POLICY BRIEF

The outsized carbon footprints of the super-rich

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ABSTRACT

Average figures for the country, regional, or class emissions of greenhouse gases can be deceiving because some people and groups have much larger carbon footprints than others. In this policy brief, we focus on the super-rich, the billionaires whose fortunes have increased by over US$1 trillion during the COVID-19 pandemic. We ask what effect these super-emitters have on the everyday behavior of average citizens and address emissions as a commons-management issue. Our research indicates that billionaires have carbon footprints that can be thousands of times higher than those of average citizens, even in the richest countries.

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Introduction

Research shows that wealthy countries and the wealthy classes in each country produce far more than their share of greenhouse-gas emissions (e.g., Hurth and Wells 2007; Kenner 2019). Several recent studies have focused on carbon inequality comparing different countries, and the wealthiest classes in each one (e.g., Jorgenson et al. 2016; Ummel 2014). For instance, Chancel and Piketty (2015) estimate that on a global basis each of the richest 1% is emitting close to 100 times more than the members of the poorest 10%.

But what about super-wealthy individuals, the 2,095 billionaires on the Forbes list, who symbolize material wealth, the power and influence it brings, and ideal lifestyles of luxury and privilege? They stand out among the 300,000 or so “ultra high net worth individuals” who each hold more than US$30 million in assets (Wealth-X 2018), owning together US$31.5 trillion in assets, an estimated 11% of the world’s total monetary wealth. In the United States, the richest three Americans have as much wealth as the poorer half of the country’s population and, in 2017, 44 people inherited fortunes of more than US$1 billion (Otto et al. 2019). East Asia has recently seen the fastest growth in the ultra-rich category.

As in the United States in the late nineteenth century, we are now entering a time of increased scrutiny of the legitimacy of wealth, and there have been calls for eliminating the entire class of billionaires (Manjoo 2019). An article on HuffPost asks, “Should billionaires even exist?” (Peck 2019) and argues that it is inherently immoral to amass so much wealth in a world with so many poor people (see also Darby 2018). Some academics have begun to talk about a maximum wage or limiting income to a relatively moderate range or “corridor” (see Gough 2017; Fuchs and Di Giulio 2016; Princen 2005; Sahakian and Lorek 2018). Rather than celebrating the hard work, inventiveness, or philanthropy of the moneyed elite, these critics are more likely to scrutinize how extreme wealth affects our shared biosphere and the well-being of the majority of humans.

But classes and global comparisons are abstract categories, and it is hard for most people to visualize a billion dollars. Perhaps familiar individuals can be much more powerful representatives of inequality, a focus for moral criticism and public approbation. The composition of the Earth’s atmosphere is an equally abstruse concept. The carbon footprint has proven a useful and common way of measuring and comparing the environmental impact of individuals, households, classes, and nations. Instead of money and property or business earnings, it focuses on spending and consumption. At a time when climate denialsists seek to divert attention away from social and political action by emphasizing individual responsibility (Levantesi and Corsi 2020; Byskov 2019), the overconsumption of the super-rich demonstrates the limitations of an individual approach – they clearly have no incentive to moderate and take responsibility for their own consumption. Too often, billionaires are cast as capitalist heroes who prosper
through their own skill and enterprise, though many have actually inherited great wealth, and their success depends on the work of others, social networks, and serendipity.

We, therefore, set out to calculate the carbon footprints of well-known billionaires, as a way to visualize and concretize the impact of consumption on the environment and the huge imbalance between different groups of people. Billionaires do more than accumulate wealth; the ways they spend it on private airplanes, luxurious yachts, and multiple palatial dwellings have an outsized effect on the commons. In this study, we calculated billionaires’ emissions related to their wealthy lifestyles, the part of their carbon footprint that is directly associated with their consumption and travel.

In reality, billionaires are indirectly accountable for much higher carbon emissions, such as the ones associated with their business ventures. Jeff Bezos’s Amazon, for example, self-reported emissions of 51.2 million metric tons of carbon dioxide (CO₂) equivalent in 2019 (Amazon 2021). Each billionaire is also an investor in diverse industries, and many are CEOs and/or owners of hedge funds, large corporations, sports teams, media networks, and other enterprises. Given this diversity, it was impossible to account for the corporate greenhouse-gas emissions that could be attributed to our sample, though Kenner (2015, 2019) has investigated high-emission industries and their shareholders. In many cases, billionaires use shell companies, foundations, estates, offshore ownership, and accounting tricks that make it very difficult to apportion industrial emissions.

