



DRIVING TRANSFORMATION

Behavior, Energy & Climate Change (BECC) / November 12-15, 2023 / Sacramento, CA

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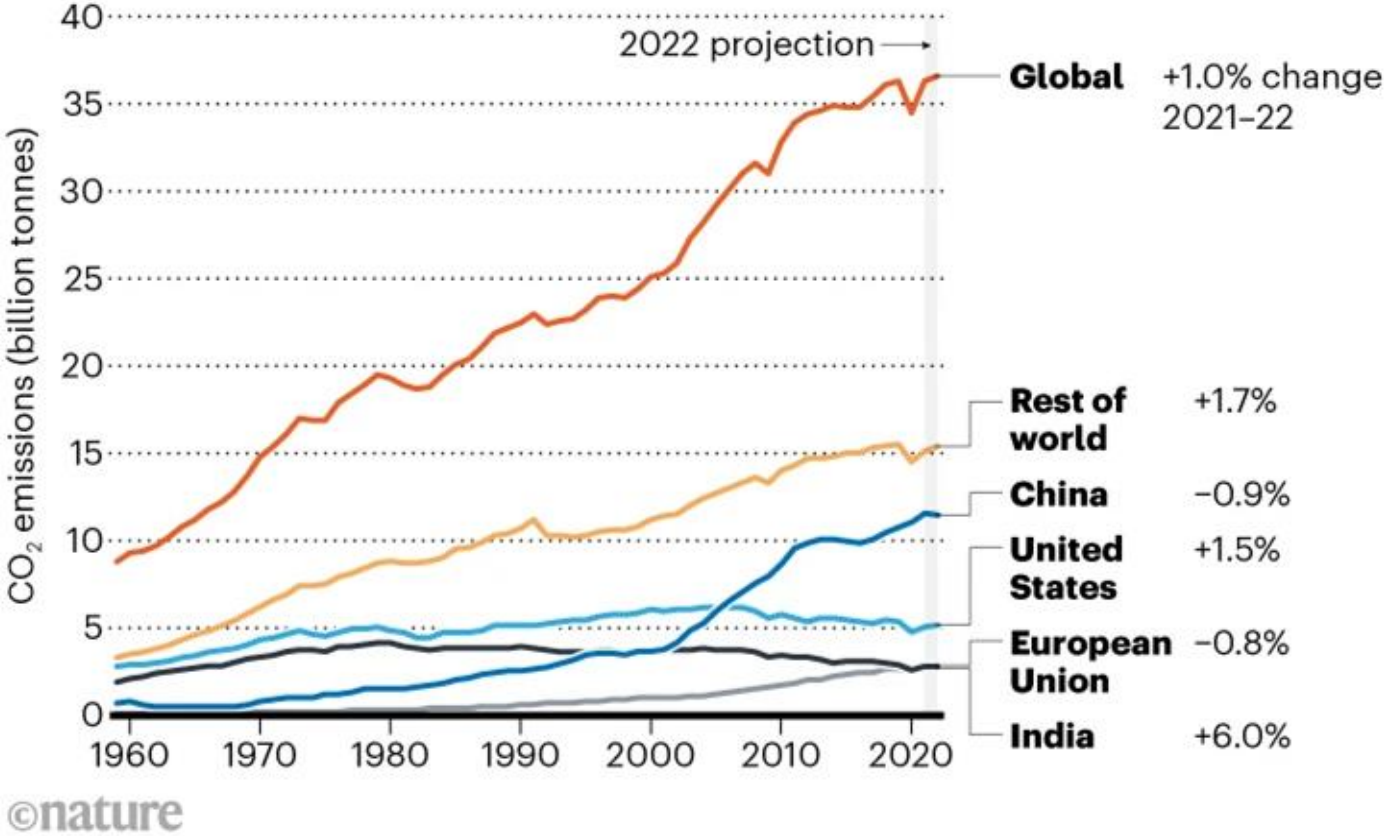
Sufficiency for a Fair and Equitable Energy Transition

November 13, 2022

Max Wei | Staff Scientist/ Lawrence Berkeley National Lab

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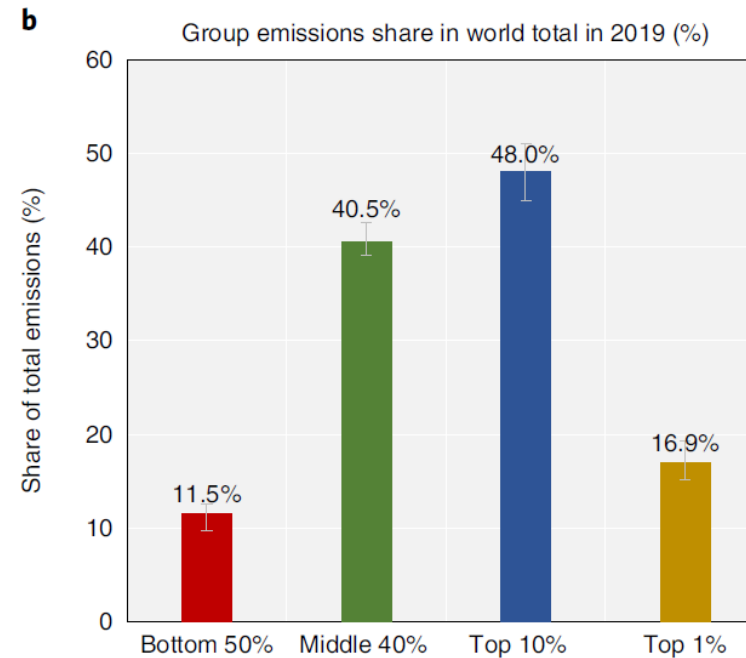
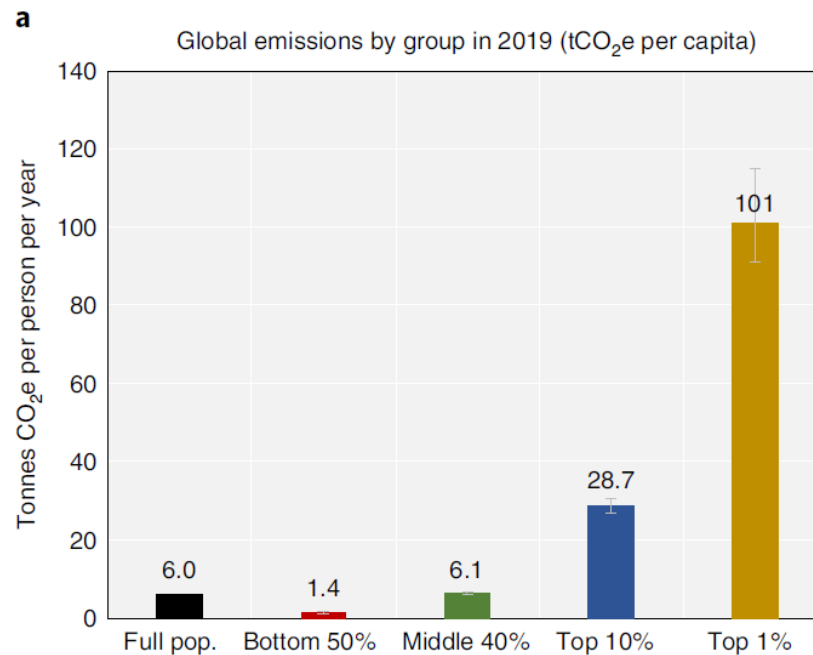
GHG Emissions still increasing



