WHY WE NEED TO REDUCE OUR CONSUMPTION

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"Over the past 25 years, the richest 10% of the global population has been responsible for more than half of all carbon emissions... Rank injustice and inequality on this scale is a cancer. If we don't act now, this century may be our last."' Antonio Guterres, UN Secretary General

INTRODUCTION

Humankind's survival requires consumption of food, water, clothing, warmth, and shelter. Each of these basic needs are provided by the environment. Current material consumption includes consumption of fossil fuels, minerals, and resources provided by ecological systems. In early years of civilisation, production of the necessities of life was enabled by stint of human effort and the use of basic tools. Later on, domesticated animals provided additional motive power. In the developed countries, we now use energy slaves in the form of machines which use fossil fuels to replace human labour and beasts of burden (Cottrell, 1955). We also now rely on sophisticated technology in place of simple tools.

Energy, production, and consumption are inextricably connected. Although the human constructs of money and debt have facilitated transactions and purchase of both energy and materials used in the production of goods and services (Graeber 2014), it is ultimately energy, the prime mover, which enables and drives production which provides our goods and services for consumption (Smil, 2017). Energy is subject to the Laws of Thermodynamics, and it is these laws and not theories of economics which dictate the limits of production and consumption and subsequent viable pathways in a transition from fossil fuels to sustainable energy sources and infrastructure.

PLANETARY BOUNDARIES

Our planet Earth has a carrying capacity which supports myriads of life forms in various ecosystems. The survival of humans depends on the survival of life forms supported by those ecosystems. If we overshoot the carrying capacity of our ecosystems, then that carrying capacity of our planet degrades. Earth would no longer be able to support the same number and variety of life forms, including that of humans.

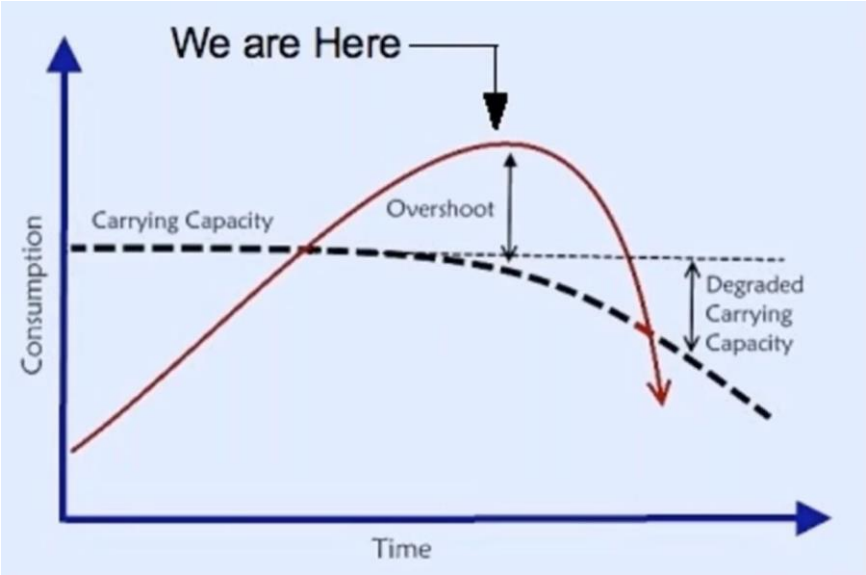

Figure 1: Overshooting Earth's Carrying Capacity

Excessive mining and use of fossil fuels and materials have resulted in climate change and overshoot of the safe thresholds of many planetary boundaries (Rockstrom et al 2009; Steffen et al. 2018; Wackernagel et al. 2021). Genetic diversity, flows of phosphorous, and flows of nitrogen have already been well exceeded. A critical boundary is phosphorous which is an essential nutrient for all life forms. Climate change is in a zone of uncertain increasing risk and is but one of many symptoms of overshoot. The future sustainability of human civilisation is becoming more jeopardised with each passing decade.

Excessive production and consumption are due to a combination of excessive growth in population and excessive growth in per-capita production and consumption. The current world population of 7.9 billion people is growing at a declining rate which could eventually lead to Zero Population Growth (ZPG). However, over the next number of decades, the world population will continue to increase due to population momentum unless dire consequences of climate change, inadequate access to energy, political strife, and over-reaching the carrying capacity of ecosystems curb and restrict further population growth. While our world population continues to grow, the only way that humankind can stay within planetary boundaries is by reducing its per-capita production and consumption.

EXPONENTIAL GROWTH AND USE OF RESOURCES

Excessive production and consumption have been exacerbated by exponential growth in populations and per capita production and consumption. Most people do not have an intuitive grasp of exponential growth. Many economists, politicians, and CEOs promote and expect an annual 3% growth rate in the GDP of an economy without fully understanding the physical consequences.

