



Air travel is one of the major reasons why the rich have a much greater carbon footprint than the poor.

The identities of the world's primary carbon culprits seem obvious. Wealthy nations such as the United States and European Union member states owe the biggest historical debt, having produced nearly half of all carbon emissions since the Industrial Revolution. Meanwhile, rapidly growing industrial economies such as Russia, India and China are making up for lost time; China accounted for 29% of emissions in 2015. But such simplified national-level bookkeeping masks a much more complicated pattern of emissions. In each country, differences in individual wealth and consumption lead to vastly different impacts on the environment (see 'Unequal emissions').

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Economists Lucas Chancel of the Paris School of Economics and Thomas Piketty of the London School of Economics brought this issue to the fore in late 2015 (ref. 1). Their report looked at the carbon footprints of individuals and households from different income brackets. The inequities were stark: they estimated that the wealthiest 10% of the world's population is responsible for 45% of global emissions. This global community of 'elite emitters' cuts across nations, ranging from the wealthy United States to poorer countries in the Middle East and Latin America. This means that efforts to control national-scale emissions might have unintended consequences at the household level: an ill-designed policy could fail to rein in the worst offenders while simultaneously punishing the world's poor communities for relatively meagre emissions. "We need to figure out how much energy and emissions are needed for populations at the bottom end of the distribution and try to safeguard that part — then address policies to people who are beyond this level," says Shonali Pachauri, who studies developing-world energy use at the International Institute for Applied Systems Analysis in Laxenburg, Austria.

Climate change is not merely a problem for atmospheric chemists and meteorologists, but also a socio-economic problem, driven by human consumption and behaviour. "Income and energy and emissions are very much intertwined," says Massimo Tavoni, an economist at the Polytechnic University of Milan in Italy. "If you have inequality of income and wealth, you have inequality of carbon dioxide emissions — there's no way around it." Accordingly, a small but passionate community of researchers has been applying tools from sociology, economics and psychology to explore the interplay between wealth and emissions. They hope to develop fair and effective strategies that might compel heavy emitters to pay their share and mend their ways without holding back the masses — especially those struggling to get out of poverty.

DIRTY MONEY

Andrew Jorgenson, a sociologist at Boston College in Chestnut Hill, Massachusetts, has spent decades studying how socio-economic

CLIMATE CHANGE

The needs of the many

The world's wealthiest have an outsized carbon footprint. Social scientists are exploring strategies for ensuring that the 'needs of the few' do not outweigh those of the rest.

BY MICHAEL EISENSTEIN

divisions affect carbon emissions. He and his collaborators analysed US CO₂ emissions from 1997 to 2012 at the state level and compared these data against various measures of income inequality². A consistent pattern emerged: carbon footprints grew larger as a state's wealth accumulated within the highest-earning 10% of the population, independent of other factors, such as level of urbanization or tendency to elect pro-environment politicians. "A higher concentration of income is associated with higher state-level emissions," says Jorgenson. "And that holds up when you take into account all of the other social drivers that we know are very important."

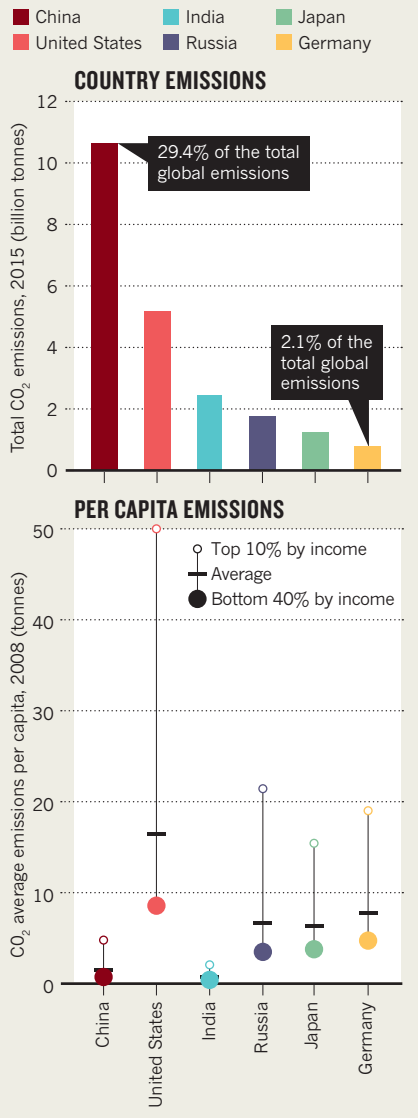
The pattern holds elsewhere, too. Across 26 high-income nations, Jorgenson's team found the same link between heavier emissions and higher concentration of wealth³. This includes many countries in Europe, even though the EU has strict standards for vehicle emissions and aggressive renewable-energy targets. Jorgenson cites a phenomenon known as the Netherlands fallacy to explain this apparent contradiction. "Their environment domestically might be in great shape," he says, "but a lot of these affluent democratic nations really do have very large per-person carbon footprints." And as seen elsewhere, the biggest emitters are clustered in the upper echelons of the socio-economic ladder. Jorgenson thinks that the link between wealth inequality and high emissions is universal, across both affluent and developing nations, and comes down to behaviour in individual households.

