricity producer have a zero profit if they disagree on K_i and p_i, the outcome of the bargaining process (Nash 1950) is the solution to

$$\max_{K_i, p_i} \pi_D^{\sigma} \times \pi_e^{1-\sigma}$$

where σ represent the bargaining power of the data center. Let x be one of the two decision variables. The FOC gives

$$\begin{aligned} 0 &= \sigma\pi_D^{\sigma-1}\frac{\partial\pi_D}{\partial x}\pi_e^{1-\sigma} + (1-\sigma)\pi_e^{-\sigma}\frac{\partial\pi_e}{\partial x}\pi_D^{\sigma} && (36)\\ &\implies \sigma\frac{\partial\pi_D}{\partial x}\pi_e + (1-\sigma)\frac{\partial\pi_e}{\partial x}\pi_D = 0 && (37)\end{aligned}$$

Applying (37) to capacity K_i, we obtain

$$\begin{aligned} \sigma\frac{\partial\pi_D}{\partial K_i}\left(p_i - c_e - r\right)K_i + (1-\sigma)\left(p_i - c_e - r\right)\pi_D &= 0\\ \sigma\left[\rho(A\delta - B\delta^2K_i) - \delta c - p_i\right]K_i + (1-\sigma)\left[\rho(A\delta - B\frac{\delta^2K_i}{2}) - \delta c - p_i\right]K_i &= 0\\ \sigma\left[A\rho\delta - B\rho\delta^2K_i - \delta c - p_i\right] + (1-\sigma)\left[(A\rho\delta - B\rho\frac{\delta^2K_i}{2}) - \delta c - p_i\right] &= 0\end{aligned}$$

$$\begin{aligned} &\implies B\rho\delta^2K_i\left[\sigma + \frac{(1-\sigma)}{2}\right] = A\rho\delta - \delta c - p_i\\ &\implies B\rho\delta^2K_i\left[\frac{\sigma+1}{2}\right] = A\rho\delta - \delta c - p_i\\ &\implies K_i = 2\frac{A\rho\delta - \delta c - p_i}{B\rho\delta^2(\sigma+1)} && (38)\end{aligned}$$

and applying (37) to the price p_i

$$\begin{aligned} \sigma\frac{\partial\pi_D}{\partial p_i}\pi_e + (1-\sigma)\frac{\partial\pi_e}{\partial p_i}\pi_D &= 0\\ -\sigma K_i\left(p_i - c_e - r\right)K_i + (1-\sigma)K_i\left[\rho(A\delta - B\frac{\delta^2K_i}{2}) - \delta c - p_i\right]K_i &= 0\end{aligned}$$

$$\implies p_i = \sigma\left(c_e + r\right) + (1-\sigma)\left[\rho\delta(A - B\frac{\delta K_i}{2}) - \delta c\right] \qquad (39)$$

Combining (38) and (39) results in

$$\begin{aligned} K_i^N &= \frac{A\delta\rho - (c_e + c\delta + r)}{B\delta^2\rho}\\ p_i^N &= \frac{A\delta\rho + r + c_e - c\delta - \sigma\left(A\delta\rho - (c\delta + r + c_e)\right)}{2}\\ &= \frac{(A\delta\rho - c\delta)(1-\sigma) + (1+\sigma)\left(r + c_e\right)}{2}\end{aligned}$$

6.3 Appendix C: Three-player game

We determine here the outcome of the three-player negotiation in which historical consumers are represented by a benevolent regulator or local government.

The respective bargaining powers of the DC, the electricity producer, and the authority representing local consumers are α, β, and $1-\alpha-\beta$. If negotiations fail, each of the three agents can count on a fallback gain equal to $\underline{\Pi}$,$\underline{\pi_e}$ and $\underline{S}$ respectively.