The doubling period of exponential growth is the time it takes for growth of any entity to double in size. Consider a culture of cancer cells starting with a single cell which grows and divides only once per day. At the end of one day, the culture has grown to two cancer cells. The doubling period is one day. Given enough nutrients, the culture would

grow to over one billion cancer cells (1,048,576) after 20 days. On the 19th day the culture size would have been a bit more than half a billion (523,288).

The time for action to counter cancer growth would have been much earlier. Cancer cells left unchecked with sufficient nutrients for growth eventually die with its host. Nothing on our planet Earth grows forever due to limits of resources on a finite planet. The only thing which can increase in size for ever, at least hypothetically, is our human construct of money. Money serves as a medium of exchange, a store of value, and a claim on current and future resources, a claim supported by our institutions. Existing physical resources do not grow in parallel with growth in claims on resources. Unchecked growth in claims on resources hastens the exhaustion of resources. The resources left remaining for future generations are less concentrated and hence more energy intensive to mine.

A close approximation of a doubling period is given by dividing 72 by the annual exponential rate of growth. For example, an annual growth rate of 3% has a doubling period of 24 years. The sum total of growth of any entity over the next doubling period is equal to the sum total of all previous growth when the exponential rate of growth is constant. Expectations that it is possible to have an economy that grows by 3% each year until the end of century (three more doubling periods) are simply unrealistic and devoid of physical reality.

What more we can learn from the properties of exponential growth? Given steady exponential growth in the extraction of resources, the absolute size of the stock of any resource has very little effect on the time it takes to exhaust the resource. If the original resource were twice as large, it would take only one more doubling time to exhaust the resource.

Delays in action are critical when exponential growth is involved. This applies to both population, energy, mineral resources, and other resources including ecosystems. William Ophuls warned us back in 1977 that the time for concern about the potential exhaustion of a resource comes when no more than about 10% of the total has been used up. So far, this warning has been ignored.

GREENHOUSE EQUIVALENTS

Greenhouse gas equivalents require some explanation as follows. Goods and services use combinations of different forms of fossil fuels which emit different greenhouse gases to the atmosphere – carbon dioxide (CO_2), methane (CH_4), nitrous dioxide (N_2O), etc. CO_2 is a long-lived greenhouse which stays in the atmosphere for between 300 and 1,000 years before being absorbed by natural processes. Some greenhouse gases are short lived and have a different impact on climate warming over time. These greenhouse gases are converted into carbon dioxide equivalents (CO_2e) where CO_2 has the value of one.

The average impact of methane on climate warming over 100 years is 25 times greater than CO_2 and the CO_2e value of 25 is used by the Intergovernmental Panel on Climate Change (IPCC), research publications, and many carbon calculators. But the impact of methane on climate warming over 20 years is 84 times greater than CO_2 and the next 20 years are the most critical years over which drastic reductions in all forms of greenhouse gas emissions are necessary. The short-term impact of methane is critical to take into account when the greenhouse gas emissions of food production are examined because ruminants (cows and sheep) belch out many tonnes of methane to the atmosphere each year.

GREENHOUSE GAS EMISSIONS

Every time we make use of fossil fuels for energy, we emit greenhouse gases to the atmosphere. These emissions have increased substantially since the 1850s. Figure 2 shows the growth in CO_2 emissions by world regions.

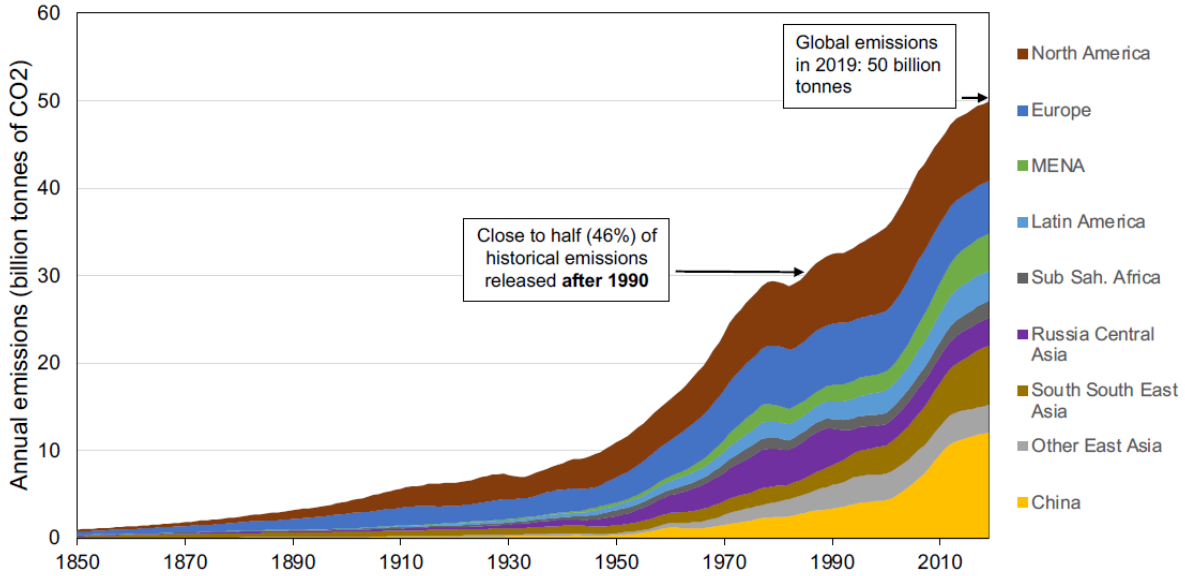

Figure 2: Global annual CO2-emissions by world regions 1850-2019 (Chancel, 2021)

