Should (some) individuals also understand and chart their path to net zero?

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6 November 2025
Webinar @ NUS Centre for Nature-based Climate Solutions

More about me (beyond my NUS affiliations)

- An environmental economist (and scientific journal co-editor)
  - A behavioral social scientist working on individual climate action
- I finished my PhD 20 years ago, at the London School of Economics
- 2005-2013: I was an assistant professor of strategy at the Kellogg School of Management
  - I think I "get" businesses
- I have been in Singapore since 2013
- As a consumer/worker, I try hard to manage my "contribution" to environmental pollution
  - Climate, biodiversity, and plastic crises are tightly linked
  - Also tightly connected with caring for the poor
- This often involves inner conflicts and tensions

For example: My most recent conflict

- I just came back from a 4-week trip
  - Miami, Chicago, West Lafayette, Atlanta, Madrid, Rome, Bologna, Barcelona
- Time with my two older boys who are in College
- Time with my mother, three siblings, and other extended family
- 5 research talks, 1 research workshop, >60 extended conversations that are directly relevant to my work
- Atmosfair platform: I worked out my apportioned share of aviation emissions:
  - 7.6 tons CO_2e (emissions at 10 km altitude)
  - All economy-cabin seating (business cabin would be 3X based on floor space)
- "Was my trip worth it?" (to me, to society)

"Was my trip worth it?"

All economy-cabin seating, one-way, 1 passenger

Origin	Destination	CO_2 (kg)	Non-CO_2 (kg)	CO_2 + Non-CO_2 (kg)	Offset suggested by Atmosfair (Euro)	Distance (km)	kg CO_2e / km	Euro / ton CO_2e
Singapore	Dubai	355	553	908	28	5,978	0.152	30.84
Dubai	Miami	1017	1621	2,638	80	12,746	0.207	30.33
Miami	Chicago	159	224	383	12	2,032	0.188	31.33
Chicago	Atlanta	103	126	229	7	1,077	0.213	30.57
Atlanta	Madrid	441	691	1,132	34	7,095	0.160	30.04
Madrid	Rome	111	147	258	8	1,432	0.180	31.01
Bologna	Barcelona	79	91	170	6	932	0.182	35.29
Barcelona	Abu Dhabi	298	461	759	23	5,273	0.144	30.30
Abu Dhabi	Singapore	445	692	1,137	35	6,018	0.189	30.78
Total 9 flights				**7,614**	**233**	**42,583**	**0.179**	**30.60**

Note: Aviation only; excludes lower-emissions train ride from Rome to Bologna

- To me, yes!
- Yet, I am accountable and feel grateful for the (largely unpriced) natural resources that my trip demanded

Brief aside: Water as a greenhouse gas?? (at altitude = GHG)

The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018

D.S. Lee [a,*], D.W. Fahey [b], A. Skowron [a], M.R. Allen [c,n], U. Burkhardt [d], Q. Chen [e], S.J. Doherty [f], S. Freeman [a], P.M. Forster [g], J. Fuglestvedt [h], A. Gettelm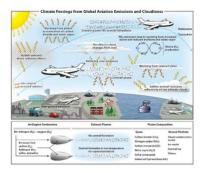an [i], R.R. De León [a], L.L. Lim [a], M.T. Lund [h], R.J. Millar [c,o], B. Owen [a], J.E. Penner [j], G. Pitari [l], M.J. Prather [k], R. Sausen [d], L.J. Wilcox [m]

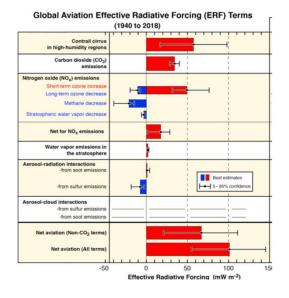## HIGHLIGHTS

- Global aviation warms Earth's surface through both CO_2 and net non-CO_2 contributions.
- Global aviation contributes a few percent to anthropogenic radiative forcing.
- Non-CO_2 impacts comprise about 2/3 of the net radiative forcing.
- Comprehensive and quantitative calculations of aviation effects are presented.
- Data are made available to analyze past, present and future aviation climate forcing.

GRAPHICAL ABSTRACT

Another brief aside: What is the "marginal impact" from I taking that flight?

Two narratives

- Short horizon/low individual accountability: **The next flight**

The plane is taking off anyway. I might as well be on it.

(Similar to: *The cow is already dead. I might as well eat the beef.*)

vs.

- Longer horizon/high individual accountability: **Supply meets demand**

The more individuals like me demand air travel, the more resources will be allocated to the sector.

(Similar to: *The more beef I eat, the more cows will be raised and slaughtered.*)

Less: Could I take ground (& public) transport?

All economy-cabin seating, one-way, 1 passenger

Origin	Destination	CO$_2$ (kg)	Non-CO$_2$ (kg)	CO$_2$ + Non-CO$_2$ (kg)	Offset suggested by Atmosfair (Euro)	Distance (km)	kg CO$_2$e / km	Euro / ton CO$_2$e
Singapore	Dubai	355	553	908	28	5,978	0.152	30.84
Dubai	Miami	1017	1621	2,638	80	12,746	0.207	30.33
Miami	Chicago							
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Atlanta	Madrid	441	691	1,132	34	7,095	0.160	30.04
Madrid	Rome							
Bologna	Barcelona							
Barcelona	Abu Dhabi	298	461	759	23	5,273	0.144	30.30
Abu Dhabi	Singapore	445	692	1,137	35	6,018	0.189	30.78
Total 5 flights (transoceanic only)				**6,574**	**200**	**37,110**	**0.177**	**30.42**

Note: Aviation only

- Would have reduced my personally accountable emissions from 7.6 to 6.6 tons of CO$_2$e
- (More later) System frame vs. individual frame

