Sparking Change

electricity consumption, carbon emissions and working time

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Contents

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1 Context: Reduced working hours are back on the policy and research agenda

Over the past few years, working time reduction has been brought firmly back onto the policy agenda. Alongside Autonomy's own report from February 2019, the Labour Party commissioned a report from the Progressive Economy Forum led by Lord Skidelsky, the New Economic Foundation have been contributing useful analysis, and working time features in some of the more ambitious IPPR papers of the past year.[1] Alongside policy work, the 4 Day Week Campaign in the UK is flourishing, with similar campaigns emerging in Ireland, Germany, the United States and elsewhere.[2]

As those documents identify, a shorter working week offers many advantages to workers, to health services and to employers. But reducing working hours also has an ecological utility that is there for the taking. The IPCC's 'Emissions Gap Report' makes it clear that nations must reduce emissions by 7.6 per cent per year from 2020 to 2030 to achieve the goal of keeping temperature rises at a maximum of 1.5°C and 2.7 per cent per year for the 2°C goal.[3] In these times of climate crisis, the idea of reducing the workweek is a potential means by which we can mitigate climate change by reducing carbon emissions.

In 2006, Rosnick and Weisbrot found that simply reducing American working hours down to European levels would have lowered US emissions by at least by 7%.[4] In 2007, the state of Utah conducted a test:[5] thousands of state employees switched to a 4-day (albeit preserving the 40-hour) workweek and found that this lead to significant energy savings, mostly due to a reduced need for AC (longer workdays meant working later in the day, when temperatures have already cooled down a bit), as well as lower carbon emissions, as a result of greatly reduced traffic on one day. Utah abandoned the experiment in 2011.[6]

More recently, Autonomy ran a thought experiment to show what level of working time reduction would be necessary in order for our carbon-intensive economies to be environmentally sustainable (i.e. in line with internationally-recognised carbon budgets).[7] That paper found that the average working week in the UK would have to be no more than nine hours per week in such a scenario, where no other variable changed. In their paper from June 2019, Fremstad, Paul and Underwood demonstrate a strong correlation between households with longer working hours and the carbon consumption of these households.[8] Working time (and its increase) proved to be a stronger indicator of unsustainable consumption than (higher) wages.

1 Harper, A. and Stronge, W. eds. (2019); New Economics Foundation (2019); Parkes, H., Rankin, L., Roberts, C., Statham, R. (2019); Skidelsky (2019)

2 See: https://www.4dayweek.co.uk/

3 IPCC (2019)

4 Rosnick, D., Weisbrot, M. (2006), 'Are Shorter Work Hours Good for the Environment? A Comparison of U.S. and European Energy Consumption', Center for Economic and Policy Research.

5 Peeples, L. (2009) 'Should Thursday Be the New Friday? The Environmental and Economic Pluses of the 4-Day Workweek'

6 Jamieson, D. (2011) 'Jon Huntsman's Four-Day Workweek Experiment Comes to End in Utah'

7 Frey, P. (2019) 'The Ecological Limits of Work'

8 Fremstad, A., Paul, M. & Underwood, A. (2019) 'Work Hours and CO2 Emissions: Evidence from U.S. Households'

2 Research question and method: Would a four-day week in the UK lead to less electricity consumption and/or fewer carbon emissions?

In this paper we will focus on electricity consumption to discover what the effects of a shorter working week would be in this regard. Using data on electricity generation and consumption we will consider what the effect would be of adding an extra weekend day or bank holiday onto the week (i.e. subtracting a working day). For our case study we chose to study winter periods (where we would expect higher electricity use) and summer periods (where we would expect lower use). This gives us a variety of data that cover the poles of the UK's climate. We used data for every day in the past years, from Jan 1st 2015 to Dec 31st 2019.

All electricity data come from the European Network of Transmission System Operators (ENTSOE).