Growth rates in the use of fossil fuels and subsequent greenhouse gas emissions have varied from 1850 to 2019. Figure 2 shows that greenhouse gas emissions released over period of 29 years from 1990 to 2018 is almost equal to the annual sum of all historical emissions from 1850 until 1990.

Unabated continuation of business-as-usual emissions of greenhouse gases to the atmosphere would rapidly risk triggering tipping elements which would result in an irreversible cascade of climate change to a hothouse Earth where very few life forms are able to survive (Lenton et al. 2008; Steffen et al. 2018).

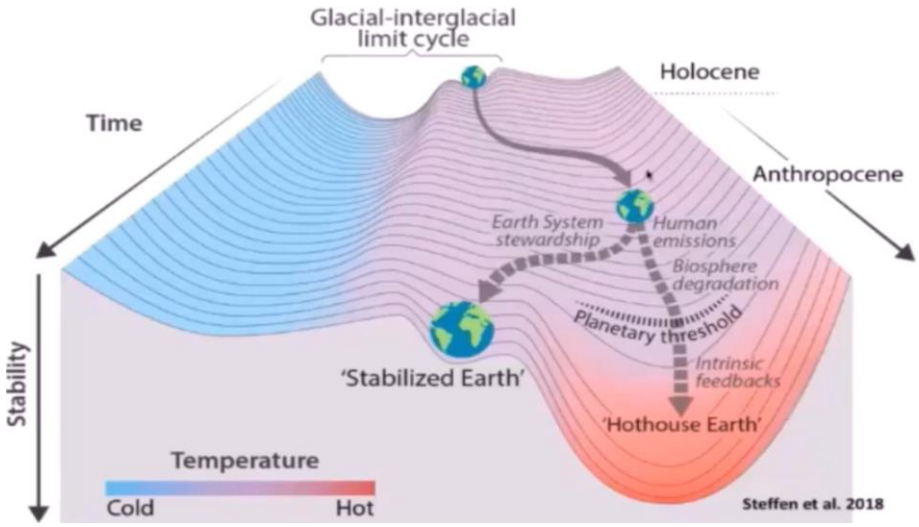

Figure 3: Hot House Earth (Steffen et al. 2018)

Climate change has been globally acknowledged and accepted as being an existential threat to humans and other life forms. The 2015 Paris Agreement was adopted by a resolution of the United Nations General Assembly to avoid this threat. The target of the 2015 Paris Agreement was to hold the global average temperature to well below 2° Celsius above pre-industrial levels and to pursue efforts to limit the temperature increases to 1.5° Celsius. The 2015 Paris Agreement recognised that business-as-usual emissions of greenhouse gases must be curbed. Adoption of a global carbon budget was agreed upon by almost all nations. The budget is an annual reducing budget, the total size of which is represented by the area under the curve of projected reductions in carbon dioxide emissions as shown in Figure 4. In 2015, the carbon budget targeted to decline to net zero by 2050 was deemed to be sufficient mitigation.

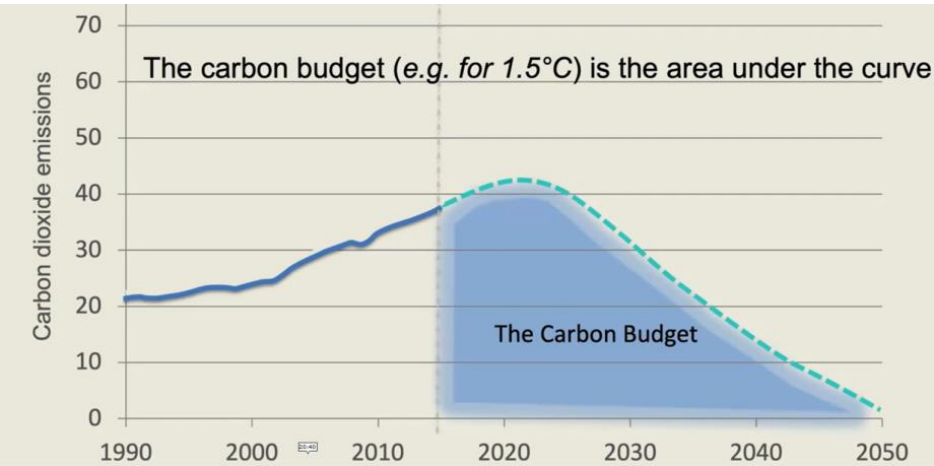

Figure 4: Global Carbon Budget Required to Mitigate the Impact of Climate Change (2015)