Global carbon emission trend (1960-2022)

Source: Global Carbon Report

Extreme global carbon inequality



- Extreme GHG emissions inequality
- Top 10% have 48% of emissions, Top 1% 17% (rt.)



Why big changes beyond technology are needed to ensure a livable, stable planet

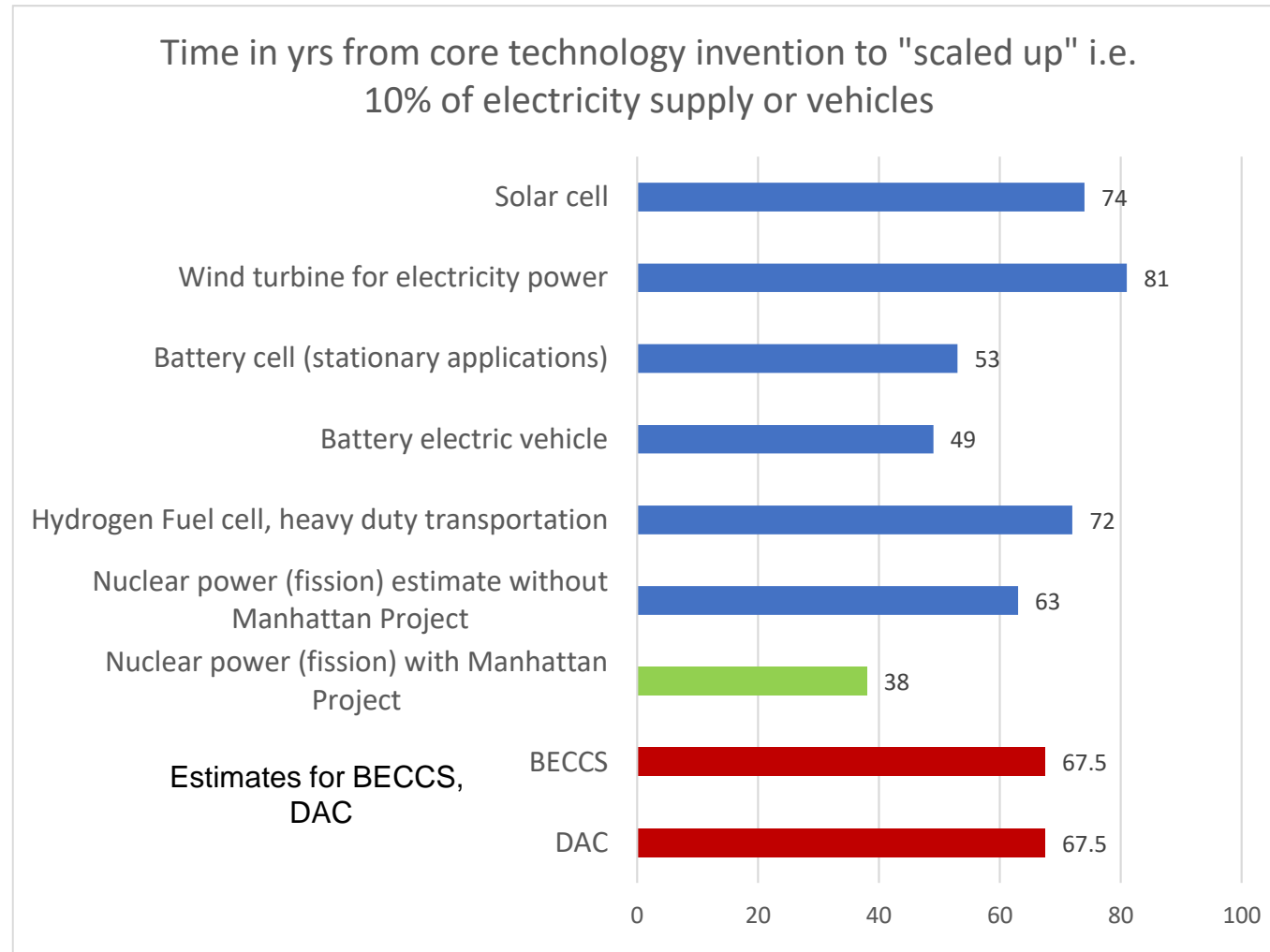
- 1.5 °C reached as early as 2028
- Increasing risk of climate tipping points above 1.5 °C and several tipping points may be breached already → much greater risk to previously stable climate system (Holocene Era)
- Current decarbonization approaches that assume BAU growth lack the **scale, scope, and speed** to decarbonize and stay within safe planetary space
- Rapid and aggressive transformation are required to meet net-zero targets