3 Estimating energy savings

In order to estimate energy savings, first we must look at the consumption, commonly called the "load" (see Chart 1)

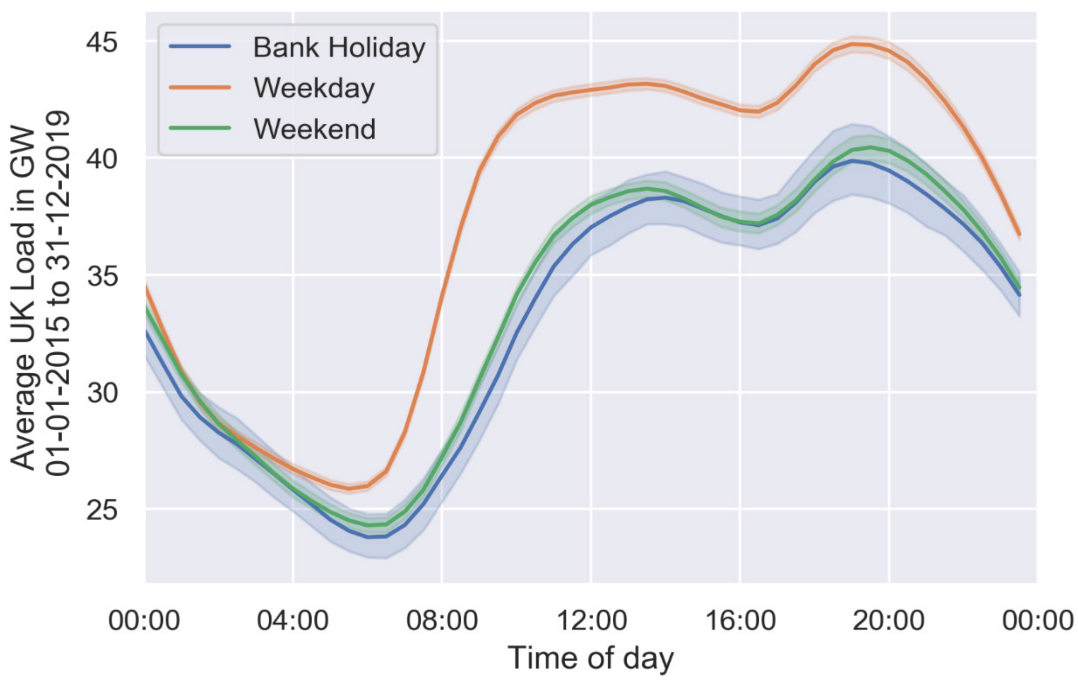

Chart 1: Average UK electricity demand (in GW) across the test period January 2015 through til December 2019 on weekdays, weekends and bank holidays, mapped across the time of day. Source: ENTSOE

In the above chart, we have plotted the total electricity demand on a typical weekday, weekend day and bank holiday, as it changes throughout the day. This is called a 'load curve'.[9]

9 The load curve was found to be consistent from year to year as well as across all five years.

The UK's total electricity load fluctuates between 20 and 45 GW of electric power. We can see that UK consumption follows daily working patterns, as the 9 to 5 workday shows up very clearly. Demand is at its absolute peak at tea-time (approx. 18:00 – 19:00), but the curve exhibits the typical double peak form, with another spike around midday. The population typically rises 2-3 hours later on the weekends, but tea-time – and the maximum energy consumption at this time - is preserved. However, overall consumption is lower by 10% on weekends. On the 30 bank holidays in our study period, consumption dropped, on average, by a further 2%.

However, the variance on these days – that is the "spread" of the data – is much larger. We must therefore look into the seasonal variations, which will have an impact in this regard.