Subsequent research by the IPCC has revised the urgency to reduce greenhouse gas emissions. The IPCC AR6 Report of 2021 indicates that the remaining carbon budget required to remain within 1.5° C of global warming with 66% probability is 400 billion tonnes of CO_2 and 300 billion tonnes with 83% probability. On a 400 billion tonnes carbon budget, an average country share of the global carbon budget would run out in 9 years. In other words, we need to target zero carbon emissions by 2030 and not by 2050. For a high polluting county such as the United Kingdom, its share of the carbon budget would run out in 3 years at current rates of use (Chancel 2021)

Any level of greenhouse gas emissions accumulates in the atmosphere. Despite international agreements to adopt zero carbon budgets with declining annual levels of greenhouse gas emissions, global annual greenhouse gas emissions have started to increase again after a brief decline due to reduced economic during the peak of our recent COVID pandemic (https://www.co2.earth). Business-as-usual growth in the use of fossil fuels for energy must not continue if we are to mitigate the impact of human induced climate change.

PEAKING OF FOSSIL FUELS

Energy is required to explore and identify where the most concentrated reserves of fossil fuels are located. The mining of materials for plant and machinery also requires the use of energy. More energy is then required to construct the necessary plant and machines to extract the fossil fuels from the ground and to run the plant and machines. The reserves of fossil fuels in the ground which are extracted represent gross energy. Net energy, also known as a surplus, is what is left over for use after subtracting the energy used in exploration and extraction (Hall 2016).

The annual rate of production of all forms of fossil fuels eventually peak, followed by a progressive reduction in the rate of production due to increasing energy costs of extraction (Bentley 2016). In Figure 5 below, the cross-hatched light-yellow area at the top of the plotted areas represents the energy required to produce net energy. All stacked areas below this light-yellow area represents net energy available over each period of extraction. The dark grey area at the bottom of the chart represents field oil.

Net field oil peaked about 1979. The combination of net field oil and off-shore drilling to 500 metres coloured light grey peaked about 2004. Off shore drilling to 2,000 metres, shale tight oil, oil sands, onshore natural gas, and biofuel have allowed total net energy to increase until about 2020. According to Delannoy and colleagues (2021), total net oil liquids will peak about 2024 and then continuously decline until 2050. Other sources of energy include coal, nuclear energy, and renewables.

Coal can be converted into a liquid form of fossil fuels, but any conversion involves heavy losses in energy. Time has run out for expanding the use of nuclear energy. New nuclear power stations would be up and running after the next two most critical decades of transition and mitigation of climate change. (Murphy 2021).

