

What do electricity production and consumption data tell us about economic activity during lockdown?

Daily electricity production and consumption data for France are a useful source for monitoring changes in business and household activity in real time. Electricity consumption in particular reflects changes in behaviour as a result of the Coronavirus crisis – whether in the decline in production in electricity-intensive sectors, such as transport, or in the transformed lifestyle of households in lockdown.

Since climate and seasonality have a significant effect on electricity production and consumption, time comparisons are made only after adjustment for the effects of variations in temperature, working days and months of the year.

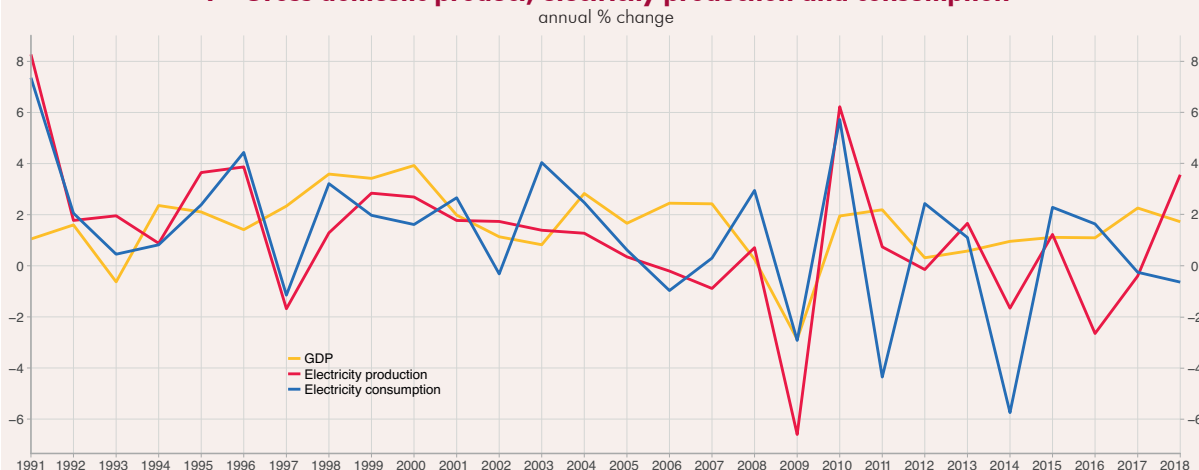
According to data from RTE (Electricity Transmission Network), total consumption for the period from 23 March to 26 April 2020 was 14% less than in a normal period. Electricity consumption by businesses connected directly to RTE (mostly large industrial companies) was down 24%, which is relatively consistent with the order of magnitude of the estimated decline in activity. During the period from 23 March to 3 April, according to data from Enedis, consumption excluding the residential sector (companies –excluding those connected directly to RTE– and the public sector) was about 27% less than normal, whereas consumption by households was about 4% more.

Because of the link between electricity production and GDP, the main activity shocks can be monitored in real time, especially during crises

Electricity data are available in real time and are among the first sources of information to be used to analyse the working of the economy. As electricity is one of the forms of energy that is used most in the production process, variations in its production and consumption reflect major changes in gross domestic product (GDP, [Graph 1](#)).

The 2008-2009 crisis provides an illustration of the way electricity production or consumption data are able to record changes in activity. Between 2008 and 2009, France's GDP declined by 2.9%. During this period, electricity consumption also fell by 2.9%. In fact, delivery data for high voltage electricity (which cover about 20% of total consumption and concern only the production sector) are available on a daily basis as they are produced directly by the electricity distribution management systems. These data are aggregated monthly and during the crisis they showed a fairly similar dynamic to that of the GDP, which is not available in real time but only several months later ([Graph 2](#)).

1 - Gross domestic product, electricity production and consumption



How to read it: between 2008 and 2009, GDP fell by 2.9%, electricity production by 6.6%

Sources INSEE, RTE, SDES

Box

1. Data

RTE (Electricity Transmission Network) is the French transmission system operator. RTE carries electricity between suppliers (French and European) and consumers, whether they are electricity distributors or industrial companies connected directly to the transmission network. RTE has:

- aggregated data on production and consumption: from January 2012, RTE's aggregated data measure immediate values (in MW) for national electricity production and consumption every 15 or 30 minutes, and thus a daily average can be calculated;
- provisional values for withdrawals by customers with direct connections, which represent about 15% of consumption in Metropolitan France: from 1st January 2020, daily data on the electricity they consume are available according to the different sectors of economic activity. These customers are the largest consumers of electricity, and may not be representative of all businesses in the sector.