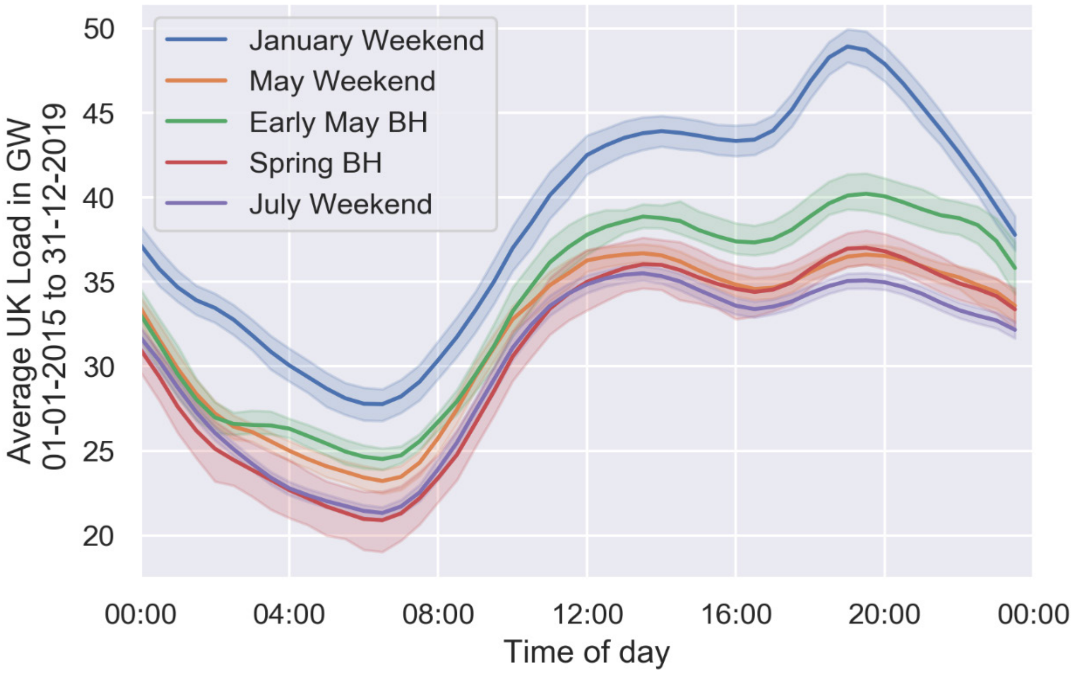

Chart 2: Average electricity load across the test period January 2015 through til December 2019 on weekends and bank holidays, mapped across the time of day.
Source: ENTSOE

There are obvious differences between an average January and an average May or July day – due to variances in lighting and heating (and perhaps cooling) demand. However, when looking at the two May bank holidays (see Chart 2), we can see that the 5 Early May Bank Holidays were above the average May weekend day in terms of consumption (+5% overall). Meanwhile, the 5 Spring Bank Holidays (end of May) were below the average May weekend in terms of consumption between midnight and 1pm and more or less matched it for the rest of the day (-4% overall). On average, across the five years, the difference between bank holidays and weekends in terms of consumption is less than 2% (9.97% less consumption on weekends and11.56% for bank holidays). As weekends are regular days off (whereas bank holidays are exceptional), we will use the rounded weekend figure of 10%.

In terms of consumption then, a 4-day workweek would then effectively mean a 3-day weekend Since on our average weekend days we consistently consume about 10% less energy, we would expect energy savings of around this number should a four-day week be enacted across the economy (this figure is similar to the estimates from Utah's experiment, after adjusting for the difference in actual working hours).

4 Sources matter

To estimate the true cost and emissions savings however, we must look at the sources of energy production – as the availability, utilisation, and hence cost of the various energy sources changes throughout the day.