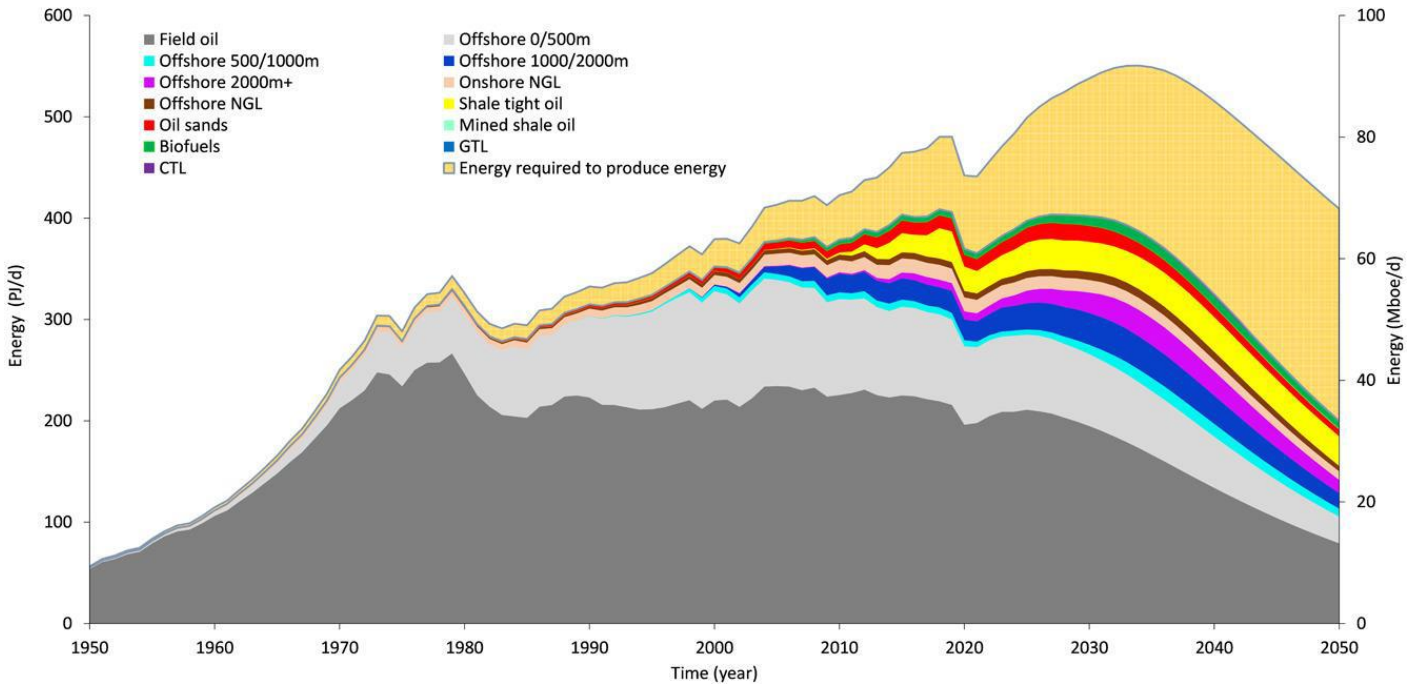

Figure 5: Energy Production of Oil & Gas From 1950 Projected to 2050 (Delannoy et al. 2021)

Over the next number of decades, global net energy production of key convenient forms of fossil fuels will decline. We need to transition as soon as possible from these fossil fuels to sustainable energy sources before the annual rate of net energy production declines to a level where a transition would be physically impossible.

RECYCLING

Life forms on Earth have relied on recycling minerals in the form of nutrients for billions of years. Most life forms require ultimate dispersal of nutrients provided by predator-prey and parasitic-host relationships, metabolic waste from other life forms, and decay from dead flora and fauna. Humans in an industrial society, as opposed to a hunter-gatherer society, require concentrations of minerals for its technology and production for consumption. Georgescu-Roegen in his book "The Entropy Law and the Economic Process" pointed out in 1971 that mineral resources required for technology will ultimately become dispersed regardless of our efforts to recycle. 100% recycling is a physical impossibility because higher recycling rates of materials require progressively more energy which ultimately limits the practical level of recycling (Mills 2020).

Figure 6 below shows the recycling process and the inevitable energy and material loss to the environment. Raw materials from the environment enter the economy, high-grade energy is used in the production process, and at all stages of production and consumption there are material and energy losses back to the environment. We can reduce the scale of mined resources needed to sustain our economies by making more efficient use of resources and we can also reduce the scale of our waste by implementing greater levels of recycling.

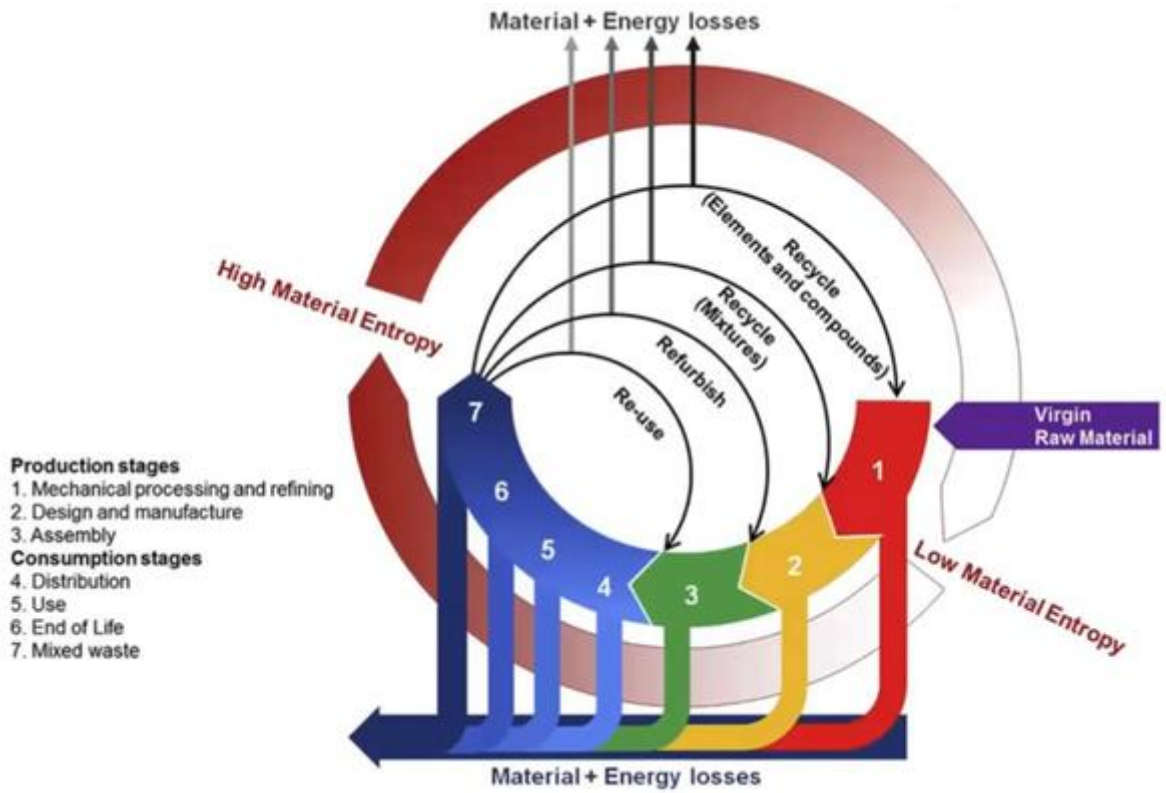

Figure 6: Recycling and Inevitable Energy & Material Loss to the Environment (Graphics source)