These data are freely available at <https://opendata.reseaux-energies.fr>.

Enedis is the main distributor of electricity (80% of consumption in Metropolitan France). The data used in this focus were provided by Enedis, and cover the period from July 2018 to April 2020. They correspond to the dynamic profiling of consumption by all customers on the Enedis network.

These data estimate the electricity used by three types of user on a daily basis, according to their subscribed power supply:

- residential, less than 36 kVA (residential use), corresponds to about 45% of consumption.
- non-residential with low subscribed power (non-residential contracts for subscribed power ≤ 36 kVA excluding public lighting), corresponds to about 10% of consumption.
- non-residential with high subscribed power (non-residential contracts for subscribed power > 36 kVA), corresponds to about 45% of consumption.

In addition, temperature data from Météo France were used to calculate "unified degree-days" (DJU) on a daily basis, using the formula:

$$DJU = \begin{cases} 17^\circ C - \text{average temperature} & \text{if } > 0 \\ 0 & \text{otherwise} \end{cases}$$

where the average daily temperature is the average of the daily minimum and maximum temperatures.

2. Methodology

Using this method, series can be adjusted for the effects of working days, variations in temperature, and months. Aggregated data by sector of customers connected directly to RTE are only available from 1st January 2020: only the working days adjustment is applied to these data.

We first estimate the coefficients of the following regression based on all the data available for the "pre-pandemic" period (before 25 February 2020, start of the variable period depending on the series).

$$Y_j = X_j \beta + \epsilon_j$$

$$= \beta_1 + \beta_2 \cdot DJU_j + \beta_3 \cdot 1^{JO}_j + \beta_4 \cdot 1^{MOIS}_j + \epsilon_j$$

Y_j is electricity consumption on day j . The explanatory variables (X) are the average daily temperatures transformed into unified degree-days (DJU), dummies for days of the week (whether working days or not, JO) and months (MOIS). For the series by sector, only the working days dummy is kept.

The coefficients are then used to calculate the predicted consumption for each day (including during lockdown). The variations shown on the graphs correspond to the residue of the previous equation (difference between observed value and predicted value) compared to the predicted value. They can therefore be interpreted as a percentage deviation from the value that would have been observed, all else being equal.

The effect of the lockdown is then estimated from the ratio of the sum of these residues to the sum of the predicted values from 23 March 2020¹. ■

1. The week of 16 March, first week of lockdown, is excluded as it produced behaviour involving a gradual adjustment and is therefore not representative.

Electricity production and consumption have fallen in France since the start of lockdown

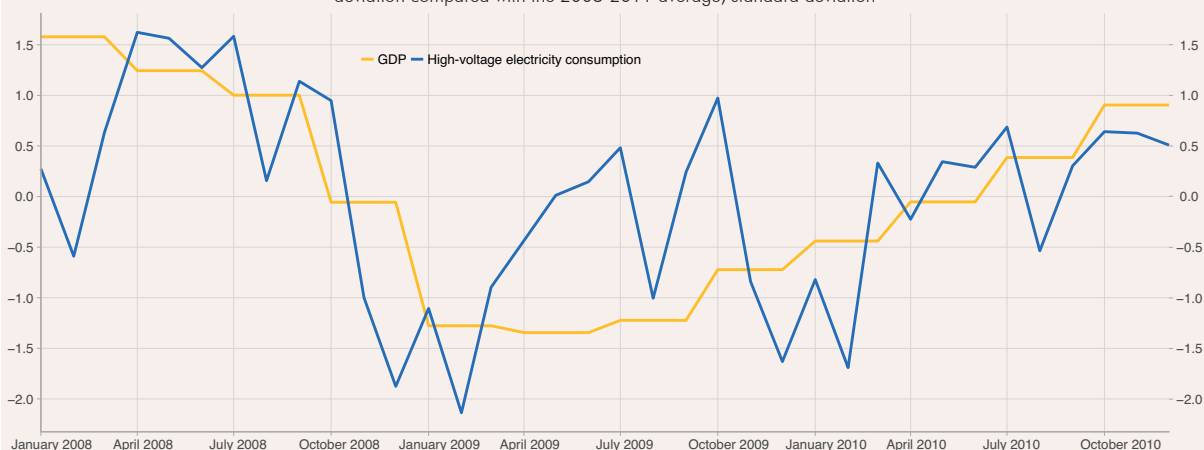
Between 23 March and 26 April, excluding the effect of the climate and working days (*Box*), electricity production was 12% lower on average than in a “normal” period of activity, and electricity consumption by businesses, households and the public sector was 14% lower (*Graph 3*). The drop was greater in consumption because of the possibility of exporting and importing electricity: in fact, national consumption accounted for 87% of production in 2019, with the rest of the electricity output being exported mainly to neighbouring countries (Germany, Belgium, Spain, United Kingdom, etc.).