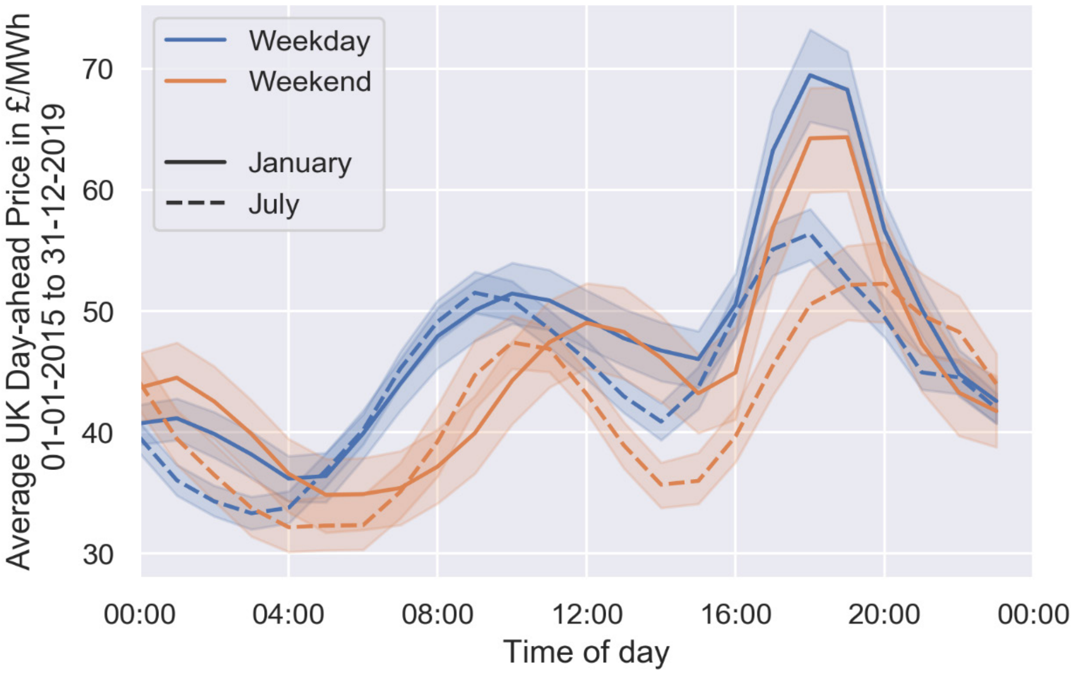

Chart 3: Average UK day-ahead price of megawatt hours across the test period January 2015 through til December 2019 on weekdays, weekends, mapped across the time of day. Source: ENTSOE

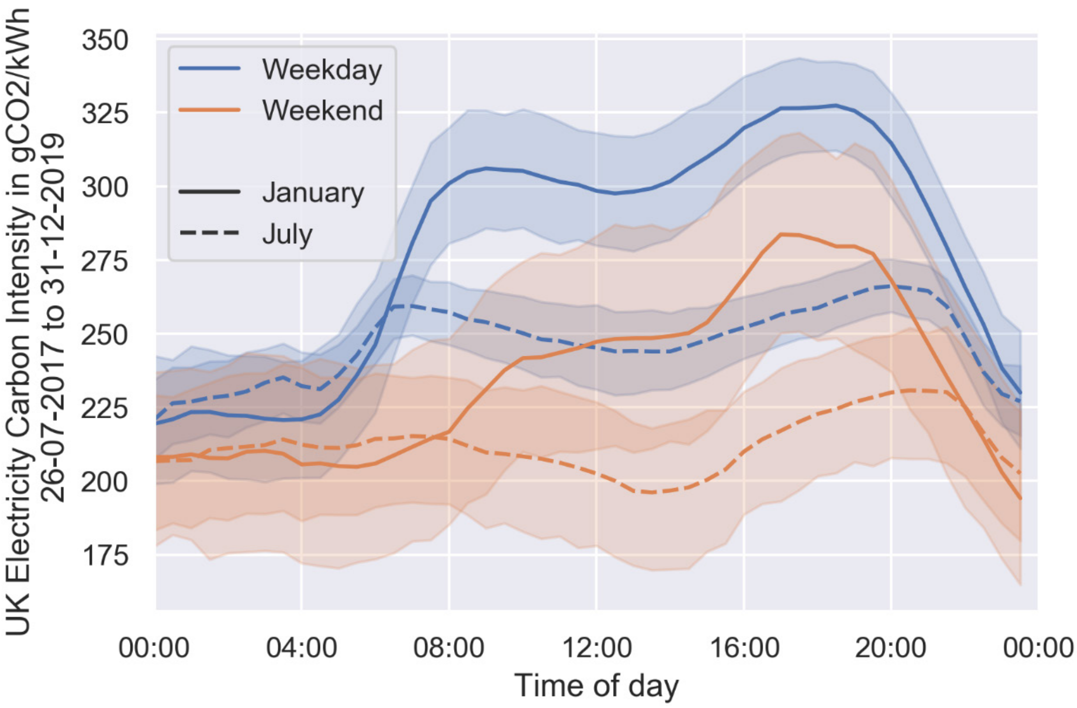

Chart 4: UK carbon intensity in CO2/kWh in January and July, mapped across the time of day. Source: National Grid ESO, available time period is Jul 26th 2017 – Dec 31st 2019.