“Any transition towards sustainability can only be effective if far-reaching lifestyle changes complement technological advancements”

Wiedmann et al., 2020, [Nature Communications](#)



Running out of time: new technologies typically take about 70 yrs to scale up



Median for 6 energy supply technologies: 68 years to scale up from core technology
Invention, start at 2005 for illustration

Note: 38 years for Nuclear fission with Manhattan Project (all-hands-on-deck \$25B, 4 year project in the desert)



Four factors to reduce GHGs

Population

Energy Conservation

Energy Efficiency

Clean Energy

$$\begin{aligned} \text{Total GHG/yr} &= \text{Pop.} \times \text{Consumption} \times \text{Efficiency} \times \text{GHG Intensity} \\ &= \text{Pop.} \times \frac{\text{Consumption}}{\text{capita}} \times \frac{\text{Energy}}{\text{Unit Consumption}} \times \text{GHG intensity} \\ &\hspace{15em} \text{(GHG per unit energy)} \end{aligned}$$

Terms

Pop. = Population

Consumption per cap e.g.

- Housing size/ density
- Diet
- Car size
- Vehicle miles travelled

Energy/ unit consumption = therms/sq ft, kWh/ft²
 gallons or kWh per mile [or 1/MPGGe]
 CO₂, N₂O, CH₄/ per lb of food
 embedded emissions per ton of car

GHG intensity : kg CO₂e/kWhe (carbon intensity of electricity)
 kg CO₂e/therm heating (carbon intensity of heating)

Objective Consistent with Zero GHG/yr

Contained pop. Growth

Energy Conservation

Energy Efficiency

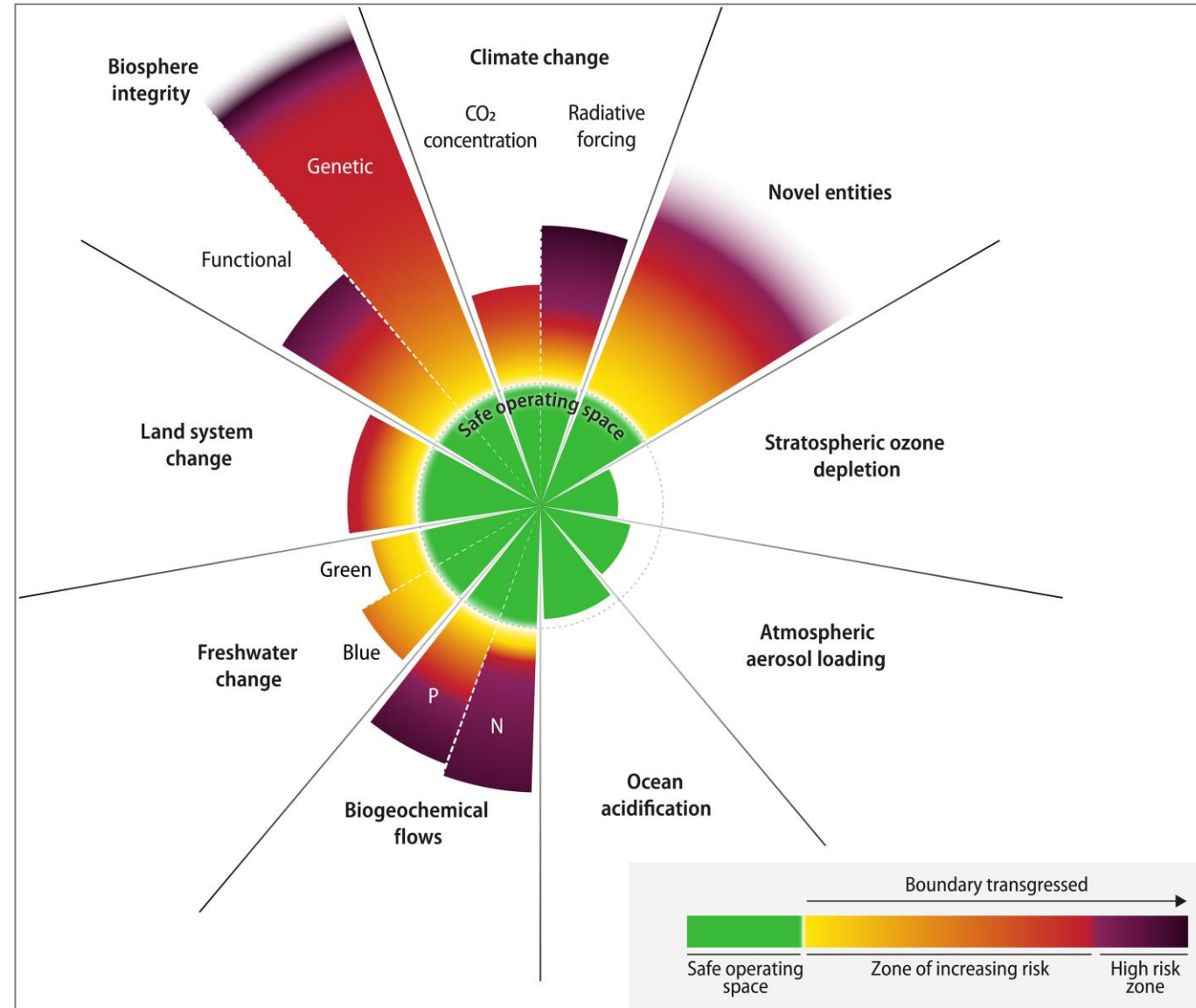
Zero carbon electricity
 Zero carbon fuels