Although electricity consumption declined a little more than production, it shows a broadly similar trend: in March especially, after slight growth at the beginning of the month, consumption began to fall sharply on 12 March. It reached a low point at the end of the first week of lockdown, which had begun on 17 March; subsequently, behaviour seemed to stabilise and a small increase was visible in April despite a few occasional dips at the beginning of the week of 20 April.

Production was hampered by a drop in demand, due to the measures taken to combat the epidemic – notably the partial shutdown of activity as a result of the lockdown – and the disruption of global production chains. Meanwhile, consumption behaviour differed between businesses and households.

2 - Consumption of high voltage electricity and GDP during the 2008 crisis

deviation compared with the 2008-2011 average, standard deviation



Electricity consumption not seasonally adjusted, or working day and temperature adjusted; GDP SA-WDA

Note: in February 2009, high voltage electricity consumption was 2.1 standard deviations less compared with its average between 2008 and 2011. In Q1 2009, GDP was 1.3 standard deviations less compared with its average over the period 2008-2011.

Sources : Insee, SDES, RTE, Enedis, calculs Insee

3 - Levels of electricity production and consumption adjusted for temperatures, working days and months

deviation from average level (%)



How to read it: on Wednesday 1st April 2020, electricity production was 6% lower than the average production level for a Tuesday in April with an identical average temperature to that recorded on this day. This average was estimated over a period from 1st January 2012 to 24 February 2020.

Sources: RTE, INSEE calculations

Consumption excluding the residential sector dropped sharply overall (about -27%)

The electricity consumption data published by Enedis cover 80% of electricity consumption in Metropolitan France. They are broken down by type of consumer: non-residential (businesses/public sector) and residential (households). In addition, among the non-residential, the subscribed power level provides an extra analysis criterion, differentiating between non-residential with a high subscribed power level (large entities or where activity is relatively electricity-intensive, e.g. industrial sites), and non-residential with a low subscribed power level (smaller entities or where activity is relatively light in electricity).

In general, businesses use electricity as an intermediate consumption to power their machines, and to light and heat their premises. In a normal period of activity, consumption in non-residential businesses with a low subscribed power level is more affected by temperatures than that in non-residential businesses with a high power subscription level, as they use electricity more for industrial output than for occupation of the premises. For all of these businesses, daily consumption is higher on working days than at the weekends – a seasonality that has changed as a result of lockdown (with a smaller increase in consumption being observed on weekdays).