Households generally consume energy for the same basic needs. Yael Parag, a social scientist at the Interdisciplinary Center Herzliya in Israel, says that household emissions are mostly attributable to transportation, climate control and appliances — and that wealth typically correlates with higher use of these items. "We know that rich people consume more electricity than poor people," says Parag. Although poor families consume less energy overall than their middle-class neighbours, they often produce disproportionate carbon emissions. "Poor people often live in less-efficient homes and use older appliances," which drives up energy usage, she adds. The differences get starker as wealth accumulates: people acquire extra homes — often stocked with high-tech toys — and engage in more-frequent air travel. Tavoni notes that although there are theoretical limits on how much the ultra-rich can consume, it is not clear where this peak is. "There is a long rising pattern before things level off," he says.

Consumption can also be contagious. Jorgenson sees evidence supporting research carried out in the late nineteenth century by economist Thorstein Veblen on 'conspicuous consumption' of luxury items as an indicator of success. "Heavy consumption by the very wealthy leads to over-consumption among the middle class and those at lower socio-economic

UNEQUAL EMISSIONS

At the national scale, China's rapidly developing economy is a big factor in global carbon emissions. But most Chinese households emit relatively little, whereas a small proportion of wealthy individuals in the United States have a huge carbon footprint. Such 'elite emitters' are increasingly problematic for developing economies, as well.



strata," says Jorgenson. In parallel, the influence of those in the elite class can create strong political pressure to water down regulations or emission-control policies. Thus, bad energy-use habits not only go unchecked, but also propagate. "If everyone rises on the same curve, it's obviously going to be a mess," says Tavoni.

DEVELOPMENTAL DAMAGE

The picture is more complicated in the developing world — particularly in countries such as India and China that are undergoing rapid growth and industrialization, but that also have large numbers of people in poverty who do not have access to electricity. "In several countries, a large portion of the population is outside the carbon economy, and yet the emissions of

the top groups can be as high as in the West," says Ian Gough, who studies social policy at the London School of Economics. Indeed, an analysis in China⁴ showed that the 5.3% of the population representing "very rich" urbanites contributed 19% of the country's household-consumption carbon footprint in 2012. These rich Chinese households have a footprint equivalent to that of the EU household average.

In rapidly industrializing countries, short-to medium-term expansion of fossil-fuel use is essential for lifting the destitute out of poverty, but this progress can be threatened by crudely applied emissions policies. For example, roughly 700 million people in South Asia cook with fires fuelled by wood, coal and other solid fuels that produce toxic smoke, contributing to an estimated 1.7 million deaths per year due to household air pollution across the region. Gas-powered stoves are much cleaner and safer, but Pachauri and her colleagues have projected that CO₂-control policies that raise gas costs by 38% could reduce the number of households that can afford to adopt clean cooking by 21% (ref. 5). Governments therefore need to ensure that this transition is affordable — for example, by subsidizing gas stoves to reduce each family's up-front investment. Similarly, roughly one-fifth of India's 1.3 billion people lack electricity, but connecting them would increase the output of the grids' fossil-fuelled power stations. This would increase emissions, although Pachauri calculates that it would probably result in only a modest rise. Between 1981 and 2011, the connection of 650 million Indians to the grid increased overall emissions by 11–25% (ref. 6) — negligible on a per capita basis. "The emissions increase from electrification has been really, really small," she says. "People who just get connected are really using almost nothing — a couple of lights and maybe a television." Yet the benefits to the families are huge.

It is less clear what happens to emissions in the long term, as households move out of poverty. Initially, increases may be fairly slow, although Pachauri notes that this has not been examined in sufficient depth to identify a definitive pattern. "For the few countries I've looked at, over the past 20 or 30 years it hasn't grown that fast," she says. Rapidly industrializing nations, however, might experience a surge of inequality, with some individuals rocketing past their peers in terms of livelihood and carbon footprint. "Even in these countries, it's really the top 10% that are contributing the large majority of the emissions," says Pachauri.

Yet many governments fail to deal with their most profligate emitters. "These nations can point to Europe and the United States, which have accounted for the bulk of historical emissions and benefited enormously," says Benjamin Sovacool, who studies energy policy at the University of Sussex in Brighton, UK. But even if wealthy nations still bear the lion's share of responsibility, heavy emitters in middle-income countries must not be let off the hook.

In 2007, Greenpeace specifically criticized India for “hiding behind the poor” — using national averages to mask the extreme emissions from its economic elites. The challenge for the international community is to chart a fair course towards reducing carbon emissions without stifling economic development, or allowing a select few to enjoy unchecked emissions.