As one might expect, prices (as per the European wholesale market, day-ahead, GB bidding zone) closely follow the demand, with a comparative difference between weekday or weekend tariffs. However, there is a very significant difference in terms of carbon intensity. The rule of thumb here is that the higher we are in terms of absolute electricity demand, the more emissions-intensive is the source that we are using. That is because currently the EU mandates the dispatch of cleaner energy sources, such as renewables, first.[10] While this might change in the future, what this currently means is that renewables enjoy an advantage when it comes to fulfilling demand, *regardless* of their price. This leads to the situation where, while this directive is still in effect, lower demand will always mean fewer emissions in absolute and relative terms (as long as we are always using less emissions intensive sources such as renewables *before* more emissions intensive ones, like fossil fuels – as is currently mandated). In fact, in our study period, we can see that British electricity was, on average 15% less carbon intensive on January weekends than on January weekdays and 14% less carbon intensive on July weekends than July weekdays (see Chart 5 and Chart 6).[11]

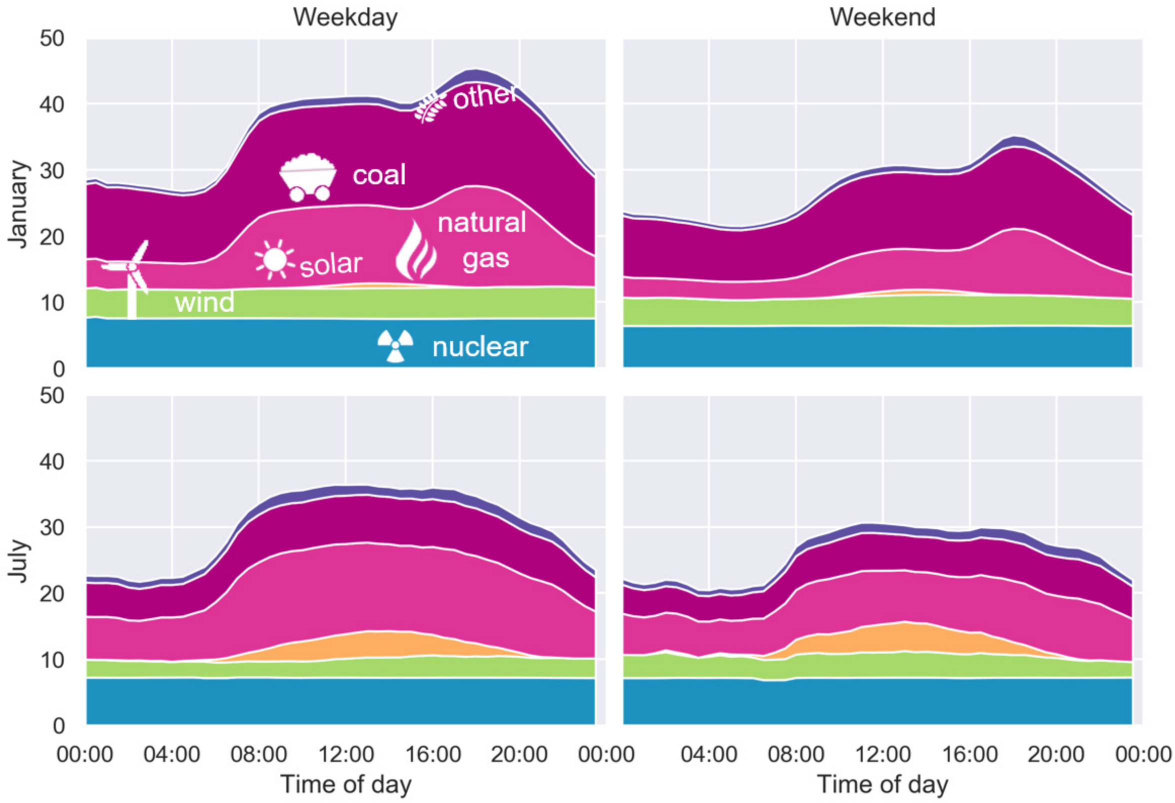

Chart 5: UK energy generation mix in gigawatts in January and July, in 2015, mapped across the time of day. Source: ENTSOE

10 EU Renewable energy directive 2009/2018, section 60 regarding "dispatch", EUR-Lex (2019); Department for the Economy (2019)