The bargaining game will determine (q, Q, p, P) to maximize

$$(\Pi(Q_e, P) - \underline{\Pi})^{\alpha} \times \left(\pi_e(q, Q_e, p, P) - \underline{\pi_e}\right)^{\beta} \times (U(q,p) - \underline{S})^{1-\alpha-\beta}$$

where

$$\begin{aligned}
U(q,p) &= aq - b\frac{q^2}{2} - pq = S(q) - pq \geq \underline{S} \\
\Pi(Q_e, P) &= \rho(A\delta Q_e - B\frac{\delta^2 Q_e^2}{2}) - c\delta Q_e - PQ_e = \Pi_G(Q) - PQ_e \geq \underline{\Pi} \\
\pi_e(q, Q_e, p, P) &= pq + PQ_e - (c_e + r)(q + Q_e) = pq + PQ_e - C_e(q + Q_e) \geq \underline{\pi_e}
\end{aligned}$$

with $S(q)$ defined in (1) and $\Pi_G(Q)$ the gross surplus of the DC, i.e. before paying the electricity bill.

Notice that, to simplify the problem, we assume $K = q + Q_e$.

6.3.1 Quantities

As we saw in section 4, quantities maximize the total surplus (here taking account of the fallback gains)

$$\begin{aligned}
TS &= U(q,p) - \underline{S} + \Pi(Q_e, P) - \underline{\Pi} + \pi_e(q, Q_e, p, P) - \underline{\pi_e} \\
&= S(q) + \Pi_G(Q_e) - C_e(q + Q_e) - \left(\underline{\Pi} + \underline{\pi_e} + \underline{S}\right)
\end{aligned}$$

At this stage, the problem is isomorphic to the one in section 3.3. Consequently, the solution is

$$q^N = \frac{a - c_e - r}{b} \tag{40}$$

$$Q_e^N = \frac{A\rho\delta - c\delta - c_e - r}{B\rho\delta^2} \tag{41}$$

and the total surplus to share is

$$TS^N = S(q^N) + \Pi_G(Q_e^N) - C_e(q^N + Q_e^N) - \left(\underline{\Pi} + \underline{\pi_e} + \underline{S}\right)$$

6.3.2 Prices

From section 4, we also know that prices will allocate this total surplus proportionally to the bargaining power of each agent.

Consequently, for the DC, we have

$$\Pi_G(Q_e^N) - \underline{\Pi} - PQ_e^N = \alpha\left[S(q^N) + \Pi_G(Q_e^N) - C_e(q^N + Q_e^N) - \left(\underline{\Pi} + \underline{\pi_e} + \underline{S}\right)\right]$$

$$\left(\Pi_G(Q_e^N) - \underline{\Pi}\right)(1-\alpha) - PQ_e^N = \alpha\left[S(q^N) - \underline{S} - C_e(q^N + Q_e^N) - \underline{\pi_e}\right]$$

$$\Longrightarrow P^N = \frac{\left(\Pi_G(Q_e^N) - \underline{\Pi}\right)(1-\alpha) - \alpha\left[S(q^N) - \underline{S} - C_e(q^N + Q_e^N) - \underline{\pi_e}\right]}{Q_e^N}$$

Similarly, for the local consumers

$$S(q^N) - \underline{S} - pq^N = (1-\alpha-\beta)\left[S(q^N) + \Pi_G(Q_e^N) - C_e(q^N + Q_e^N) - \left(\underline{\Pi} + \underline{\pi_e} + \underline{S}\right)\right]$$

so that

$$p^N = \frac{(\alpha+\beta)\left(S(q^N) - \underline{S}\right) - (1-\alpha-\beta)\left[\Pi_G(Q_e^N) - C_e(q^N + Q_e^N) - \left(\underline{\Pi} + \underline{\pi_e}\right)\right]}{q^N}$$

and for the electricity producer, the net gain is

$$\begin{aligned} & p^N q^N + P^N Q_e^N - (c_e + r)(q^N + Q_e^N) - \underline{\pi_e} \\ = \ & \beta\left[S(q^N) + \Pi_G(Q_e^N) - C_e(q^N + Q_e^N) - \left(\underline{\Pi} + \underline{\pi_e} + \underline{S}\right)\right] \end{aligned}$$

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