More: Fly in comfort & style

Penelope Cruz,
Brand ambassador for
Emirates Business Class

All business-cabin seating, one-way, 1 passenger

Origin	Destination	CO_2 (kg)	Non-CO_2 (kg)	CO_2 + Non-CO_2 (kg)	Offset suggested by Atmosfair (Euro)	Distance (km)	kg CO_2e / km	Euro / ton CO_2e	CO_2e B : E
Singapore	Dubai	1422	2211	3,633	109	5,978	0.608	30.00	4.0
Dubai	Miami	4067	6485	10,552	317	12,746	0.828	30.04	4.0
Miami	Chicago	239	338	577	18	2,032	0.284	31.20	1.5
Chicago	Atlanta	155	189	344	11	1,077	0.319	31.98	1.5
Atlanta	Madrid	1705	2671	4,376	132	7,095	0.617	30.16	3.9
Madrid	Rome	169	223	392	12	1,432	0.274	30.61	1.5
Bologna	Barcelona	118	137	255	8	932	0.274	31.37	1.5
Barcelona	Abu Dhabi	1193	1844	3,037	92	5,273	0.576	30.29	4.0
Abu Dhabi	Singapore	1780	2769	4,549	137	6,018	0.756	30.12	4.0
Total 9 flights				**27,715**	**836**	**42,583**	**0.651**	**30.16**	**3.6**

Emissions factors based on floor area, e.g., "a passenger in premium class emitted 2.6 to 4.3 times more CO2 per km than a passenger in economy class, depending on aircraft"

Graver, B., Rutherford, D. & Zheng, S. CO_2 emissions from commercial aviation. International Council on Clean Transportation (2020)

Bofinger, H. & Strand, J. Calculating the carbon footprint from different classes of air travel. World Bank Policy Research WP 6471 (2013)

UK DEFRA (Department for Environment, Food & Rural Affairs) and DESNZ (Department for Energy Security and Net Zero). Greenhouse gas reporting: conversion factors (2023)

What is 7.6 tons CO_2e? (my one trip)

- Bottom 50% of world population emits 1.4 tons CO_2e per person **per year**
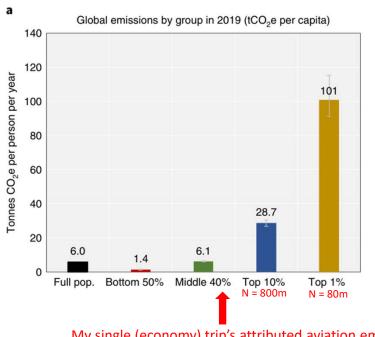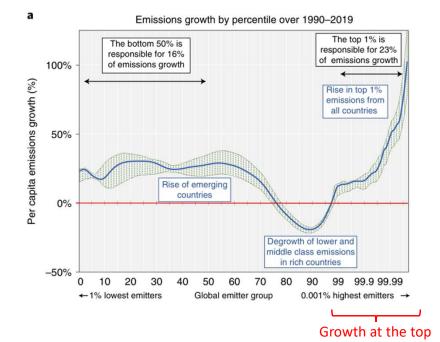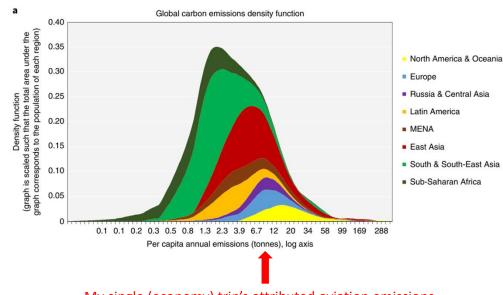
- Environmental justice

Global carbon inequality over 1990–2019

Lucas Chancel

All humans contribute to climate change but not equally. Here I estimate the global inequality of individual greenhouse gas (GHG) emissions between 1990 and 2019 using a newly assembled dataset of income and wealth inequality, environmental input-output tables and a framework differentiating emissions from consumption and investments. In my benchmark estimates, I find that the bottom 50% of the world population emitted 12% of global emissions in 2019, whereas the top 10% emitted 48% of the total. Since 1990, the bottom 50% of the world population has been responsible for only 16% of all emissions growth, whereas the top 1% has been responsible for 23% of the total. While per-capita emissions of the global top 1% increased since 1990, emissions from low- and middle-income groups within rich countries declined. Contrary to the situation in 1990, 63% of the global inequality in individual emissions is now due to a gap between low and high emitters within countries rather than between countries. Finally, the bulk of total emissions from the global top 1% of the world population comes from their investments rather than from their consumption. These findings have implications for contemporary debates on fair climate policies and stress the need for governments to develop better data on individual emissions to monitor progress towards sustainable lifestyles.

a Global emissions by group in 2019 (tCO_2e per capita)

My single (economy) trip's attributed aviation emissions

a Emissions growth by percentile over 1990–2019

Growth at the top

What is 7.6 tons CO_2e? (my one trip)

- Distributions of individual emissions **per year**
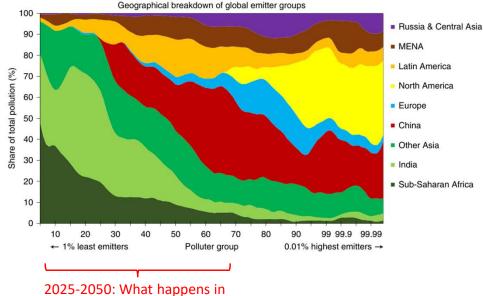
- Going forward: Global South will be critical

Global carbon inequality over 1990–2019

Lucas Chancel ✉

All humans contribute to climate change but not equally. Here I estimate the global inequality of individual greenhouse gas (GHG) emissions between 1990 and 2019 using a newly assembled dataset of income and wealth inequality, environmental input-output tables and a framework differentiating emissions from consumption and investments. In my benchmark estimates, I find that the bottom 50% of the world population emitted 12% of global emissions in 2019, whereas the top 10% emitted 48% of the total. Since 1990, the bottom 50% of the world population has been responsible for only 16% of all emissions growth, whereas the top 1% has been responsible for 23% of the total. While per-capita emissions of the global top 1% increased since 1990, emissions from low- and middle-income groups within rich countries declined. Contrary to the situation in 1990, 63% of the global inequality in individual emissions is now due to a gap between low and high emitters within countries rather than between countries. Finally, the bulk of total emissions from the global top 1% of the world population comes from their investments rather than from their consumption. These findings have implications for contemporary debates on fair climate policies and stress the need for governments to develop better data on individual emissions to monitor progress towards sustainable lifestyles.