11 Exact numbers are, respectively, 15.64% and 13.95%

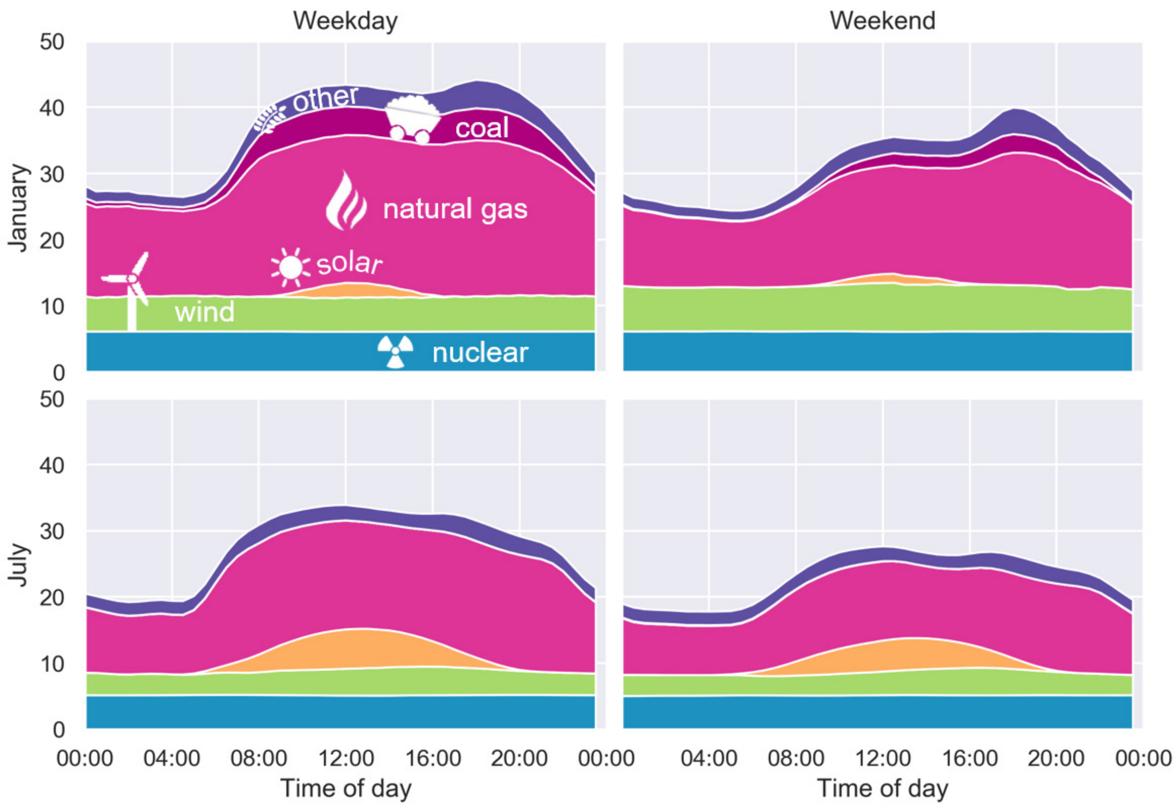

Chart 6: UK energy generation mix in gigawatts in January and July, in 2019, mapped across the time of day. Source: ENTSOE

5 The Compound Effect

In conclusion we find that if we were to introduce a four-day workweek, which, as we saw, we can assume would effectively replace a workday with a weekend day, would potentially reduce our energy consumption for that day by 10% and our emissions intensity by 15%.

These two effects have a compound effect: the lower electricity consumption of the weekend combines with lower carbon intensity, therefore potentially lowering emissions by as much as 24%.[12] In sheer numbers, this means saving 98 thousand tons of CO2 in July or 135 thousand tons in January (Chart 7).

In 2017 (the last year with available official emissions data), the UK energy sector produced a total of emissions of 112.6 million tons of CO2 equivalent.[13] That means that each week, on average, the UK produces just over 2 million tons of CO2.[14] A four-day week could reduce these emissions, on average over the contrasting seasons, by as much as 117 thousand tons of CO2 per week. This is equivalent to a 5.4% reduction of overall emissions from the sector – or removing 1.3 million cars from the road annually.[15]

12 Exact numbers for percentage reductions in emissions are: is 23.5% in Jan, 24.1% in July.

13 Department for Business, Energy, Energy & Industrial Strategy (2019)

14 Exact number: 2,159,000 tons.

15 EPA (2018) gives the average annual carbon dioxide emissions of a typical passenger vehicle as 4.6 tons CO2. Therefore, 117 thousand tons per week would equal 6.084 million tons per year ≈ 1.3 million cars (judged by average American cars).

