Electricity Consumption as a Near Real-time Indicator of COVID-19 Economic Effects

BY BEN MCWILLIAMS AND GEORG ZACHMANN

The COVID-19 health crisis and associated lockdowns are clearly having huge economic impacts. Economic activity has been impacted by both demand and supply reductions. Understanding the relative size of such effects is important for policymakers at the national and European level. However, real time trackers of economic activity are hard to come by. GDP figures are typically released only on a monthly or quarterly basis.

Data on national electricity consumption are released daily and can be manipulated to offer some indication as to the size of the ongoing economic disruption in different countries. This is possible because so much modern economic activity has become reliant on the use of electricity. Significant drops in average daily electricity consumption of around 20% occur on weekends and during public holidays when large parts of the economy are shut down.

Using electricity demand data from available European countries as well as Russian regions, we are able to track how consumption has evolved in response to national lockdown measures. Results generally confirm the expected effects. Effects are quite dramatic in Italy, with some of the harshest lockdown measures, whilst effects are almost negligible in Sweden where lockdown measures have not seriously been implemented.

Methodology

Electricity demand will be affected in myriad ways by the crisis. Industrial demand will decrease due to the forced or voluntary closure of many manufacturing plants. Moreover, shops, restaurants, bars, pubs, and other operations within the services sector have been forced to shut down.

On the other hand, there may be a slight increase in household electricity demand as a result of people spending more time at home. For example, an increase in internet usage from video calling might contribute to increased consumption.

	2020	2019
Week 1	2nd March - 6th March	4th March - 8th March
Week 2	9th March - 13th March	11th March - 15th March
Week 3	16th March - 20th March	18th March - 22nd March
Week 4	23rd March - 27th March	25th March - 29th March
Week 5	30th March - 3rd April	1st April - 5th April
Week 6	6th April - 10th April	8th April - 12th April
Week 7	13th April - 17th April	15th April - 19th April

Table 1: Comparison of weeks

Ben McWilliams and **Georg Zachmann** are with Bruegel. Zachmann can be reached at georg.zachmann@bruegel.org

We are interested in better understanding the effects on economic activity. We focus on peak-hour consumption (08:00-18:00) because this is when most economic activity would normally take place. We consider only working days, ignoring weekends and removing any public holidays from the sample. The few resulting missing values are interpolated over.

We calculate an average consumption across peak hours. We compare this directly with the corresponding day from 2019 to compute daily ratios. For weekly ratios, average peak consumption across each week in 2020 is compared with the corresponding week in 2019 as shown in table 1.

Confounding factors

Other underlying factors influence demand, in addition to COVID-19. Temperature is perhaps the most important. In particular countries, a significant share of space and water heating is electric and one would expect significant fluctuations depending on daily temperatures. We therefore adjust average peak values from each year by the temperature differential.

In order to understand the relative effects of temperature on peak consumption for each country we ran bivariate regression analyses. We took a sample of winter months from the past two years and regressed average daily temperatures on average peak consumption. This provided us with the slope coefficients listed in Table A1 (appendix). These coefficients were used to adjust values from 2020, depending on the temperature differential with the corresponding day from 2019.

One complication that arises from our data is that Entso-e provides the actual total load on the transmission grid. This means that any generation produced within distribution grids or "behind-the-meter" appears in the data as a reduction in demand. Given that we compare 2020 to 2019, the difference this makes should be largely removed. However, for certain countries, there may have been slight increases in distributed generation year-on-year. This would exert a small downward pressure on presented ratios. The effect may be larger on particularly sunny or windy days when solar panels and wind turbines within distribution grids produce a larger share of overall consumption. Slight disturbances to day-to-day variation may thus result. It is more unlikely that weekly reported figures would be influenced by this.

Data sources

We take data on 'actual total load' from the Entso-e transparency platform. We take temperature measurements from the National Centers for Environmental Information, selecting the best covered weather station from each national capital. For Russia,

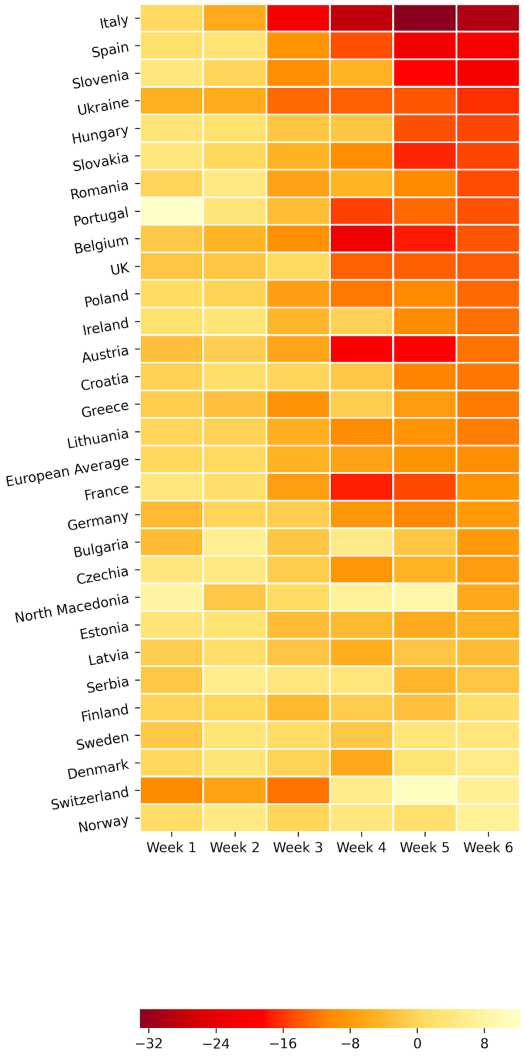
both data on load and temperature are taken from The Unified Energy System of Russia. We also take data on national public holidays from available online sources, and these dates are excluded from national analysis.