a

Global carbon emissions density function

Density function (graph is scaled such that the total area under the graph corresponds to the population of each region)

Per capita annual emissions (tonnes), log axis: 0.1 0.1 0.2 0.3 0.5 0.8 1.3 2.3 3.9 6.7 12 20 34 58 99 169 288

Legend:
- North America & Oceania
- Europe
- Russia & Central Asia
- Latin America
- MENA
- East Asia
- South & South-East Asia
- Sub-Saharan Africa

My single (economy) trip's attributed aviation emissions

b

Geographical breakdown of global emitter groups

Share of total pollution (%)

Polluter group: ← 1% least emitters ... 0.01% highest emitters →

Legend:
- Russia & Central Asia
- MENA
- Latin America
- North America
- Europe
- China
- Other Asia
- India
- Sub-Saharan Africa

2025-2050: What happens in the Global South will be critical

The Economist

The climate action that matters is in the global south, argues an architect of the Paris agreement

But, writes Christiana Figueres, innovation still has to outpace climate impacts

---

cfigueres and **outrageoptimism** •••

cfigueres ✔ 17h

The world is no longer waiting for Washington. This time the global south is leading the way.

Our clean-energy future won't be decided in the boardrooms of the old energy powers, but in the bustling cities and industrial corridors of a new sunbelt stretching from Latin America to Africa, Asia and Australia.

A new economy is rising, powered by clean electricity, digital innovation and renewable technologies.

The question now: can the exponential

♡ 💬 ➤   🔖

544 likes

17 hours ago

Log in to like or comment.

Christiana Figueres
Global Climate Leader ◆ Co-Host,
Outrage + Optimism ◆ Former UN C...

I used to think that it was our collective responsibility to guarantee to future generations that they would have a perfect world.

Especially now that I am a recent grandmother, I look back and see how wrong I was. We cannot guarantee to future generations that they're going to have a perfect world. We simply cannot.

So, what can we do? We can do our darndest. We can wake up every morning and make a choice: 'Where am I going to direct my energy today?'

Individuals as climate
actors, e.g., Christiana, YOU

What is 7.6 tons CO_2e? (my one trip)

CASE REPORT

Check for updates

Promoting sustainability education through hands-on approaches: a tree carbon sequestration exercise in a Singapore green space

Sorain J. Ramchunder[1] · Alan D. Ziegler[2]

Nature-based climate solutions

"Tree equivalents"
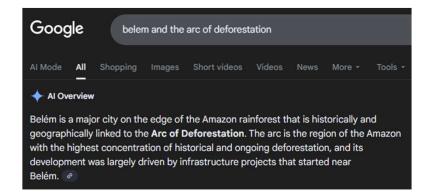
- 1 mature raintree (samanea saman) stores 10 tons of CO_2e above and below ground

Key to note:

- Trees' (and forests') "ecosystem services" go **way beyond** carbon storage

Connection to COP30
Belém, in the Global South

Google   belem and the arc of deforestation

AI Mode   All   Shopping   Images   Short videos   Videos   News   More ▾   Tools ▾

✦ AI Overview

Belém is a major city on the edge of the Amazon rainforest that is historically and geographically linked to the **Arc of Deforestation**. The arc is the region of the Amazon with the highest concentration of historical and ongoing deforestation, and its development was largely driven by infrastructure projects that started near Belém. 🔗

Climate actors

- The need to shift away from Business As Usual (BAU)
  - Not if, but at **what speed**, and which **policies enable that speed**?
- Imperative: Not only the energy transition but also the **protein transition**
  - The latter is often missed in the public discourse
- Actors shifting away from BAU?
  - Governments: National, provincial, city
  - Businesses
  - Local communities, e.g., churches/mosques
  - Should (some) **individuals chart their own path to net zero**?
- Individuals: Multiple roles as consumers, workers, investors, citizens
  - How do **individuals enable policies**?

On the less-known protein transition:
Bezos Centre for Sustainable Protein at NUS

Since 1970, the human population has doubled, while the population of all other vertebrates has halved   Sir Andrew Steer, Bezos Earth Fund, at the recent launch

3/4 of all agricultural lands (a land mass the size of China + India, times two, plus Indonesia) is used to grow feed for animals or graze them, while they only deliver 1/3 of our protein supply   Mirte Gosker, Good Food Institute

A multi-disciplinary team to address a whole-of-society challenge

Individuals in multiple climate actor roles

NUS Institute for Public Understanding of Risk keynote address in May 2025

NUS National University of Singapore

Lloyd's Register Foundation Institute for the Public Understanding of Risk

Environmental *Change* Institute

eci | UNIVERSITY OF OXFORD | UNIVERSITY OF BATH

Multiple roles of individuals for climate action

Dr Sam Hampton
University of Oxford and University of Bath

One Earth

CellPress
OPEN ACCESS

Review

Choices for climate action: A review of the multiple roles individuals play

Sam Hampton[1,2,*] and Lorraine Whitmarsh[1]
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[2]Environmental Change Institute, Oxford University, Oxford, UK
*Correspondence: sah53@bath.ac.uk
https://doi.org/10.1016/j.oneear.2023.08.006
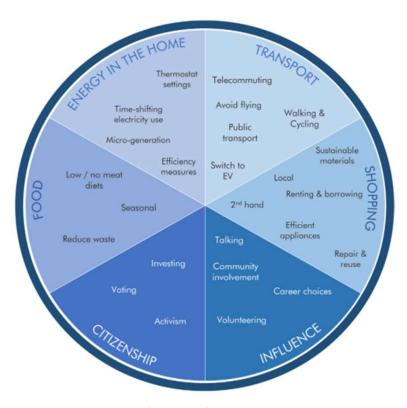
SUMMARY

Tackling climate change requires significant behavior change to reduce emissions, yet the scale required is far from being achieved. Behaviors are influenced by psychological characteristics, social and cultural norms, material and spatial environments, and political conventions. Much social scientific debate continues to be characterized by calls for *either* individual *or* system change, but a more cross-cutting perspective to understand various factors that can enable and accelerate pro-environmental choices is needed. This review provides an interdisciplinary synthesis of evidence on the potential and limitations of individual choice to mitigate climate change. We identify six domains of individual choice for climate action (food, energy, transport, shopping, influence, and citizenship). We find that individual, social, physical, and political factors combine to shape low-carbon choices but in ways specific to each domain, demanding different responses from policymakers. Effective climate action requires a mix of interventions which address the multiple roles played by individuals: structural change by governments ("upstream" interventions), businesses and local authorities making sustainable options more available and attractive ("midstream"), and informational measures to shape individuals' decision-making ("downstream").