We also lacked reliable data on billionaires’ personal consumption of food, clothing, and household items, and on the consumption of their families, servants, and entourages. The Internet is full of accounts of lavish celebrations and entertainment, which may involve flying hundreds of people for long distances and extravagant spending on luxury products that may have dramatic effects on the well-being of distant workers and the natural environment. The billionaires also portray a glamorous lifestyle that is admired and emulated around the world, and it is important to emphasize that we all bear some of the costs.

It would be extremely difficult to include the life-cycle emissions of their possessions, the manufacture and disposal of yachts, aircraft, and dwellings. Measuring the “sunk carbon” in dwellings and yachts requires a level of detail about these possessions that we do not have, and studies show it varies considerably over time and between regions for housing (Goldstein, Gounaridis, and Newell 2020). Wooden dwellings may be seen as forms of carbon storage or sequestration, while bricks and concrete are carbon-intensive. In any case, buildings and yachts can have long lifetimes, which reduces their emissions on an annual basis (Green Ration Book 2010).

It is important to remember that the carbon footprints presented in this study are therefore only a small portion of reality, the tip of the iceberg. It is evident that privacy laws and the limitations of public data protect the super-rich and help hide a considerable amount of their consumption. Nevertheless, we think our calculations are illustrative and reflect on fundamental issues of climate justice by contributing to ongoing debates over who is responsible for climate change.

**Methods**

There is no single correct way to calculate carbon emissions for individuals, even those relatively frugal people with few needs and wants, much less the super-rich. Some individual carbon footprints are measured by dividing total national emissions by the number of individuals or households. Other calculators look in detail at the impact of each daily behavior like commuting, cooking, washing, heating, and cooling. Another method uses the average or individually measured energy use of appliances; heating, ventilation, and air-conditioning (HVAC) systems; and vehicles and travel and then converts these measures into emissions based on the carbon intensity of regional or national energy production. None of the existing personal carbon calculators are oriented toward the lifestyles of the exceptionally rich, who have multiple luxurious dwellings and often travel using private aircraft and yachts. We had to develop our own methods for estimating their carbon footprints using simplifying assumptions based on averages where available and, in each case, we have made a deliberate effort to choose the most conservative estimates possible to make sure we were not unfairly inflating anyone’s carbon footprint.

Most billionaires keep their possessions and consumption private and often hidden by vesting ownership in family members or trusts. The super-rich in the Middle East and Asia are particularly secretive, and we were not able to audit anyone in these regions. This is not in any way a representative sample of billionaires – our subjects are highly visible and predominantly from the United States and Western Europe where the super-rich sometimes display their possessions and practices in public, while others are covered by the press or are revealed in litigation or tax records. We combed through 82 databases of public records to trace houses, vehicles, aircraft, and yachts, and were able to compile dossiers for twenty prominent billionaires (see Table 1).

This is not by any means a random sample, but it
Table 1. Estimates of 2018 emissions for twenty billionaires in metric tons of CO₂ equivalent and their 2018 wealth.

| Individual and source of wealth | Estimated wealth (in 2018 in billions of US dollars) | Dwellings | Transportation | Yachts | Total |
|--------------------------------|-----------------------------------------------------|-----------|----------------|--------|-------|
| Roman Abramovich               | Steel magnate, owner of UK’s Chelsea soccer team    | 10.8      | 274.1          | 8,484.7 | 22,440.0 | 31,198.8 |
| Sheldon Adelson*               | Casinos                                             | 35.5      | 201.6          | 4,381.9 | 7,344.0  | 11,927.5  |
| Giorgio Armani                 | Fashion designer                                    | 8.9       | 298.0          | 10.3   | 3,672.0  | 3,980.3   |
| Bernard Arnault                | Owner of Louis Vuitton                               | 72.0      | 180.9          | 1,264.4 | 8,976.0  | 10,421.3  |
| Ernesto Bertarelli             | Pharmaceuticals and real estate                      | 8.9       | 69.4           | 1,860.3 | 8,160.0  | 10,089.7  |
| Jeff Bezos                     | Founder of Amazon                                   | 112.0     | 171.0          | 2,053.2 | –       | 2,224.2   |
| Michael Bloomberg              | Mass media, politician                              | 50.0      | 330.6          | 1,450.9 | –       | 1,781.5   |
| Sergey Brin                    | Co-founder of Google                                | 47.5      | 18.5           | 1,964.8 | 4,896.0  | 6,882.9   |
| Michael Dell                   | Founder of Dell Technologies                         | 22.7      | 523.8          | 6,529.2 | –       | 7,053.0   |
| Larry Ellison                  | Co-founder of Oracle                                 | 58.5      | 241.6          | 1,988.3 | 6,936.0  | 9,165.9   |
| Tilman Fertitta                | Food service, sports                                | 4.3       | 233.7          | 2,890.1 | 2,040.0  | 5,163.8   |
| Bill Gates                     | Co-founder of Microsoft                              | 90.0      | 85.3           | 7,407.6 | –       | 8,263.1   |
| David Geffen                   | Co-founder of DreamWorks                             | 8.0       | 71.5           | 1,988.3 | 16,320.0 | 18,379.7  |
| Laurene Powell Jobs            | Widow of Apple co-founder Steve Jobs                 | 18.8      | 215.8          | 1,988.3 | 5,304.0  | 7,508.1   |
| Roman Abramovich               | Steel magnate, owner of UK’s Chelsea soccer team    | 6.6       | 424.2          | 3,090.6 | 6,528.0  | 10,042.8  |
| Elon Musk                      | CEO of Tesla Motors and SpaceX                      | 19.9      | 115.6          | 1,964.8 | –       | 2,084.3   |
| Larry Page                     | Co-founder of Google                                | 48.8      | 16.5           | 1,964.8 | 3,264.0  | 5,248.9   |
| Ronald Perelman                | Owner of MacAndrew and Forbes                       | 9.8       | 186.9          | 2,053.2 | 5,304.0  | 7,544.1   |
| Eric Schmidt                   | Former CEO of Google                                | 13.4      | 69.2           | 1,484.4 | 1,632.0  | 3,185.6   |
| Carlos Slim                    | Telecommunications                                  | 67.1      | 56.6           | 3,672.0 | 2,448.0  | 5,163.8   |
| Total                          |                                                     | 713.5     | 3,785.2        | 54,836.7 | 105,264.0 | 163,885.9 |