What is sufficiency? Energy conservation to avoid further breaching planetary boundaries

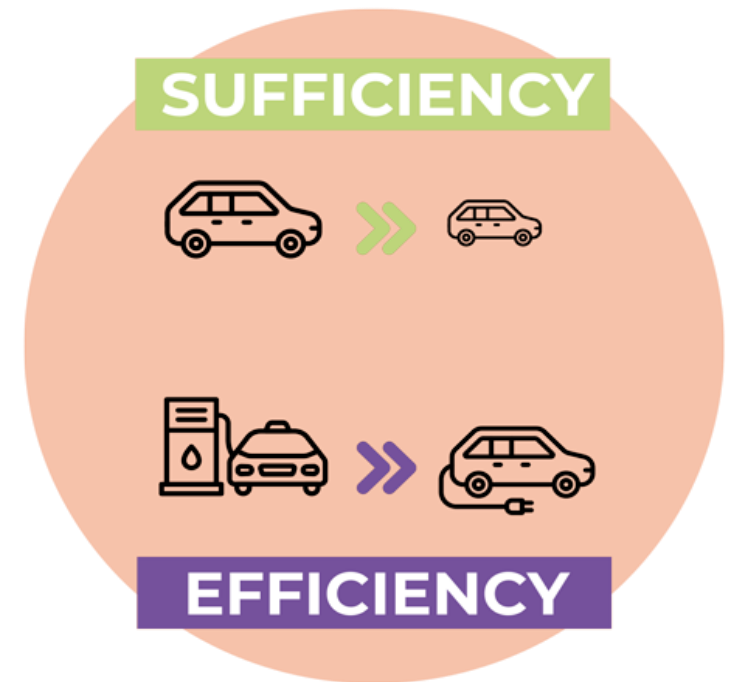
- **Earth beyond six of nine planetary boundaries**
- A renewed wake-up call to humankind that Earth is in danger of leaving its Holocene-like state (last 12,000 years of stability)

“When you’re in a hole, stop digging”



Sufficiency is about reducing absolute demand through **changes in behavior, lifestyle**, and collective organization through **technology and policy innovations** while delivering human well-being.

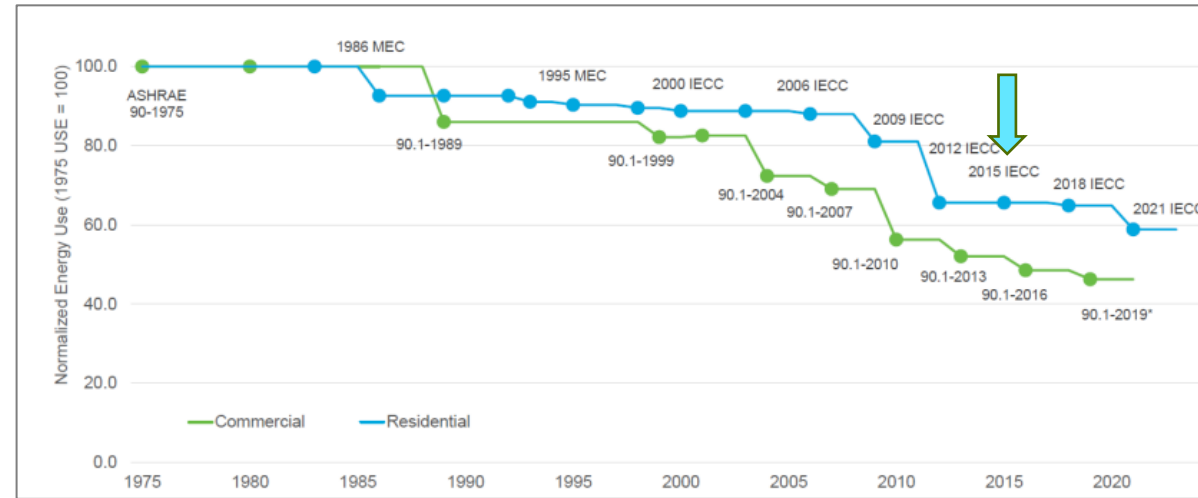
Reducing consumption **IS POSSIBLE** while maintaining good living conditions & well-being.



Energy savings in an average new single family home since 1975 is much lower when larger home sizes taken into account

- Building codes: ~35% normalized energy savings from 1975 to 2015
- But home sizes increased by 60% and by 75% on a per capita basis
- Larger homes and smaller household sizes reduce energy savings per capita to ~ 9%
- Larger homes mean more stuff
- Suburban, exurban homes can mean more driving

*The planet doesn't care about relative savings.
The planet cares about absolute GHG reductions.*

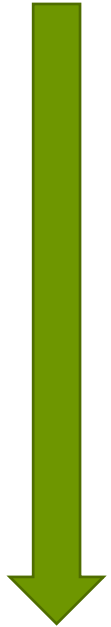


Why sufficiency? Many important reasons...

- Potential for **deep demand reduction**
- **Eases the broader decarbonization** effort
- **De-risks** future dependence on unproven technologies
- Potential **co-benefits** such as resilience, equity, and well-being
- **Avoid disruptions** from forced sufficiency
- **De-risks** future resource conflicts



How to achieve sufficiency



*Increasing
Impact?*

- Education
- Behavior change (change narratives and shift norms)
- Technology-facilitated sufficiency
- Policies & Regulations (e.g. disincentives for overconsumption)
- **Technology, Policy, and Social Innovations**
- **Paradigm change** – move away from our consumption-based economy



Solow and others on growth, well-being, and status

“I do not think that growth itself is or should be a particular objective for a modern economy.”

Nobel economist Robert Solow of “Solow Growth Model” (2023)

“The fundamental problem with economics is ... most economists measure human well-being in monetary terms.”