Individual climate action: Linkages

The six domains of choice for climate action (Hampton and Whitmarsh, 2023)

A combination of upstream, midstream, and downstream interventions is needed to enable and scale choices for climate action (Hampton and Whitmarsh, 2023)

Who is responsible: Two polar narratives (again)

- GHG emissions are (largely) the result of the choices and behaviours of a billion or so individuals. The role of businesses and governments is to respond to their demands.

vs.

- Individuals make choices which are highly bounded, constrained by what systems of provision make available, and influenced by powerful vested interests.

(including, e.g., *personal carbon calculators are a ploy to deflect responsibility away from corporations*, as in the BP/"Big Oil" and "Make America Beautiful" business campaigns)

Connecting the "i-frame" and the "s-frame"

The i-frame and the s-frame: How focusing on individual-level solutions has led behavioral public policy astray

Nick Chater[a] and George Loewenstein[b]

[a]Behavioural Science Group, Warwick Business School, University of Warwick, Coventry, UK and [b]Department of Social and Decision Sciences, Carnegie Mellon University, Pittsburgh, PA, USA
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gl20@andrew.cmu.edu; https://www.cmu.edu/dietrich/sds/people/faculty/george-loewenstein.html

Abstract

An influential line of thinking in behavioral science, to which the two authors have long subscribed, is that many of society's most pressing problems can be addressed cheaply and effectively at the level of the individual, without modifying the system in which the individual operates. We now believe this was a mistake, along with, we suspect, many colleagues in both the academic and policy communities. Results from such interventions have been disappointingly modest. But more importantly, they have guided many (though by no means all) behavioral scientists to frame policy problems in individual, not systemic, terms: To adopt what we call the "i-frame," rather than the "s-frame." The difference may be more consequential than i-frame advocates have realized, by deflecting attention and support away from s-frame policies. Indeed, highlighting the i-frame is a long-established objective of corporate opponents of concerted systemic action such as regulation and taxation. We illustrate our argument briefly for six policy problems, and in depth with the examples of climate change, obesity, retirement savings, and pollution from plastic waste. We argue that the most important way in which behavioral scientists can contribute to public policy is by employing their skills to develop and implement value-creating system-level change.

s- And i-frame approaches can still often be mutually reinforcing. For example, i-frame measures, such as health warnings on cigarette packets or antismoking public information campaigns, may increase public support for s-frame measures including advertising bans, and outlawing smoking in public places (Sunstein, 2022a).

These same "implementational" questions arise when considering how to implement a carbon tax. Psychological insights, and research using psychologically informed research methods, can contribute tremendously to design decisions regarding whether a carbon tax should be imposed upstream (e.g., on miners, drillers, manufacturers, or retailers) or downstream (on consumers), if such a tax should be integrated with the price of the product or segregated (Chetty, Looney, & Kroft, 2009), and, crucially, how tax revenues should be returned to the public.
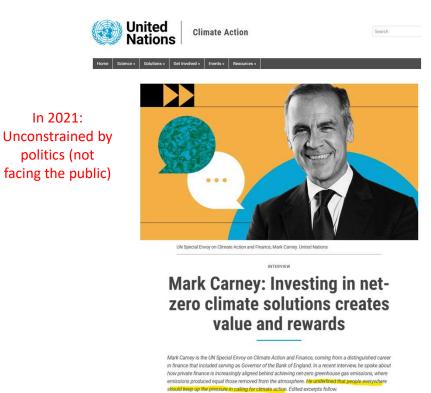
Why we need an educated and engaged public

- Economists' (like me) obsession with carbon pricing: Are we ready?

In 2021: Unconstrained by politics (not facing the public)

In 2025: Constrained by politics (remaining electable in North America today)
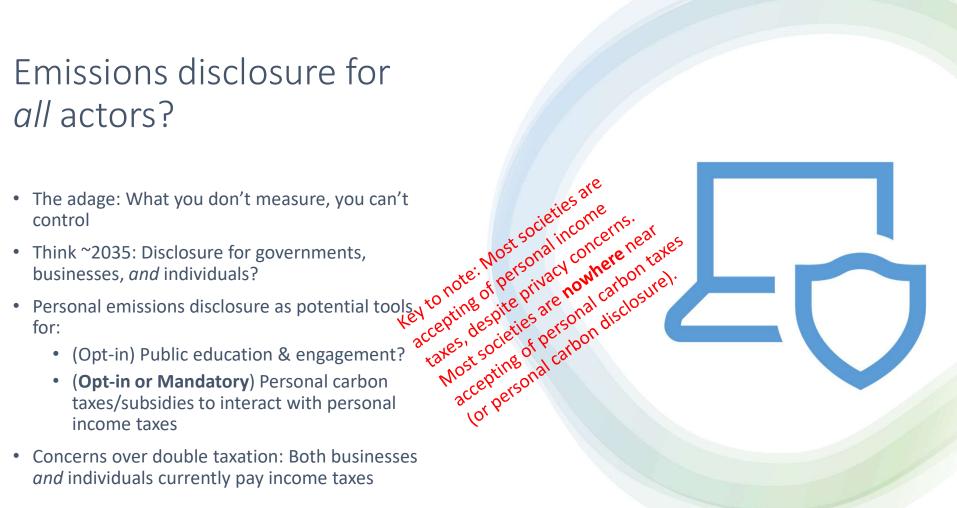
Emissions disclosure for *all* actors?

- The adage: What you don't measure, you can't control

- Think ~2035: Disclosure for governments, businesses, *and* individuals?