Notes: *Died in 2021.

does clearly represent the range and causes of the emissions from billionaires’ personal possessions.

There is also a significant time lag in information about billionaire lifestyles; the portfolio of residences and vehicles is constantly changing as they buy, trade, and sell them. We have settled on the year 2018 as an accounting year, and we focus on ownership rather than the specific uses of each dwelling, yacht, and vehicle.

Dwellings

We do not know exactly the energy mix that individual billionaires use to heat, cool, and run the appliances and electronics in their many dwellings, nor can we directly verify their total energy use or the effectiveness of insulation or other energy-saving measures. We used the publicly known floor areas for each dwelling, or we developed our own estimates of size based on Google Earth imagery, though sometimes we could not tell if the house had multiple levels, in which case we only counted one. When we were unable to locate or measure a specific dwelling, we used 5,000 square feet (ft²) (465 square meters (m²)) as a default, which is at the low end of the range in our total sample of billionaires’ houses. We used the most recent United States Energy Information Administration Residential Energy Consumption Survey (USEIA 2018) to calculate total energy use per ft²; 36,000 British thermal units (BTUs)/ft²/year for their highest income category (US$140,000 or more per year) and 29,400 BTU/ft²/year for their largest home category (greater than 3,000 ft²). The average of these two figures is 32,700 BTU/ft²/year which converts to electrical use of 9.6 kilowatt hours per square foot per year (kWh/ft²/year) or 103 kilowatt hours per square meter per year (kWh/m²/year). We have not corrected for climate, assuming that air-conditioning in tropical regions roughly balances with heating in temperate areas. The annual kWh used by each dwelling was multiplied by the appropriate electricity grid greenhouse gas-emission factor (Carbon Footprint 2019; USEPA 2020; Hinostroza et al. 2015).

This method reduces all the different fuels used to power homes to an electrical equivalent in kWh, even though some of the fuels used in home heating may have higher (e.g., oil) or lower (e.g., solar or wind) emissions per BTU. We could only account for carbon emissions associated with electricity; if some of these houses require energy for heating from sources other than electricity (e.g., gas, wood) it has not been accounted for due to lack of data about each dwelling’s energetic needs. This means that we are underestimating the energy use by billionaires’ dwellings in places with low carbon electricity, for example, France and Switzerland. We also expect that custom-designed billionaires’ homes will tend to be particularly energy inefficient with their extensive glazing, swimming pools, and open plans.

While most dwellings are fully inhabited for only a part of the year, they are kept ready for their owners with staff and constant maintenance, and the residences may also be occupied by friends and family members, so they are generally kept heated and cooled to preserve their valuable furnishings and contents. We added 2,800 kWh per year for each swimming pool present (Gallion et al. 2014). In the few cases where we had adequate data, we also
added 0.2 kilograms (kg) of CO₂/m² of lawns and gardens to cover mowing and maintenance (Redmond 2015).