Nobel economist Angus Deaton (2023)

“Social esteem or value is connected to what we can consume...Money displayed in terms of consumer goods just becomes a measure of worth”

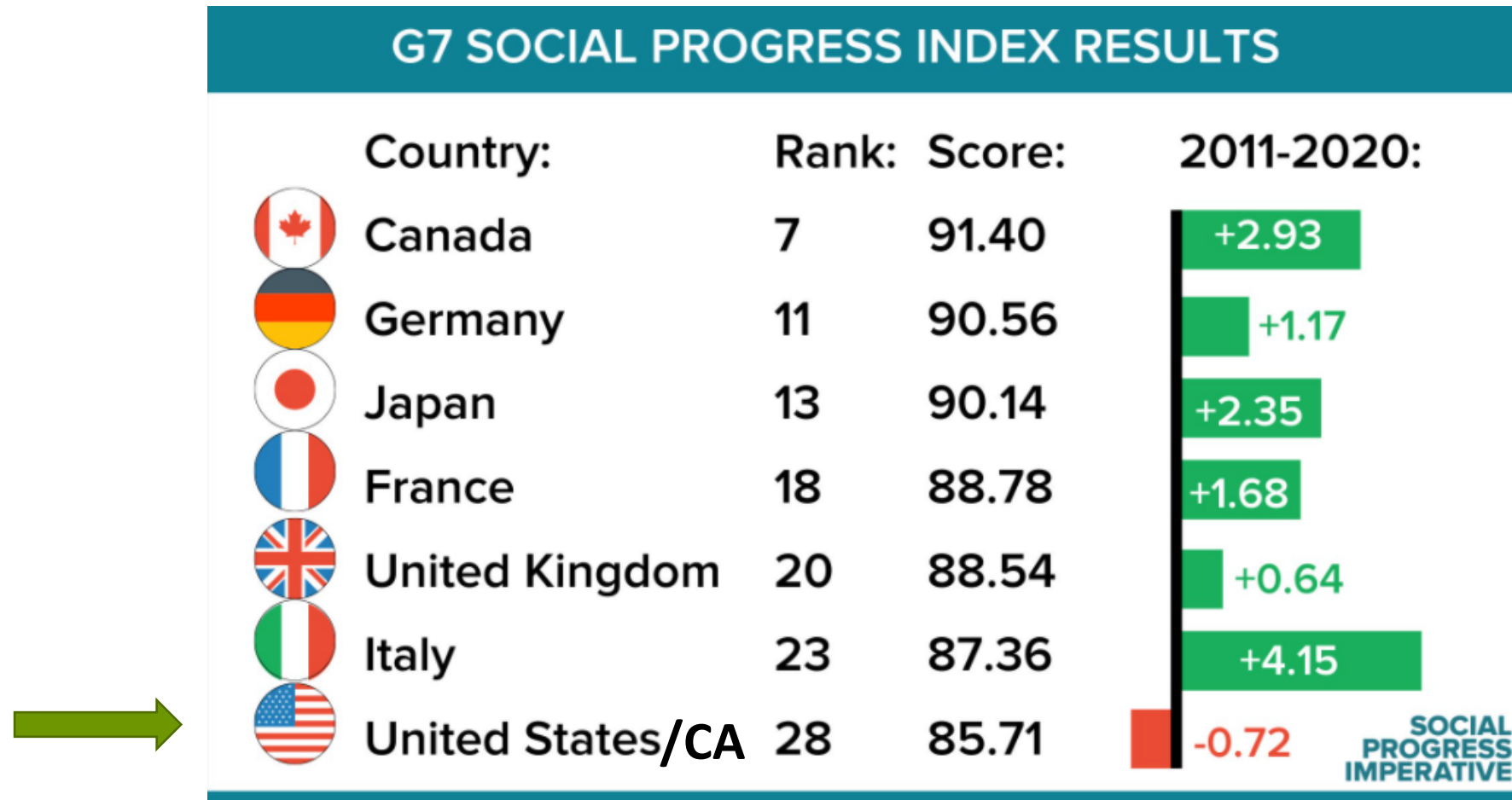
Juliet Shor, sociologist/economist on why we buy too much (2021)

***Need to evolve from sole focus on economic growth
& rethink what we value and what societal objectives are***



Material well-being is no guarantee of social progress

US is #28 and deteriorated from 2011 to 2020



(Pre-COVID data)

Some action areas for greater sufficiency

What?	How? Examples
Higher density development	Less restrictive zoning, ADUs
Right sizing, less consumption	Overconsumption fees/taxes, feebates
Less driving	Urban planning, land use planning
Food & Diet	Education, school purchasing
<i>Metrics, frameworks</i>	<i>Repairability, extended lifetime, multi-functionality, utilization</i>



*Food/diet example:
A mindset of Ingenuity and Creativity
for something delicious*





Centenarians:

**Sufficiency in materials
Plant-based diets
Abundance in real human
connections and activities &
activity**

Today's discussion

How do we quickly achieve
much greater sufficiency (& equity)
together with energy efficiency and clean energy
to ensure the best chance
for a stable and livable planet?