- Personal emissions disclosure as potential tools for:
  - (Opt-in) Public education & engagement?
  - (**Opt-in or Mandatory**) Personal carbon taxes/subsidies to interact with personal income taxes

- Concerns over double taxation: Both businesses *and* individuals currently pay income taxes

Key to note: Most societies are accepting of personal income taxes, despite privacy concerns. Most societies are **nowhere** near accepting of personal carbon taxes (or personal carbon disclosure).

NUS Institute for Public Understanding of Risk

NUS Sustainable and Green Finance Institute

Sumit Agarwal is the Low Tuck Kwong Distinguished Professor of Finance, Economics, and Real Estate at National University of Singapore (NUS) Business School and managing director of the Sustainable and Green Finance Institute (SGFIN) at NUS.

Alberto Salvo is associate professor of economics at NUS and a research affiliate at SGFIN.

Ask NUS economists

How would a person's carbon scorecard work?

One way to assess the impact of your carbon choices is by tracking digital spending

Source: *The Straits Times*, pA18
Date: 22 April 2022

Carbon scorecard: informing consumers so that they learn to do their bit

Source: *The Business Times*, p19
Date: 1 March 2022

Introducing this will help people make more environment-friendly choices. BY SUMIT AGARWAL AND ALBERTO SALVO

The three sectors in which households most influence carbon emissions – that is, have a large carbon footprint – are utilities such as electricity and water; transportation; and food, including plastic packaging that ends up incinerated.

We propose that Singapore develop a carbon score for individuals. Just as individuals have a credit or health score, they can have a carbon score.

Few consumers realise that the "green" difference between eating beef and a diet rich in plant protein is about 25 times. While not as green as beans and lentils, even chicken and pork fare better than red meat farmed from ruminant livestock.

Should society choose this path, in future, we can tax households progressively according to their annual carbon footprint, similar to how authorities tax individual income. For instance, the carbon tax rate can be zero up to a threshold of 5 tonnes per year; S$5 per tonne for the next ton; S$10 per tonne for the next ton, and so on. Most individuals would fall in the first bracket and pay no annual carbon tax.

NUS | National University of Singapore — Sustainable and Green Finance Institute

Consumption Carbon Footprint: Country Level Data Framework
SGFIN Whitepaper Series #9

Consumption Carbon Footprint: Country Level Data Framework

Badarinza, F., Enerio, J., Joshi, D., Sulaeman, J. and Agarwal, S. (2025). Consumption Carbon Footprint: Country Level Data Framework, SGFIN Whitepaper Series #9.

Meaningful action stems from education, and education starts with information. We at SGFIN would like to contribute to the global effort of empowering individuals with actionable insights on sustainable lifestyles, by building a country agnostic model allowing for the estimation of household carbon footprints.

As public debates continue to dispute who bears the responsibility to act, when and how much, we believe that there is an effort we all need to make at a personal level – to understand the environmental impact of our consumption, and to strive to make changes towards more sustainable lifestyles.
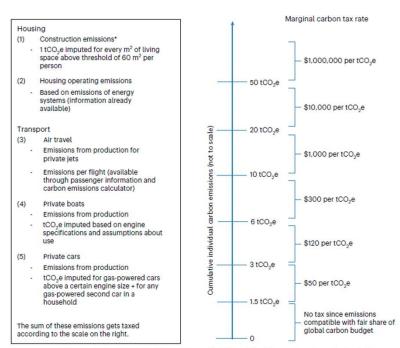
Given available technologies, current consumption behaviour is incompatible with the goal of keeping global warming below 2 °C. Economists present carbon pricing as the most efficient tool to induce people to adjust their consumption behaviour. This Perspective critically analyses the ethics, economics and politics of one key form of carbon pricing: carbon taxes are levied to discourage fossil-fuel-intensive consumption. The core claim of this Perspective is that progressive individual carbon taxes (that is, taxes whose rate increases the more emissions an individual generates) are not only more effective but also more just than the flat-rate carbon taxes prevalent today.

Fig. 4 | A proposal for a progressive carbon tax schedule. Categories of emission sources on the left, marginal tax rates for different emission brackets on the right.

Key to note: Most societies are accepting of personal income taxes, despite privacy concerns. Most societies are **nowhere** near accepting of personal carbon taxes (or personal carbon disclosure).

Two NUS experiments, seeking to educate climate citizens, rather than nudge behaviour

Incentivized personal carbon scores lower the carbon intensity of urban mobility and spill over to pro-science climate attitudes

Research team:

National University of Singapore (NUS)

Alberto Salvo (PI, Economics & Climate Action Council), Leonard Lee (Co-PI, Institute for the Public Understanding of Risk & NUS Business School), Yuen Wei Lun (Marketing), Lynn Tay (Sociology), Lim Fang Ding (Economics), Suveen Ellawela (Computer Science), Charleston Chan (PPE), Tan Jia Min (Engineering)

Land Transport Authority (LTA)

Leong Wai Yan (Chief Transport Economist—at the time), Yong Hui Le (Transport Economist—at the time)

Motivation of study 1

- How to raise the public's engagement with the interconnected climate-biodiversity-plastic crises?
  - Globally, political leaders are timid given the scale of the problem
  - Public acceptance matters

- Can positive and hopeful messaging and rewards in a specific consumption domain spill over to climate-change policy support?
  - Go live every February as part of a Singapore Climate Awareness month?