### Transportation

Travel is a prominent element in the carbon footprint of the super-rich, enabled by an array of ground vehicles, private aircraft (including jets of different sizes, light planes, and helicopters), and yachts with their many tenders and recreational vehicles like jet skis, submarines, ski boats, and hovercraft. Emissions vary widely within each class of vehicle and according to how often they are used. Most of these vehicles also require continual maintenance, which uses unaccounted energy and materials.

To calculate the carbon footprint of the private jets and helicopters owned by the billionaires in our sample, we started with each model’s fuel consumption in liters per hour (LPH) and applied the CO₂ emission factor of jet fuel (2.6 kilograms of CO₂ per liter (kg of CO₂/L)) based on a minimum value of 200 hours per year of flying for a private aircraft according to industry sources. We used a minimum figure of 110 hours per year for helicopters based on pilot experience. We doubled the emissions figures for jets based on the greenhouse effect of high-altitude emissions as estimated by the Intergovernmental Panel on Climate Change (Sausen et al. 2005). Two billionaires in our sample (Armani and Slim) did not own a private jet, so we estimated their travel distance counting roundtrips from their base home to workplaces and resorts, and used emission figures for commercial first-class passage on long- and short-haul jets.

To estimate the emissions from ground transportation we counted two cars in regular use – one for passengers and one for security (many billionaires have large collections of exotic automobiles, but we assume that only two could be driven at one time). We approximated annual use as the average distance traveled by car per year in the home country, at an average fuel consumption of 5.5 kilometers per liter (km/L) of diesel, an average for high-security sport-utility vehicles (SUVs). We could not include estimates for Brin, Musk, or Page, who drive electric vehicles because we do not know the source of the electricity.

### Yachts

Among the many possessions of billionaires, large “superyachts” are by far the largest producers of greenhouse gases. Three-quarters of the billionaires in our sample owned a yacht with an average length of 276 feet (84 meters), and their average carbon equivalent emissions were 7,018 tons per year. While the size and luxury facilities of many superyachts are public knowledge, the details of their use and fuel consumption are not. Menano de Figueiredo (2018) developed a model of how much time out of the year an average superyacht is anchoring, cruising, maneuvering, moving from place to place, and docking based on actual cruising records of ten vessels. We use these averages to estimate fuel use, based on a minimum of 30 days per year of cruising by the owner (Roy et al. 2011). The average size of superyachts is constantly growing, as is the number of energy-using luxuries like pools, hot tubs, private submarines, tenders, jet skis, helicopters, and sophisticated electronics. We use a conservative method to estimate their increasing emissions as they scale up, though this should be considered an approximation given the complexities of hydrodynamics, engine efficiency, and means of propulsion at different speeds.

### Results

Table 1 displays our estimates of 2018 emissions for each of the twenty billionaires, along with their estimated 2018 wealth; the two values have a small negative correlation ($R = -0.301$). Dwellings were responsible for an average of 2.3% of a billionaires’ total emissions, while transportation and yachting accounted, respectively, for 33.4% and 64.3%. There is also no significant correlation between the billionaires’ ages and their carbon emissions, and our figures suggest that once past the billion-dollar mark, the number of billions does not seem to make a difference.

Eighteen of the twenty billionaires in our sample own a private aircraft, while the rest may have used a corporate-owned or leased aircraft. Their choice of aircraft makes a huge difference as well: a personal Boeing 767 (Abramovich) uses an average of about 5,000 kilograms of fuel per hour (kg/h), compared with the much smaller Gulfstream G550 seating 8–10 people and using 1,070 kg/h.

To our surprise, housing was a relatively small part of the billionaires’ emissions, even though the twenty sample billionaires owned an average of 5.5 often palatial houses and apartments scattered across Europe, the United States, and the Caribbean with an average size of 13,476 ft² (1,252 m²). The average CO₂ emissions from billionaires’ dwellings are about 190 tons per year, compared with the global average of about 5 tons per capita for every aspect of life.
Conclusions

While many billionaires have taken pro-environmental actions in their personal lives or their corporate connections or donate money to climate-change organizations and purchase carbon offsets, none of these actions actually “cancels out” their total emissions. A 90-meter yacht can be touted as energy efficient or environmentally friendly, but as critics of “eco-chic” point out, it is still a huge waste of resources, a frivolous luxury in a warming world (Barendregt and Jaffe 2014). The efficacy of carbon offsets is often questioned, with some asserting that they enable consumption (Lovell, Bulkeley, and Liverman 2009). Their philanthropy is often self-serving and may cause further increases in emissions (Goldberg 2009). Even among billionaires, there is a lot of room for reducing emissions and setting an example, if they are willing to change their lifestyles.