Figure 7 shows current recycling rates of metals. Only a few metals have a recycling rate of over 50%. According to UNEP (2011), iron and steel have an end-of-life recycling rate of 70-90%. The recycling rate of lead in the United States reached 76 percent in 2019. These values represent the highest end-of-life recycling rates among all the industrially-used metals. Some rare metals necessary for the production of batteries not only have a very low recycling rate, but are also scarce and are already a supply risk (Michaux 2019).

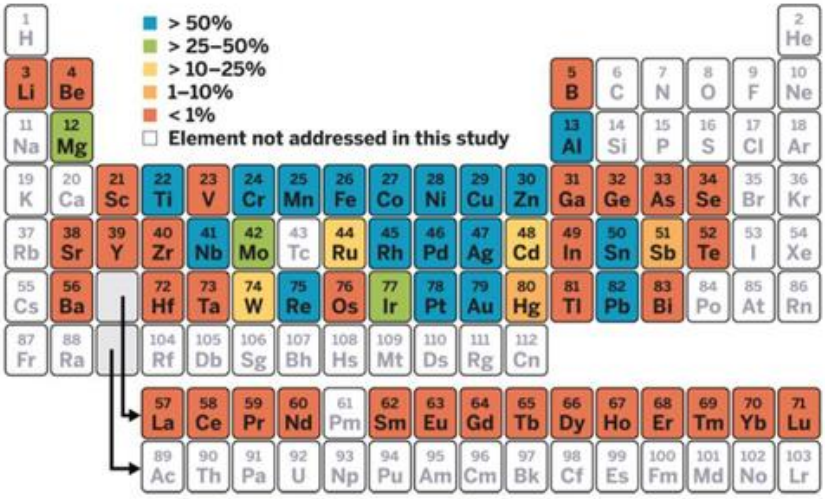

Figure 8. Recycling rates of metals (Source: United Nations Environment Programme, Recycling Rates of Metals (2011) / C&EN May 30, 2011) (Copyright License: https://creativecommons.org/licenses/by-nc-sa/4.0/)

Figure 7: Recycling Rates of Metals (Michaux 2019)

Assume that all metals have a recycling rate of 90%. After only 6 and 7 cycles of recycling, 53% and then 48% of the original material is available for reuse. The half-life is therefore, say, 7 cycles. Assume the time in use is 30 years - for example, components of photovoltaic panels and wind turbines. The half-life would then be about 200 years. Every 200 years, the original mined material would be halved. After 1,000 years, there would be only 3% of the original mined material in use. The current rates of recycling of many metals nowhere match 90% and higher rates of recycling do not bode well for the long-term future because higher rates of recycling require progressively more energy than lower rates. Some metals require more energy to recycle than other metals at any chosen rate of recycling.

When use of a resource grows exponentially, the use of resources over the last doubling time is equal to the sum total of use over all previous doubling times. Any growth in the mining of resources therefore compounds the shortening in the time frame during which it is physically possible to mine that resource. A high technological society can be sustained for a longer period when there is no growth in the mining of resources.

The grades of mined materials have steadily decreased, especially since the 1930s as shown in Figure 8. Without extraordinary advances in mining and refining technology, the 10% of world energy consumption currently used for mineral extraction and processing would rise as lower grade and more remote deposits are mined (Mudd 2009). Very low concentrations of minerals and metals are too energy costly to concentrate for use. The energy costs of recycling will eventually exceed that of mining low concentrations of metals and minerals still in the ground.

Energy is required for many other purposes other than mining and recycling of minerals and use of energy has a hierarchy of necessary uses. In the long term future, society will need to accept that some minerals are too energy costly to continue using in its technology.