- Are individuals accepting of personal carbon scoring (privately)?
  - Atmospheric carbon is the new currency in town

Building blocks in the urban mobility RCT

- Building blocks
  - (from product…) Carbon labelling
  - (…to person) Personal carbon scores
  - Positive, hopeful messaging of more local co-benefits, e.g., active mobility, safer travel
  - Testimonials by peers
  - Low-carbon rewards

- Focus on educating climate citizens

RCT sample: Young adults (window of opportunity)

Participants: NUS undergraduates
- *Research on consumption patterns of different demographic groups in Singapore*
- 16-week study: January to May 2024 (total ~120 minutes of participation)
- Earn between $100-$110

- **Effective sample size, N = 327** (power calculation)
  - 59% female, mean age 21y, 57% living off campus, 81% no family car
  - Randomly assigned into a control group and two treatment groups (balancing tests)

- Participants maintained an 11-week **personal travel diary**, shared transactions from transport platforms, and stayed tuned by Telegram/email

Building block: Personal carbon scores

Week 6: Monday 26 February to Sunday 3 March		Participant: Yuen Wei Lun	Your average carbon score from Wks 6-8 (g of CO2 per km)	Total motorized distance traveled from Wks 6-8 (km)
Friendly note:	Remember that fewer car rides are choices that you can take to protect our climate, our rainfall, and our sea level.		**118**	52

Day of the week	Date	Trip No.	Origin Description	Postal code, address, landmark description	Destination Description	Postal code, address, landmark description	Travel Mode	(For private car rides only) Size of traveling party	Average CO2 emissions (g/km) since Week 6 to this trip	Distance on Googlemaps
Monday	26/2/2024	1	Home	688646	School	NUS Kent Ridge campus	Public transport (e.g., M... ▼		40	17.8 km
		2	School	NUS Kent Ridge campus	Lunch	West Coast Plaza	Walking ▼		NA	3.4 km
		3	Lunch	West Coast Plaza	Shopping	Ion shopping mall	Private car (e.g., taxi, rid... ▼	2	67	14.3 km
		4	Shopping	Ion shopping mall	Home	488D Choa Chu Kang Avenue 5	Private car (e.g., taxi, rid... ▼	1	118	20.0 km
		5					(Please select an option) ▼			

Individual choices ∩ carbon labels → Personal carbon scores averaged over 3-week periods

Our carbon labels: A hierarchy accounting for limited bandwidth
    (1/1) Car, single rider: 200 g of CO_2 per km
    (1/2) Car, shared rider: 100 g of CO_2 per km
    (1/5) Public transport: 40 g of CO_2 per km

Building block: Low-carbon rewards

Week 6: Monday 26 February to Sunday 3 March	Participant: Yuen Wei Lun	Your average carbon score from Wks 6-8 (g of CO2 per km)	Total motorized distance traveled from Wks 6-8 (km)
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		5					(Please select an option) ▼			

Low-carbon rewards by 3-week period:

$5 for average carbon score ≤ 60 g of CO_2 per km

Another $5 for average carbon score ≤ 45 g of CO_2 per km

Environmental education and spillover effects
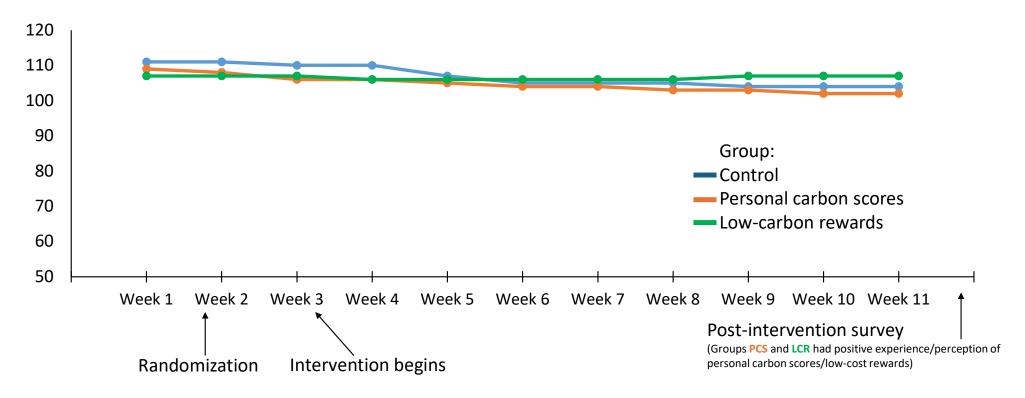
- Less interesting: **Domain-specific**
  - Exposure to environmental education and low-carbon rewards did shift observed behaviour
  - Treatment reduced (stated) agreement with the environment having "little" or "no" influence on a participant's public transport choices

- More interesting: **General views**
  - Stronger general pro-environment attitudes among treated participants than in the control group, e.g.,

  With our current lifestyles, humans are abusing the environment.
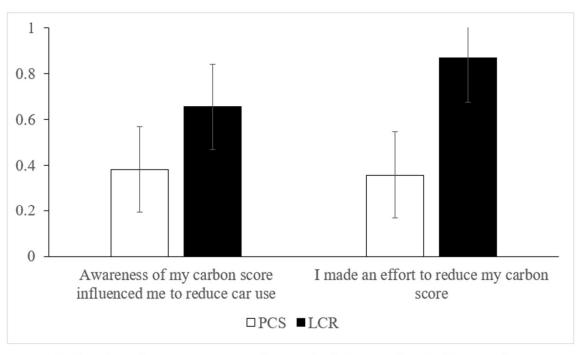
  Actions to reduce environmental impact are very important for people to consider when getting around, shopping, and at home.

Very high engagement across all groups

Group with most exposure: No attrition from week 1 to week 11

Engagement with personalized education

Notes: We linearly code responses to questions on the influence of, and effort to reduce, one's carbon score as Strongly Disagree = −2, Disagree = −1, …, Strongly Agree = 2. The vertical axis shows the mean agreement score among subjects in each group with the indicated statement.

*"initially i had always been someone who took grab to school, but participating in this programme has made me change my habits, and i now try my best to take public transport. this active change has actually lifted my mood, and i really do enjoy walking and taking the bus now. i believe it is **little choices like this that help reinforce a sense of hope** that we have some agency over the outcomes of climate change."*

~ Participant C
(who wrote in voluntarily)