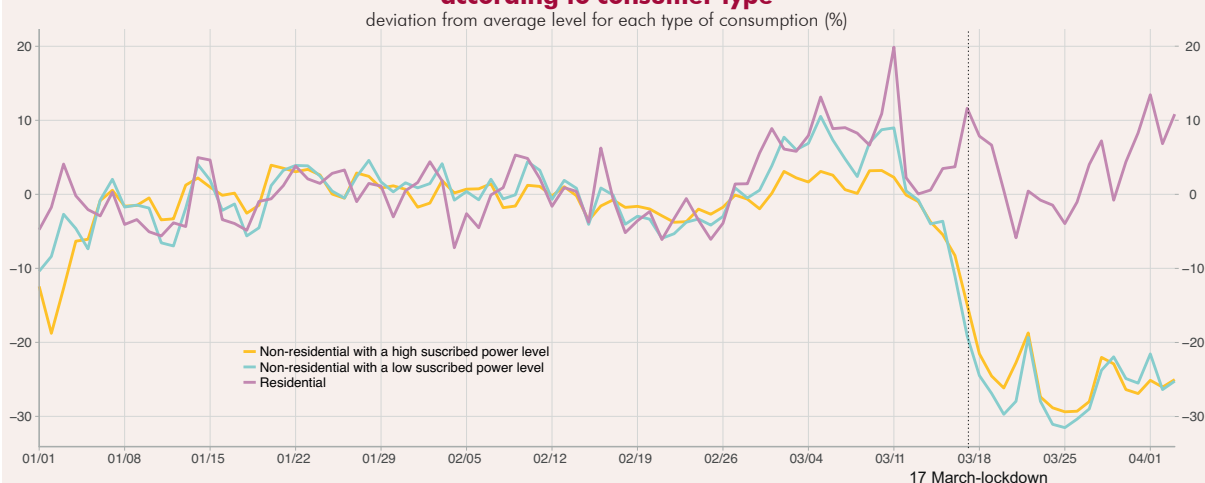
Over the period 23 March to 3 April, electricity consumption for the whole non-residential sector was on average 27% less than in a normal period (*Graph 4*). It fell rapidly after 17 March, then stabilised with fluctuations around a lower level. The non-residential sector with a high subscribed power level was certainly affected mainly by the drop in production activity, and the sector with a low subscribed power level by the cessation of non-essential activities.

Electricity consumption only of companies connected to RTE shows a sharp drop in transport and, to a lesser degree, in industry

The disparities in consumption by companies according to sector of activity were greater than those observed according to subscribed power level. And more specifically, during lockdown, changes in consumption level differed considerably according to sector.

Using RTE data gives an initial estimate of the effect of lockdown for some sectors of activity (those for which a certain number of companies, which are not necessarily representative, are connected directly to the network). Electricity consumption between 23 March and 26 April, compared with the earlier period, reveals some significant sectoral disparities (*Graph 5*). The drop in consumption is particularly strong in the transport and storage services sector (-58%), for an estimated decline in activity of -59% on 7 May, which can be explained by the strong reduction in activity by SNCF and RATP in particular. The drop in electricity consumption was less than that estimated for activity in the specialised, scientific and technical activities sector (-25% in electricity consumption for an estimated drop in activity of -44%) and in the manufacturing industry (-18% for electricity and -38% for activity). Electricity consumption fell a little less in the water production and distribution sectors (-14%), and the electricity, gas, steam and air conditioning sectors (-10%). Finally, in the extractive industries and the information and communication sector, electricity consumption was virtually stable. Differences between the decline in activity and the decline in electricity consumption were due to the fact that companies connected

4 - Levels of consumption adjusted for temperatures, working days and months according to consumer type



How to read it: on Wednesday 1st April 2020, electricity consumption by Enedis customers with the profile of a non-residential consumer with a high subscribed power level was 25% less than the average consumption level for a Tuesday in April with an identical average temperature to that recorded on this day. This average was estimated over a period from 1st July 2018 to 24 February 2020.

Sources: Enedis, INSEE calculations

directly to the network were not representative of the sector, either in the intensity of their electricity use, or in the effect of lockdown on their consumption.

From the intensity of electricity consumption in the branches it is possible to make the link between the decline in activity and the decline in electricity consumption

Sectoral disparities in reductions in electricity consumption are a good reflection, in their scale, of disparities in losses of activity. However, the relationship between activity and electricity consumption can be refined by taking into account the intensity of electricity consumption in companies, which in fact varies strongly depending on the branch. If we assume that at the level of each branch, intermediate consumptions make up a fixed share of production, and that within these consumptions electricity is also a fixed share, a loss of value added results in an identical decline (in relative terms) in electricity consumption. Thus the overall drop in electricity consumption (for all branches) is due to the drop in electricity consumption in each branch, which can be assumed to be equal to the decline in branch activity:

$$\text{Growth rate } IC^{\text{electricity}} = \sum_{\text{branches}} IC^{\text{electricity}}_{\text{branch}} / IC^{\text{electricity}}_{\text{all branches}} \times \text{Activity growth rate}_{\text{branch}}$$

The total decline is calculated across all branches at a detailed level (138 branches), and gives an estimate of the drop in electricity in the productive sector of -23%. The overall decline in activity (estimated at -33%) is therefore greater than its impact on the consumption of electricity as an intermediary consumption.