Sufficiency as a Strategy for Building Decarbonization

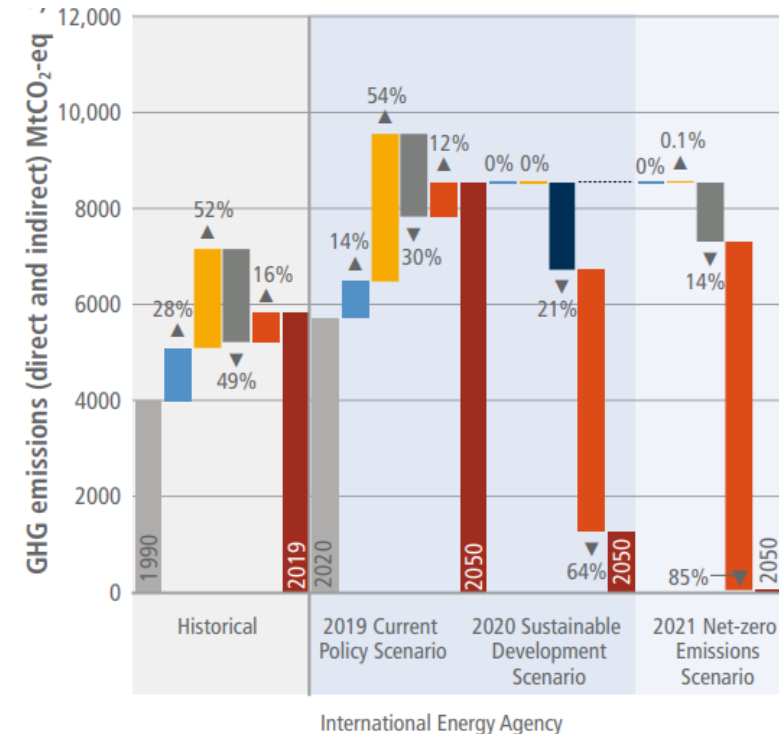
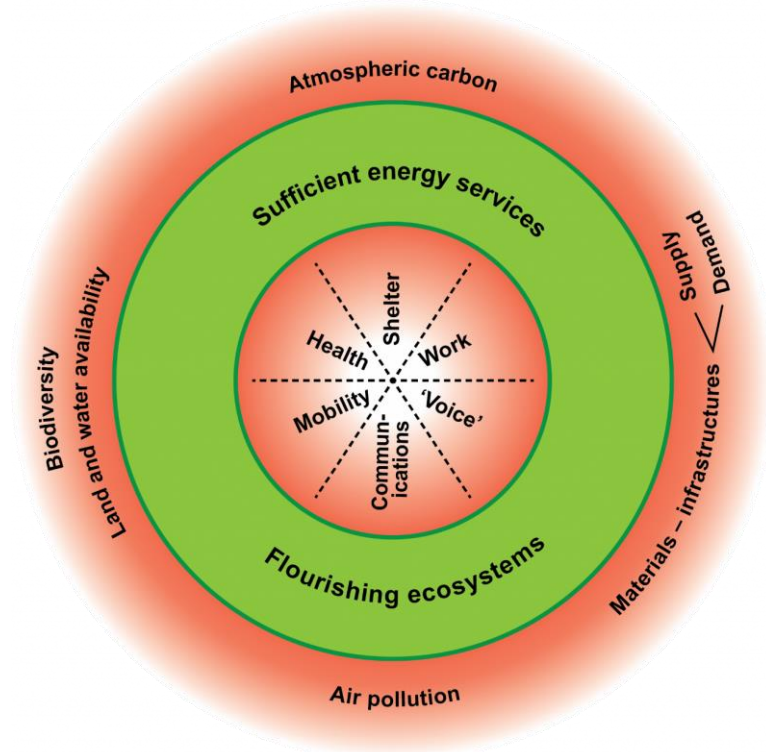
November 13, 2022

Jeetika Malik | Postdoc Researcher, Lawrence Berkeley National Lab

Convened by:

Sufficiency in Buildings

Building Energy Sufficiency is about reducing absolute energy demand through **behavioral and lifestyle changes** by enabling **technology and policy** innovations.



International Energy Agency

▲ Shows the increase of GHG emissions because of the lack of sufficiency measures and the slow penetration of renewable

Legend: Total – 1990, 2020; Population; Efficiency; Sufficiency; Renewables; Total at the end of the period – 2019, 2020 and 2050

Sufficiency: A state in which people’s basic needs for energy services are met equitably and ecological limits are respected. (Darby and Fawcett 2018)

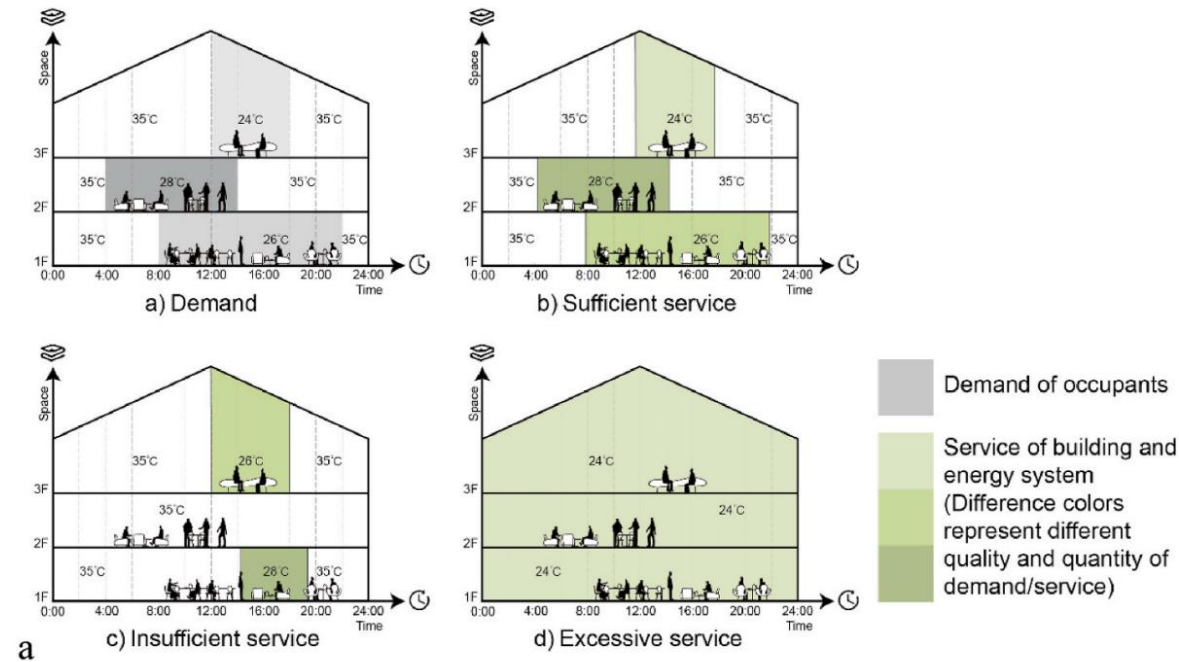
Lack of sufficiency policies* accounted for 52% growth in global residential emissions (IPCC, 2022)