Results

Europe

Figure1 provides an overview of how electricity consumption has evolved in Europe since 2nd March 2020. Each coloured cell represents consumption in a week from 2020 relative to consumption from 2019 once adjusted for temperature. The range of differences are from -32% change to a positive 8%

Figure 1: European electricity consumption % change relative to 2019



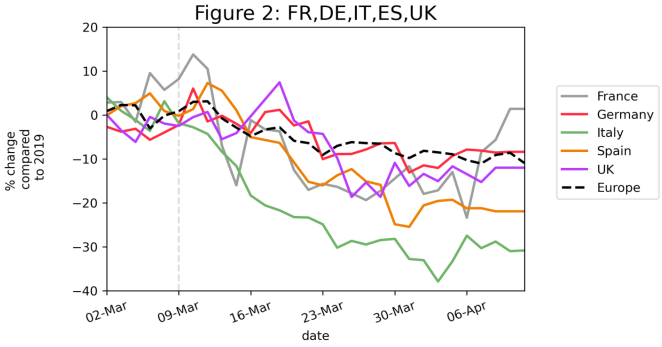
change. The figure is ordered according to the largest relative reduction in demand during the most recent week, as of publication, week 6.

Figures 2-4 show the daily evolution of electricity demand for selected European countries. Common features in all graphs are the dashed line on the 9th March representing when President Conte of Italy imposed a national quarantine. Other European countries reacted at different speeds and imposed lockdowns at later dates. Everything before the dashed line can be assumed to be pre any lockdown measures. The 'Europe' plot represents average electricity consumption across all considered countries.

There are certain unusual spikes in countries' demand. This can be explained by some of the factors outlined above: for example, on certain (sunny and windy) days the share of consumption may shift significantly between the distribution and transmission grid. Moreover, our method of temperature adjustment improves accuracy but is not perfect. It may cause some overcompensation of demand, e.g., France on the 8th and 9th March (our temperature adjustment likely overcompensates for the fact that the temperature was much hotter on those days than in 2019). Such fluctuations are why we believe weekly averages are a better indicator of how large effects are. Using electricity demand to track daily effects is certainly appealing but it appears more robust to do so on a weekly basis. Nonetheless, daily data provide an insight into how countries immediately reacted to their lockdown measures.

Figure 2 shows demand for France, Germany,

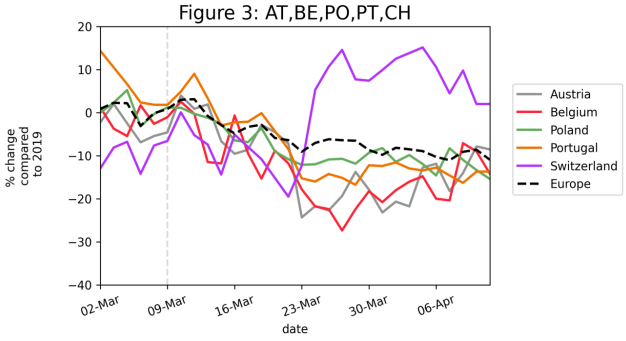
Figure 2: FR,DE,IT,ES,UK



Italy, Spain, and the UK. Italian electricity demand has been the worst affected, consistently 30% below 2019 levels. Spanish demand has trended to around a 20% reduction since lockdown measures. Lockdown measures in the UK were introduced between 20th and 23rd March. Before those dates, demand had not responded much at all to the COVID-19 crisis. Post 22nd March, UK demand reacted sharply dropping to levels of 15% below 2019.