TAXATION WITH DECARBONIZATION

Sovacool thinks that the most immediately effective approach would be to set fossil-fuel prices that mirror the true cost to the planet. “We don’t have to live with no Internet, no showers and warm beer — we’ve just got to pay,” he says. However, he acknowledges that this approach requires modification to avoid hitting the poor disproportionately hard. “You have to have a redistributive element that will protect vulnerable populations, either by giving them discounts or subsidizing their energy use,” he says.

Targeted tax-based approaches could prove more equitable. In their report¹, Chancel and Piketty modelled three different versions of an international carbon tax in which countries pay a share of the bill for climate-change adaptation based on their population of top emitters — such that countries would be incentivized to rein in these individuals. They also note that an air-travel tax of just over €5 (US\$6) per ticket could raise €150 billion a year. This is half the amount that the United Nations Environmental Programme estimates would be needed to help the developing world to adapt to climate change. Similarly, Gough sees potential in ‘smart’ value-added tax frameworks, which selectively levy surcharges on high-emission luxuries (such as ‘gas-guzzling’ vehicles or business-class flights) and thus reward energy-conscious spending in general. However, these redistributive strategies will almost certainly face considerable opposition from both the business world and the public, and remain purely at the conceptual stage.

An alternative to taxation is personal carbon trading, which empowers individuals to take responsibility for their energy use by buying and selling credits for household emissions through a government-run exchange, similar to industrial cap-and-trade systems. “Everyone receives a carbon budget, and they have to act within that budget,” explains Parag. These schemes have the advantage of being highly progressive from a socio-economic perspective. “Poor people who emit less carbon will be the winners, because they would be able to sell the extra credits to the richer people who on average emit more,” she says. Explored in the United Kingdom at the start of the millennium, the concept was shelved by the government’s environmental agency as an idea “ahead of its time”: impractical to implement, and challenging to sell to the

public. “People can’t even manage their bank accounts well, and now you’re introducing a new ‘coin’ — a carbon currency,” says Parag, who was involved with the research.

Insights from psychology and behavioural science could help to steer energy wastrels onto the right path without the need for tax or trading schemes. In 2009, US National Research Council psychologist Paul Stern and his colleagues identified 17 simple household-level behavioural changes that could have a big impact⁷. All can be done with existing technology — for example, car pooling and efficient water heaters — and could collectively cut US emissions by up to 7.4% within 10 years, roughly one-quarter of the 26–28% reduction called for by the Paris Agreement. “People do the first things that come to mind, like turning out the lights when you leave the room,” says Stern. “But there are higher-impact things that are less frequently done, typically involving technology.” Some of these behaviours are already incentivized, but typically through com-



Gas stoves are better for air quality than solid-fuel stoves.

plex tax rebates rather than up-front rewards. Stern considers incentives to be an important attention-getter — particularly given that even environmentally minded people are unaware of all of their options. Better marketing will be crucial to making people aware of which home improvements and lifestyle changes produce the biggest cost and carbon savings. But even experts need a hard push — Stern notes that it took him six years to install solar panels on his home, despite a long-standing intent to do so.

PEER PRESSURE

In the end, it took a direct recommendation from a colleague for Stern to take action, and some researchers are now looking at how such network effects might be better exploited. “We are very much influenced by what others think,” says Tavoni. “We are social animals who make social comparisons.” Parag’s research is now focused on what she calls ‘middle-out’ environmental messaging. This approach, developed with Kathryn Janda of the University of Oxford, UK, goes after people who are able to influence

large numbers of individuals at once: such as religious leaders, who can talk to congregations and policymakers. She also sees opportunities in working with businesses involved in construction and architecture. “Once a building is built, it’s hard to change energy consumption,” says Parag. “But if a building is designed with energy efficiency in mind, the savings will come effortlessly.”

Although most social and behavioural strategies are targeted at the large mass of middle-income energy consumers, they could also have an impact on Chancel and Piketty’s elite emitters. Tavoni notes that shifting fashions in wealthy social circles may already be promoting decarbonization, such as the rise of sleek but expensive electric cars like the Tesla, or the growing adoption of vegetarianism. Indeed, a 2017 study found that lifestyle changes such as these — and, more controversially, having fewer children — can markedly reduce household emissions⁸.

However, it is challenging to design interventions to promote such environmentally oriented decision-making. And even well-intentioned people can be resistant to making sacrifices to respond to a problem as seemingly distant as climate change.

The good news is that as the social sciences help to shape conversations at the climate-policy table, issues of equality and justice are falling under the spotlight. Jorgenson notes that he and his colleagues routinely collaborate with US agencies such as the Environmental Protection Agency, NASA and the Global Change Research Program. Sovacool is an adviser for the Intergovernmental Panel on Climate Change on its upcoming assessment, and notes that issues related to energy and climate justice have become the explicit focus of multiple chapters. Jorgenson thinks such collaborations are overdue. “One thing environmental social scientists have been saying for a long time, which drives our natural-science and engineering colleagues nuts, is that we cannot just rely on technological solutions,” he says. “I wish we could, but we can’t.” ■

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