*considers only floor area reduction

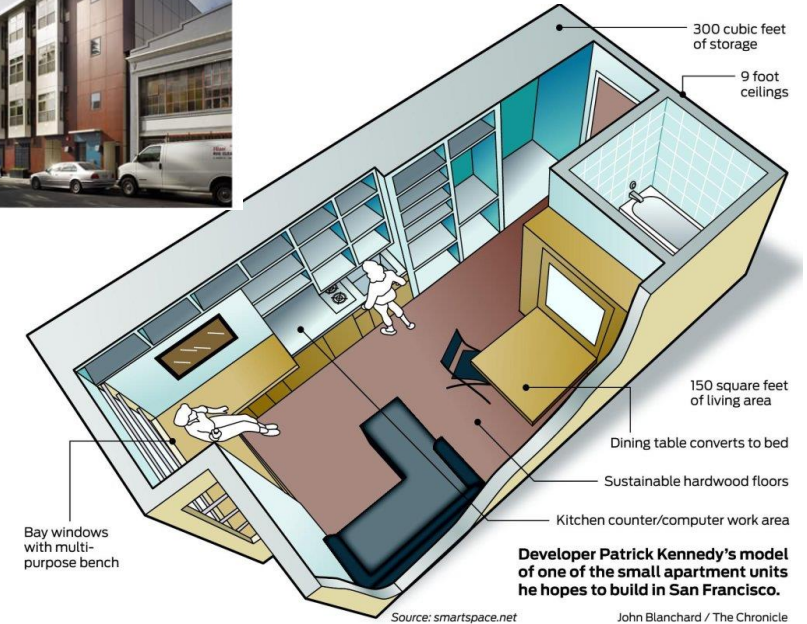


Sufficiency is more than behavioral change...

Enabling Technologies and Policies



Technology: Decentralized building terminals for flexible adaptability (Hu et al. 2023)

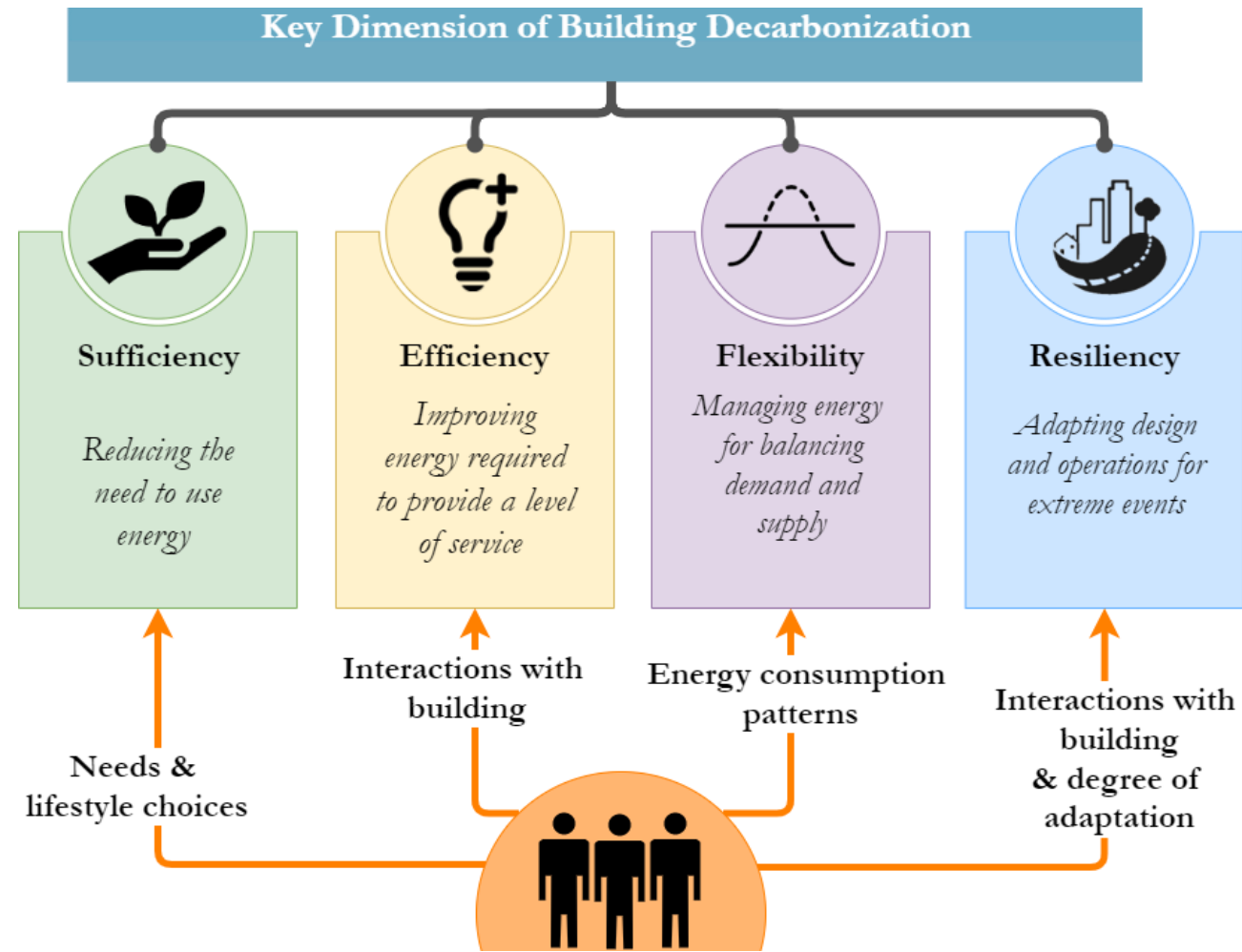


*CITYSPACE® project, S.F. completed in 2013
 LEED Platinum certified*

Policy development: Amendment to SF building laws in 2013 - minimum dwelling size from 290 sq. ft to 220 sq ft.