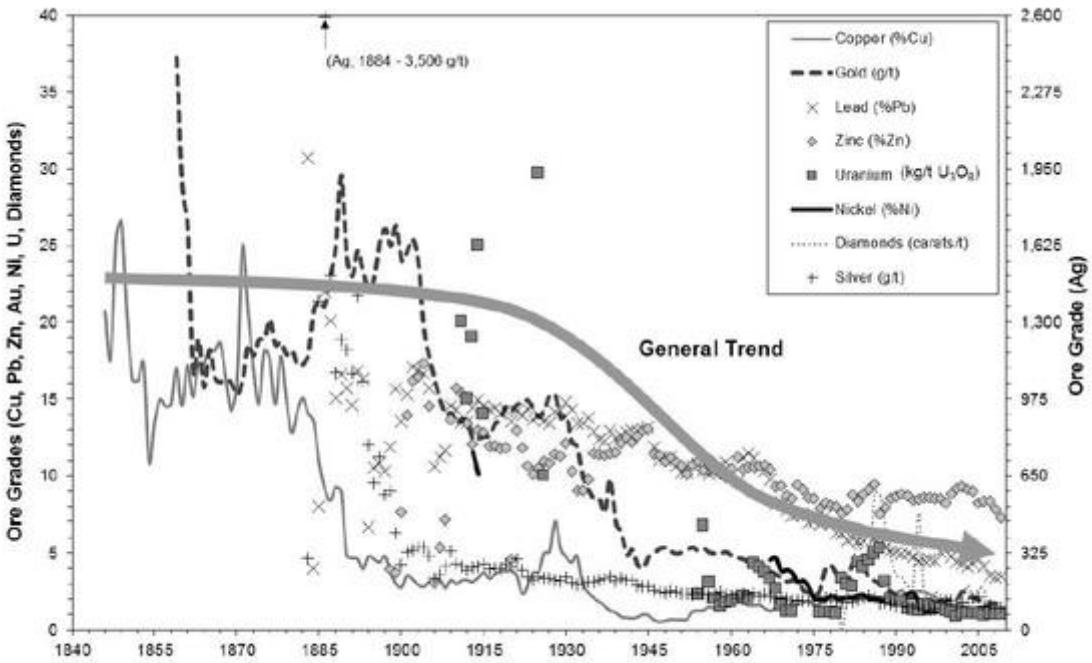

Figure 16. Grade of mined minerals has been decreasing (Source: Mudd 2009- updated 2012, Analyst- Gavin Mudd)

Figure 8: Decreasing Grades of Mined Materials (Mudd 2009, updated Mudd 2012)

A balance of longevity in use and the rate of recycling is necessary to reduce the energy costs of keeping minerals and metals in use over each generation of the population. This balance needs to weighed up against the energy costs of mining for new minerals and metals and the extent of their scarcity.

Figure 9: Balancing Rate of Recycling & Longevity Against Mining for Minerals & Metals

Metals and minerals which are ultimately dispersed to the environment after use represent the loss of resources which cannot be used by future generations. If our species of humankind should continue to exist in the far distant future, then future levels of technology will inevitably decline due to the inability to concentrate dispersed minerals and metals. Humans will have the choices of accepting a declining level of technology or reducing their scale of technology to support a smaller population. The ultimate prospect for humans is a return to being hunter-gatherers. This life style does not necessarily need to be brutish and short so long as humans in the distant future are able to retain essential repositories of knowledge.

Our focus is on the shorter-term future, and especially the next number of decades, where our actions or lack of actions will largely determine the future of our children's grandchildren. Figure 10 shows the waste hierarchy of human settlements. Actions further up the hierarchy reduce impacts on the environment and enable a higher level of technology for future generations.

Figure 10: The Waste Hierarchy

Disposal of some waste is inevitable. For modern civilisations to exist at a technology level way beyond the stone tools of the hunter-gatherer, there will always be waste which flows out of the economy into the environment. The environment can accommodate a degree of waste, but we need to ensure the level of our waste does not exceed the environment's capacity to assimilate that waste. We need to use benign technology. We also need to question whether higher levels of technology necessarily provide greater levels of happiness and wellbeing.

Before final disposal of materials into the environment as waste, we should first Recover and Repurpose materials as much as possible, followed by Recycling and Reusing materials in a replacement or different form. The most effective way to reduce waste is to Refuse to use materials in the first instance for unnecessary and extravagant purposes. By doing so, we Reduce our need to mine for materials and subsequent waste.

MINERALS NEEDED FOR BATTERIES VERSUS RESERVES

There is a common assumption by many that solar based energy can provide the same scale of net energy that fossil fuels have provided so far. Simon Michaux (2019) has challenged that assumption with a study of the minerals and metals required by photovoltaic panels, wind turbines, and battery storage.

In Figure 11 below, the global reserves of metals as of 2018 needed by batteries to phase out global fossil fuels are coloured blue and the metals needed are coloured yellow. Copper is currently not an immediate problem, but nickel, cobalt, lithium, and graphite present serious problems. Global reserves of nickel, cobalt, and lithium for batteries are simply not large enough to supply enough metals to scale up renewables to fully replace the global net energy currently provided by fossil fuels. There are alternative less scarce minerals such as sulphur and aluminium which can be used for batteries, but there is a difference between what is possible on a small scale and what is viable on a large scale over successive replacement cycles.