Enhancements to the NUS Dining App
A beta version for participating NUS Residential Colleges
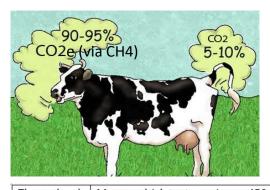
Motivation of study 2
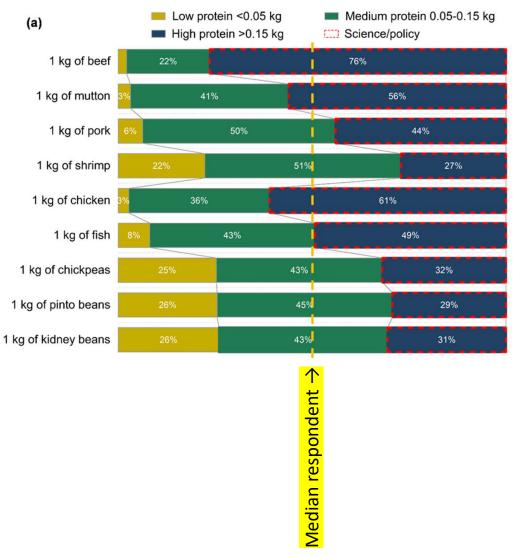
- Similar to study 1, except in the food domain

- Address nutrition-climate knowledge gaps in food

- Global food system today
  - ~25% GHG emissions & ~50% habitable land
  - Exacerbates the twin climate and biodiversity challenges
  - Growing meat consumption

- Co-benefits beyond sustainability
  - Human health, animal welfare, food security, zoonotic disease risk, antibiotic resistance

Theme (e.g.)	Message (rich text, maximum 450 characters)
Explainer/ Protein	HealthXchange.sg by SingHealth (MOH) has been promoting the benefits of whole foods. Singapore General Hospital's Dr Ng Lee Beng advises to **"swap a few meals a week for more plant-based meals", including plant sources of proteins**. HealthXchange.sg notes that "the American College of Lifestyle Medicine recommends an eating plan based predominantly on **a variety of minimally processed vegetables, fruits, whole grains, legumes, nuts and seeds.**" 💪 🌍
Protein	At the annual meeting of the Global Pulse Confederation in Singapore this May, Temasek head for agri-food, Anuj Maheshwari, noted: "**Growing up in India, one hears 'Eat your Dal, child, if you wannabe strooOONG!**'" To a roomful of applause, Mr Maheshwari further quipped of the planetary benefits of plant proteins: "**If beef is the Hummer, pulses are the electric car**". 👌 🌍 Pulses = beans, lentils, chickpeas, etc.
Protein/fats/ health	Do you have friends or family with high cholesterol? A top tip in HealthXchange.sg's 9 Ways to Lower LDL (Bad) Cholesterol Naturally is: "Cut back on cholesterol-rich foods, saturated fats and trans fats. **Cholesterol is found in foods of animal origin such as meat and poultry.**" The story further notes that **plant foods and whole grains—foods high in fibre and good sources of protein—** can help reduce your risk of heart disease.

Knowledge gap: *For a protein-rich meal, I need to eat animal meat*

Agriculture's climate damage and biodiversity loss

LETTER

Increased transparency in accounting conventions could benefit climate policy

Gerard Wedderburn-Bisshop [iD]

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Abstract

Greenhouse gas accounting conventions were first devised in the 1990's to assess and compare emissions. Several assumptions were made when framing conventions that remain in practice, however recent advances offer potentially more consistent and inclusive accounting of greenhouse gases. We apply these advances, namely: consistent gross accounting of CO_2 sources; linking land use emissions with sectors; using emissions-based effective radiative forcing (ERF) rather than global warming potentials to compare emissions; including both warming and cooling emissions, and including loss of additional sink capacity. We compare these results with conventional accounting and find that this approach boosts perceived carbon emissions from deforestation, and finds agriculture, the most extensive land user, to be the leading emissions sector and to have caused 60% (32%–87%) of ERF change since 1750. We also find that fossil fuels are responsible for 18% of ERF, a reduced contribution due to masking from cooling co-emissions. We test the validity of this accounting and find it useful for determining sector responsibility for present-day warming and for framing policy responses, while recognising the dangers of assigning value to cooling emissions, due to health impacts and future warming.

Knowledge gap: *Food is natural and renewable, so low on resource demands*

This **anonymous** survey consists of four questions and then a few quick questions about yourself. It should take <5 minutes to complete and as a token of appreciation you will earn $5. Some questions may not be easy; that is OK, please just answer to the best of your knowledge or perception, without consulting the internet. Thank you.
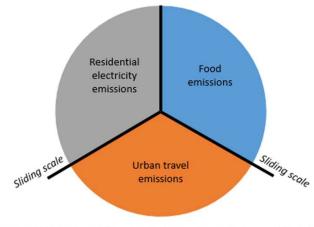
Question 1.

A "carbon score" (or carbon footprint) is the total amount of greenhouse gases, measured in grams of CO_2 equivalent (**g CO_2**), emitted to produce and use a product. For **food**, this includes emissions from farm to retail; for **air conditioning**, from natural gas extraction to electricity generation and use; and for **car rides**, from oil extraction to driving. In Singapore, most cars use petrol, buses run on diesel, and trains use electricity.

Now, consider a typical NUS undergraduate's family—usually living with parents in Singapore before university. About 50% of families own a car, and about 80% have air conditioning at home.
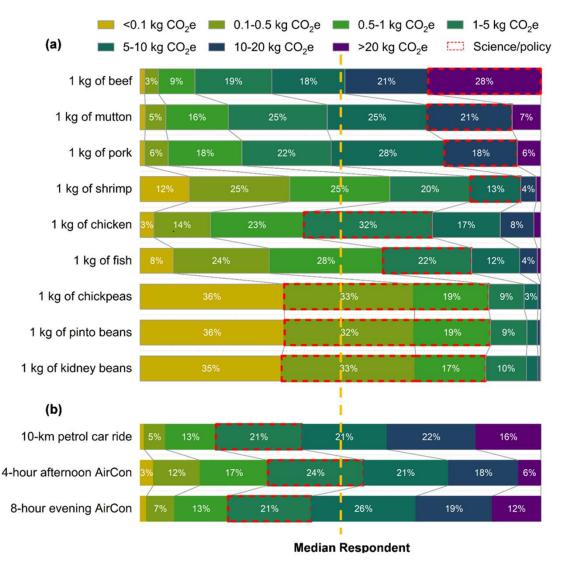
Over a month, estimate **what proportion of this average family's CO_2e emissions comes from: (1) food, (2) urban mobility, and (3) residential electricity use.**