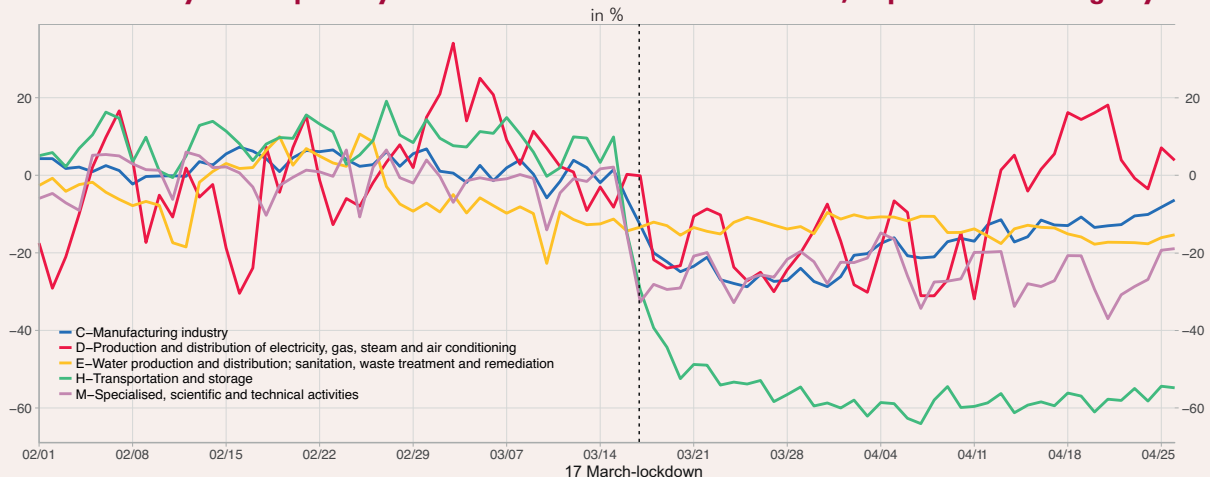
Some very electricity-intensive sectors (manufacture of chemical products – C20A, steel industry – C24A and transport – H49A) have experienced substantial declines in activity. But these effects are more than offset by sectors where activity has also declined but which are not very electricity-intensive and which weigh heavily in value added (construction work – F43Z, human health activities – Q86M and activities linked with employment – N78Z).

This decline in consumption in the productive sector obtained from the decline in activity is consistent with that estimated from electricity data which was -24% over the same comparison period.

Lockdown has altered household behaviour, with electricity consumption up by about 4%

Among Enedis customers, “residential” consumption, with a low subscribed power level, corresponds to electricity consumption by households. It is generally affected by temperature more than consumption by companies, as electricity is mainly used to supply heat and light at the coldest times of day and when there is least sunshine.

5 - Electricity consumption by sector for customers connected to RTE, adjusted for working days



How to read it: on Tuesday 17 March 2020, the first day of lockdown, electricity consumption by manufacturing industry companies connected directly to the electricity network was 13% lower than the average level of consumption for a Tuesday. Only sectors with a decline of more than 2% are shown on the graph. Sources: RTE, INSEE calculations

Its weekly profile is the reverse of that for companies, as it is higher during the weekend than during the week. However, once again, this seasonality has been less evident during lockdown.

From 23 March to 3 April, household consumption was slightly higher (about +4%) than during a normal period (*Graph 4*). After an increase at the beginning of March, it peaked in the first week of lockdown, then subsided a little and increased once again at the beginning of April. Different factors can be distinguished, with both upward and downward effects, but the upward effect prevails overall:

- households in lockdown heat and light their homes more (+);
- they eat at home, which results in increased use of electrical appliances, especially for cooking food (+);
- they also use digital technology more in order to work remotely, obtain information or entertain themselves (+);
- family grouping at home, especially with students and young people returning to their parents' home, has led to economies of scale and has reduced the overall need for heating (-);
- lockdown has led to a different distribution of the population across the country: winter ski resorts have closed and some city dwellers have left to go to their second homes, thus increasing the share of the population in regions with milder temperatures and potentially changing the type of heating energy (-). ■

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