The lifestyles and consumption choices of the super-rich are followed by millions through social media (Brockington 2009; Gössling 2019). Common property theory tells us that free riders reduce everyone’s motivation to properly manage a resource pool, a logic that appears at every level of greenhouse-gas politics (Ostrom 2009). If we perceive the global atmosphere as a common good, owned by no one, a single person’s bad behavior affects everyone else, canceling out their individual sacrifices and the efforts they make to cut their own waste.

We found no positive correlation between wealth and carbon emissions in our small sample, and some may argue that while the overconsumption of billionaires is thousands of times that of an average citizen, their wealth is greater by a far larger proportion, so that highly concentrated wealth is less harmful to the environment than the same wealth widely distributed. But radical redistribution is not a real possibility, and unlike private property and wealth, the atmosphere belongs equally to everyone. Consumption by billionaires is problematic not only because it is carbon-intensive but also because it ultimately undermines public consensus that could support public policies to reduce emissions and avert climate catastrophe. We suggest public shaming may be an effective strategy to pressure the wealthy to reduce their consumption, as it has in many cultures throughout history (Foster et al. 1972).

New social media and online networks provide opportunities for public shaming though some writers have concentrated on its dangers and individual casualties (e.g., Ronson 2015). Public shaming has proven to be an important form of discipline on Wall Street, where a number of prominent figures have fallen following accusations of infractions ranging from sexual harassment to insider trading (Bloomfield 2014; Skeel 2005). Research shows that an effective shaming campaign requires a legitimate platform, good background research, careful targeting, and an offer of a remedy or goal, such as cutting an individual footprint by half or divesting particular investments (Pawson 2002; Bloomfield 2014, Rosenblatt 2013).

What are individual responsibilities in an environmental crisis of unprecedented scale and danger? Anthropologists have found that every society places limits on acceptable conduct and punishes violations, and they have documented many cultural “leveling mechanisms” which act to reduce inequality. We hope to provoke further discussion of limits and constraints in the pursuit of sustainable consumption.

Notes
1. These sources ranged from Forbes magazine’s billionaire webpages to publications such as Architectural Digest, newspapers, online journals (such as Superyachtfan.com), and public databases (such as the many county assessor offices in the United States).
2. See https://aerospace.honeywell.com/en/learn/about-us/blogs/2017/08/the-real-cost-of-owning-a-business-jet. This does not include fuel used for maintenance or unladen travel between destinations.
3. According to Aviation International, most helicopter pilots working on yachts average less than 200 hours per year (https://www.ainonline.com/aviation-news/aviation-international-news/2006-10-16/flying-helicopters-worlds-superyachts200) and a recent job advertisement states between 100 and 120 hours per year (https://helijobs.net/2020/10/a109-vip-yacht-pilot-international/), while other sources report trends toward much higher use without specific numbers. We use 110 hours as a minimum annual average.
4. Calculations for commercial air travel are based on https://www.carbonindependent.org/22.html that does not differentiate business from economy travel and uses a seat occupancy rate of 65%.
5. High-security vehicles are typically used by high-worth individuals (see https://www.bloomberg.com/news/articles/2019-10-31/the-market-for-bulletproof-cars-is-sky-high). Large secure SUVs can expect from 5 to 6 km/L (11 to 14 miles per gallon), for an average of 5.5 km/L of fuel. The preferred fuel for high-security vehicles is diesel, which produces 2.6 kg of CO₂ per liter burned (https://ecoscore.be/en/info/ecoscore/CO2#).text=Petrol%3A,carbon%20per%20liter%20%20petrol)
6. A permanent crew typically lives aboard these yachts. According to Roy et al. (2011) they generate about 22% of the full cruising rate of 12.9 tons per day (397 tons per 30.66 days) and 22% of 12.9 = 2.8 tons per day × 157 days, which equals about 446 tons, added to the 1,187 during the rest of the year, which equals 1,633 tons per year of CO₂ emissions from a
relatively modest yacht of 45 meters. This is a very conservative figure given some other estimates.

7. We use the curve of fuel loading in Figure 2.2 of Roy et al. (2011) as a proxy for the actual amounts of fuel used by yachts of different sizes. This estimate is considerably lower than those generated by an online yacht-cost estimator (https://www.luxyachts.com/yacht-cost-calculator).

Disclaimer

The data in this article represents the authors’ best estimates, based on publicly available data for 2018. It is possible that the named individuals have taken significant action to lower their carbon footprint since 2018, when this information was published. The views in this article represent the views of the authors and do not represent the views of the publisher of the journal.

Disclosure statement

No potential conflict of interest was reported by the authors.

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