Prioritize energy sufficiency for building decarbonization



Malik et al., 2023. *Prioritize energy sufficiency to decarbonize our buildings*, Nature Human Behaviour.

Sufficiency as a response to energy crisis



Germany: Issued a set of recommendations

- Public buildings and office buildings to stop heating in transition spaces such as corridors or large halls.
- Got rid of a requirement for tenants to maintain a minimum temperature in apartments.
- City level: reducing street lighting and setting temperature limits in public buildings.



Italy: Drafted an emergency savings plan

- Limiting heating to 19 degrees and cooling to 27 degrees.
- Reducing street lighting at night and closing shops early.



Spain: Adopted a radical approach

- Businesses to curb air conditioning at 27 degrees in summer and heating to 19 degrees.
- Install automatic locks to prevent doors from being left open while heating systems are running
- Shopfronts to go dark from 10 p.m.



Finland: A nationwide energy-saving campaign

- A degree lower: turn down temperatures on internal heating by at least one degree.
- Shorter showers, a call to limit showers to five minutes.

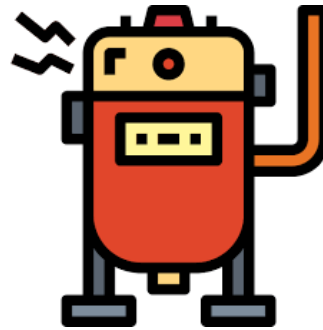


Examples from around the world



French Energy Sobriety Plan

- Aim at reducing 10% our overall energy consumption by 2024.
- Measures- maximum temperature of 19°C in public buildings, dimming or turning off public lights at certain hours, teleworking etc.



UK Boiler Plus Standard- improving the way people use energy in their homes, giving people a greater choice to maximize energy efficiency.



Right to repair- making repair of appliances an appealing option, extending product lifetime.



EU 'Save Energy' Directive



India's Mission LiFE



Correcting the misconceptions around Sufficiency

Profound lifestyle changes are required to implement sufficiency and our lifestyles CAN change!

Example, Smartphones changed the way we communicate, inform ourselves, and consume

Preferences ARE malleable- these changes can be stimulated by a set of levers

Example, Covid-19 radically influenced the lifestyle practices and Video Conferencing tools enabled work-from home and changed workers preferences towards travel, work, etc.

Reducing energy consumption IS POSSIBLE while maintaining good living conditions and well-being.

Example, ≤ 75 GJ/ person is the energy sufficiency threshold, beyond which higher energy-consuming countries show no or little increase in health, happiness, well-being etc. (U.S. average- 268 GJ/person and global average 79 GJ/person).



Operationalizing Sufficiency...

- How can we integrate sufficiency with efficiency?
- What are the indicators for measuring sufficiency?
- How can sufficiency be mainstreamed?
- How to leverage technology and policy for operationalizing sufficiency?





Thank you

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Fostering Building Energy Sufficiency

Stakeholder	Action Items
Government & Policy Makers	<ul style="list-style-type: none">• Integrate voluntary sufficiency initiatives into the national decarbonization agendas (e.g. EU 'Save Energy' Directive)• Revise building codes and appliance standards• Restructure tax policies and split incentives between landlords and tenants (e.g. New Zealand government's Warmer Kiwi Homes program).
Building and Energy Scientists	<ul style="list-style-type: none">• Integrating the energy and carbon impacts of sufficiency measures into national decarbonization assessment modeling tools [such as SCOUT]• Model impacts of sufficiency measures such as heating, cooling, and reduction in appliance usage in other sectors including transportation, food and manufacturing.
Non-profit & community-based organizations	<ul style="list-style-type: none">• Promote energy-sufficient behaviors and energy literacy by harnessing behavior contagion and informational instruments• Partner with industry, government and science organizations to break down siloed thinking via engaging in true co-design (e.g. European Futures for Energy Efficiency).
Urban Planners, Architects, Designers	<ul style="list-style-type: none">• Implement participatory urban planning policies to promote energy sufficiency• Design flexible spaces and create co-living• Consider ecosystem services such as tree shading or urban greening to reduce cooling loads.
Technologists	<ul style="list-style-type: none">• Engage with other disciplines such as social scientists in co-design from the beginning.• Develop novel solutions such as appliances with higher quality and longer lifetimes, variable power options and improved serviceability• Implementing decentralize building systems (e.g. modular design of HVAC systems, portable air conditioners, heating and cooling chair)

Extra slide - Proposed panel structure – highlight equity/policies and how to leverage/add value to existing programs & policies

- Welcome
- Presentations – Max, Jeetika 25'
- Opening remarks by Susan, Reuven 5-10'
- I. Discussion topics (where/how can behavior-change related programs play a role) 30' including 10' q&A
 - Transportation-related considerations/ programs – Reuven
 - Does this include air flights?
 - Buildings-related considerations/ programs - Jeetika
 - If time: Food/diet-related discussion/ any programs?
 - Q&A#1 on these topics
- II. Discussion topics (making it cool/ values/ broader impacts) 25' incl. 10' q&a
 - Voluntary simplicity programs – Reuven
 - How to make this cool/ mainstream/normalized? - Susan
 - If time: Role of values/ethics; “Winners/Losers” & how to manage?
 - Q&A #2 on these topics