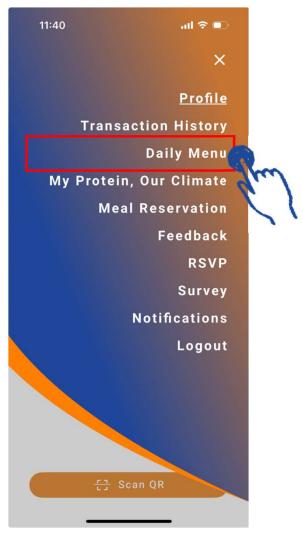**Sectoral share of average NUS student's family CO_2e emissions**

■ Food emissions ■ Urban travel emissions ■ Residential electricity emissions
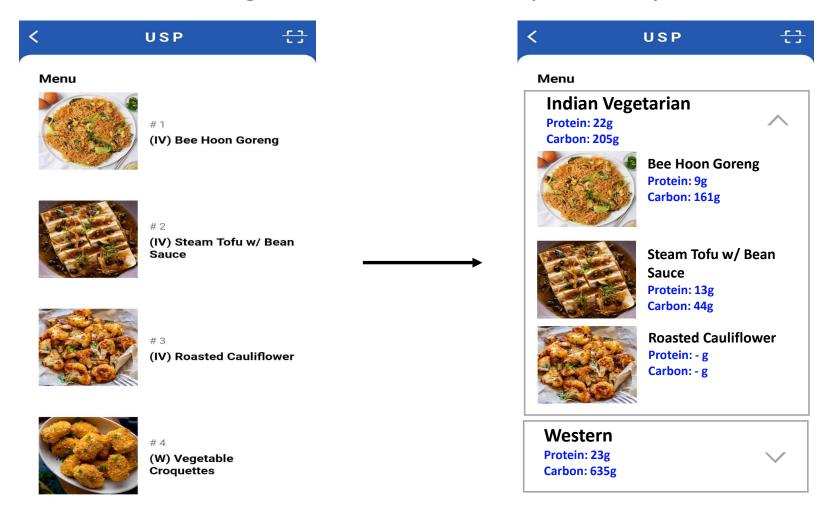
Knowledge gap:
Emissions from beef vs. chicken vs. plant proteins vs. car rides

"My Protein, Our Climate" education feature 1

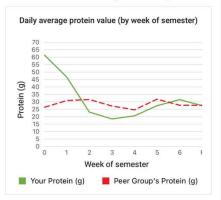# Enhanced dining menu: Personal & planetary health
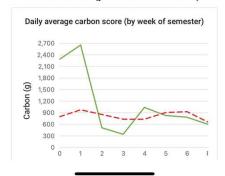
"My Protein, Our Climate" education feature 2

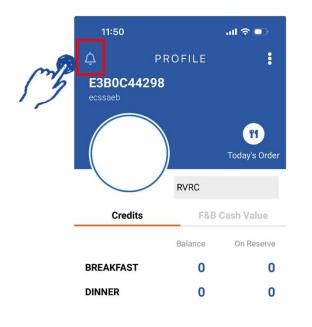Personalization (strictly private, just like Transaction History)
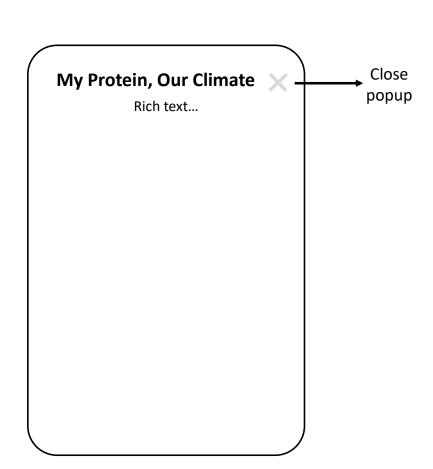
"My Protein, Our Climate" education feature 3
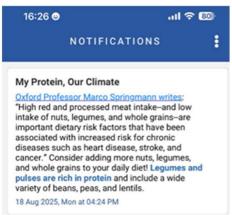

Close popup

Key: Educate rather than nudge deeply personal choices

Four examples of (at most) weekly messages, overseen by an inter-disciplinary Review Board

Welcome to the new dining semester! Your College is participating in a beta version of **My Protein, Our Climate**, a new personal information feature in the NUS Dining App. If interested, it will privately inform you on a weekly basis of **two specific attributes of the food you purchase at your College**: (i) Your **daily average protein intake based on these purchases**, and (ii) The **daily carbon equivalent emissions associated with your food purchases**.

HealthXchange.sg by SingHealth (MOH) has been promoting the benefits of whole foods. Singapore General Hospital's Dr Ng Lee Beng advises to **"swap a few meals a week for more plant-based meals", including plant sources of proteins.** HealthXchange.sg notes that "the American College of Lifestyle Medicine recommends an **eating plan based predominantly on a variety of minimally processed vegetables, fruits, whole grains, legumes, nuts and seeds.**"

Following on from last week's message on the beta version of **My Protein, Our Climate** 💪🌍. Note that the feature does not capture foods you consume outside of your College and is based on averages and estimates. If you enjoy this information about your food, please help us improve and expand this service in the years to come.

A food's carbon label estimates the **greenhouse gas emissions (in grams of CO2e)** required to grow and deliver the food to you in Singapore, **from "farm to fork"**. These emissions include methane emitted by cattle or rice paddies, and CO2 emitted on transport. **My Protein, Our Climate** 💪🌍 shows your **average carbon scores**, alongside your **average protein scores**, based on your purchases and average servings at the College canteen.

General policy opportunity

- Systemic change needs public support
- Demand for FinTech platforms to track one's choices
  - **Opt-in + open-data** regulations (UK): Need to safeguard privacy
  - Integrate **local co-benefits**, e.g., nutrition, step tracker, planetary health (CO_2), monetary cost
  - Bring into the disclosure effort, into the problem and the solution
- Tool for public engagement, manage eco-anxiety (on the rise)
  - Until energy and protein transitions are underway (2040?)
  - Link between education, accountability, and support for costly decarbonisation
  - C., a subject in the urban mobility project, volunteered:

  It is little choices like this that help reinforce a sense of hope that we have some agency over the outcomes of climate change