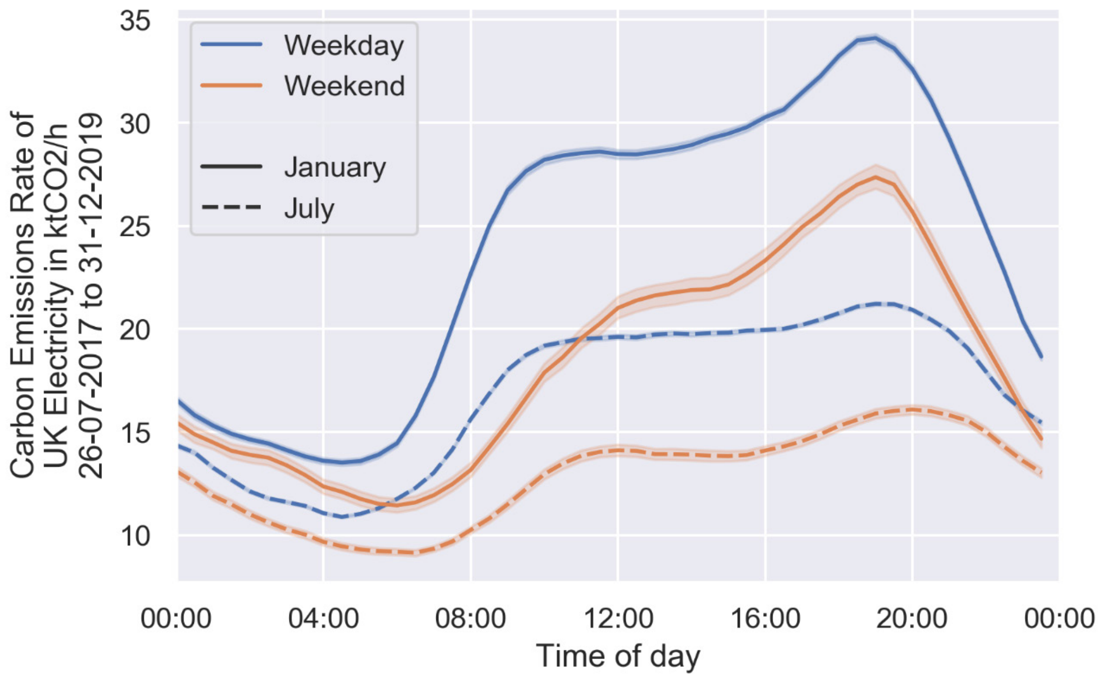

Chart 7: Carbon emissions rates in January and July in kilotons of CO2 per hour, mapped across the time of day. The study period is between July 2017 and December 2019.
Source: ENTSOE

6 The Growing Environmental Case

We must note that the above calculation does *not* account for the carbon savings from the reduced commuting that a four-day week would entail, which studies have shown would have a further, significant impact.[16]

Taken together, the emissions savings from reduced electricity use, reduced commuting-based emissions and reduced use of carbon-intensive goods that exist on the fringes of a work-intensive lifestyle could be hugely significant. We could also take into account the financial savings that would accrue from the reduced electricity use that would result from extending the weekend, but that precise calculation is beyond the scope of this paper.

16 Knight et al. (2012)

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Data set

All data comes from the European Network of Transmission System Operators (ENTSOE) accessible at: https://transparency.entsoe.eu/dashboard/show.

Bank holidays within the study period

New Year's Day > 2015-01-01
Good Friday > 2015-04-03
Early May bank holiday > 2015-05-04
Spring bank holiday > 2015-05-25
Christmas Day > 2015-12-25
Boxing Day > 2015-12-28
New Year's Day > 2016-01-01
Good Friday > 2016-03-25
Early May bank holiday > 2016-05-02
Spring bank holiday > 2016-05-30
Boxing Day > 2016-12-26
Christmas Day > 2016-12-27
New Year's Day > 2017-01-02
Good Friday > 2017-04-14
Early May bank holiday > 2017-05-01
Spring bank holiday > 2017-05-29
Christmas Day > 2017-12-25
Boxing Day > 2017-12-26
New Year's Day > 2018-01-01
Good Friday > 2018-03-30
Early May bank holiday > 2018-05-07
Spring bank holiday > 2018-05-28
Christmas Day > 2018-12-25
Boxing Day > 2018-12-26
New Year's Day > 2019-01-01
Good Friday > 2019-04-19
Early May bank holiday > 2019-05-06
Spring bank holiday > 2019-05-27
Christmas Day > 2019-12-25
Boxing Day > 2019-12-26