Figure 3 shows Austria, Belgium, Poland, Portugal, and Switzerland. The first four all follow a standard

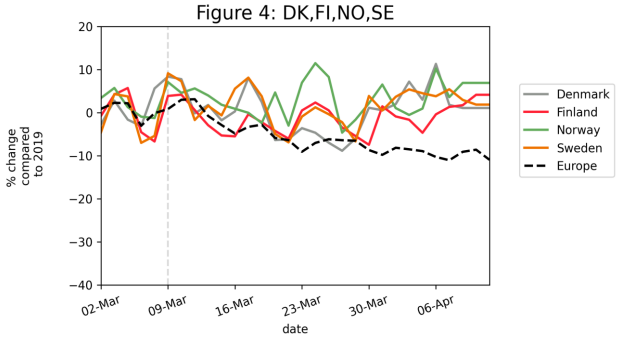
Figure 3: AT,BE,PO,PT,CH



response with demand decreasing in line with lockdown measures. Switzerland is an unusual case were demand does not appear to have been negatively impacted by the COVID-19 crisis.

One interesting development has been the lack of any reduction in the Nordic countries of Denmark, Finland, Norway, and Sweden as shown in figure 4.

Figure 4: DK,FI,NO,SE



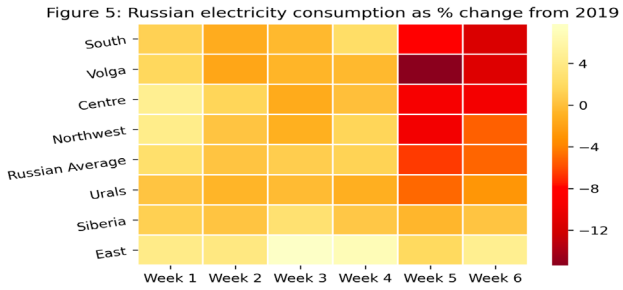
Sweden has been a relative outlier among European countries without announcing any severe lockdown measures. However, the other Nordic countries have not experienced any significant reductions in electricity demand in spite of implementing their own lockdown measures.

The overall European line represented in all figures shows that European demand has been approximately 10% below 2019 from 16-March until the end of our current sample.

Russia

Figure 5 focuses upon Russia regions. Russia

Figure 5: Russian electricity consumption as % change from 2019



declared lockdown slightly later than European countries. On the evening of March 29th, lockdown measures were announced for Moscow which were then gradually extended to the rest of Russia. Initially, a 'non-working' week had been announced but measures were quickly scaled up. The following Monday 30th corresponds to week 5 in our data. The immediate effects are very clear. In western Russian regions, there was a drop in electricity consumption of around 10%. Regions further to the east did not experience the same shock.

Figure 6: Russian regions

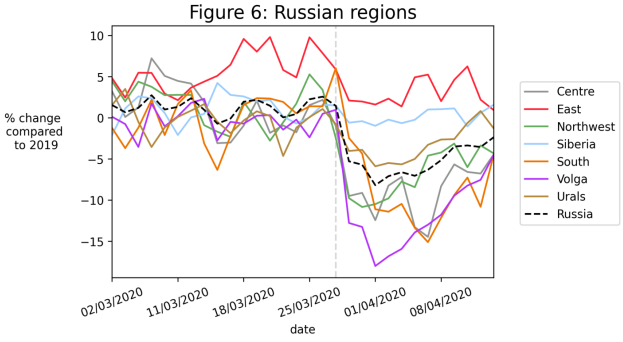


Figure 6 provides a closer look at Russian regions on a daily basis. The shaded line on 27/03/2020 shows the last day before lockdown measures were imposed. There is an immediate reaction in all regions. Demand in the Volga region appears to drop the most by about 15% before gradually recovering over the next week. The next most affected region appears to have been the South region. The black shaded line shows the average reduction across all Russian regions. Interestingly, many Russian regions appear to be increasing consumption again after the initial sharp drop. However, it is perhaps too soon to read too much into this.

Concluding remarks

In many European countries, as well as Russian regions, electricity demand has reacted sharply to the announcement of COVID-19 lockdown measures. There are certainly difficulties associated with a comparison of electricity consumption between years. Yet, the indicator is certainly revealing and can be utilised by policymakers in order to better understand the size of economic shocks which countries are currently facing. Over the coming weeks and months, electricity demand will continue to play a key role in estimating economic disruption and particularly how well economies are able to recover and move out of lockdown mode.

Appendix

Country	Change in peak consumption (MW) for a 1 degree Celsius increase	Country	Change in peak consumption (MW) for a 1 degree Celsius increase
Austria	-104	Portugal	-88
Belgium	-103	Romania	-92
Bulgaria	-112	Serbia	-85
Croatia	-28	Slovakia	-33
Czechia	-104	Slovenia	-17
Denmark	-55	Spain	-350
Estonia	-18	Sweden	-393
Finland	-176	Switzerland	-90
France	-1726	Ukraine	-291
Germany	-331	UK	-610
Greece	-154		
Hungary	-54	**Russian Regions**	
Ireland	-29	Centre	-276
Italy	-306	East	-59
Latvia	-10	Northwest	-131
Lithuania	-15	Siberia	-160
North Macedonia**	-13	South	-207
Norway	-305	Urals	-170
Poland	-165	Volga	-98

Table A1: Change in peak consumption for a 1 degree Celsius increase estimated by country