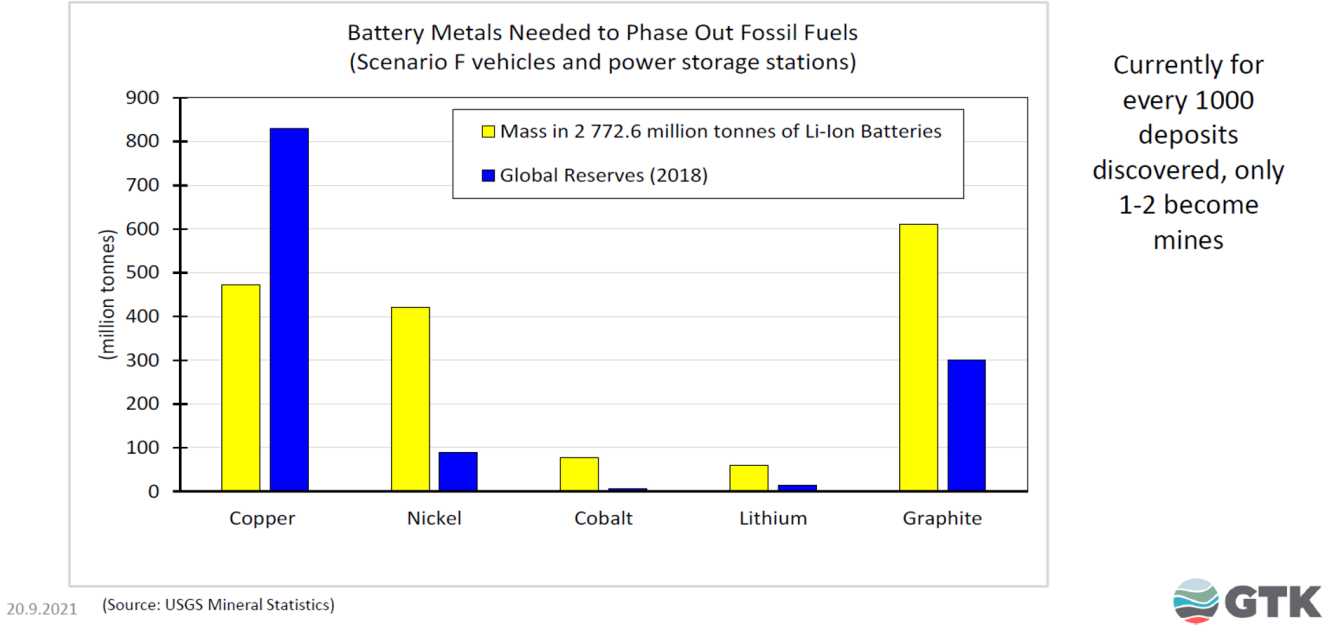

Figure 11: Minerals Needed for Batteries versus Reserves (Michaux 2019)

RENEWABLE ENERGY

Production of photovoltaic panels, wind turbines, and battery storage requires the use of high-grade energy and the metals and minerals used in production also require high-grade energy to mine. Continued production of solar-based high-grade energy provided by photovoltaic panels and wind turbines backed up by battery storage requires replacement of components at regular intervals. Each cycle of component replacement is subject to progressive limitations due to the increasing scarcity and decreasing concentration of mined metals and mineral and the limits of recycling. Photovoltaic panels and wind turbines are commonly referred to as being renewables, but these “renewables” cannot be fully renewed at the same previous scale in the distant future. Nonetheless, the term ”renewables” will be used from hereon.

A transition from fossil fuels to renewables requires major investments in renewable energy production and infrastructure. These investments require the continued use of fossil fuels because the current scale of renewables cannot produce more renewables without the use of key fossil fuels. We need to make our investments on a reducing carbon budget so as to stay on track within our targets of net zero carbon emissions by 2050, if not earlier. The only way to do this is by reducing our current levels of consumption on those goods and services which are extravagant or unnecessary to enable continued wellbeing and quality of life for current and future generations.

It is impossible to scale up renewable energy to meet current energy per-capita levels because renewable energy is critically dependent on the use of scarce and rare minerals (Michaux 2021; Bihouix 2021). Reaching "Net Zero" globally by 2050 would require six times the amount of mineral resources used today (IEA 2021). We would have to use fossil fuels to mine these materials and build, implement, and replace this enormous renewable energy infrastructure. At the same time, the net energy available from fossil fuels will soon peak and then will begin to decline (Delannoy 2021). We simply cannot quantitatively replace current energy consumption provided mainly by fossil fuels with energy from renewables (Michaux 2021; Seibert & Rees 2021; Bihouix 2021). We need to learn how to live well on less energy and materials per capita.

DECOUPLING OF ENERGY AND MATERIALS FROM OUR ECONOMY AND GREEN GROWTH

Proponents of what has been named "green growth" argue that technological progress and structural change will enable a decoupling of consumption from adverse impacts on the environmental and accordingly promote "green" growth (World Bank 2012).

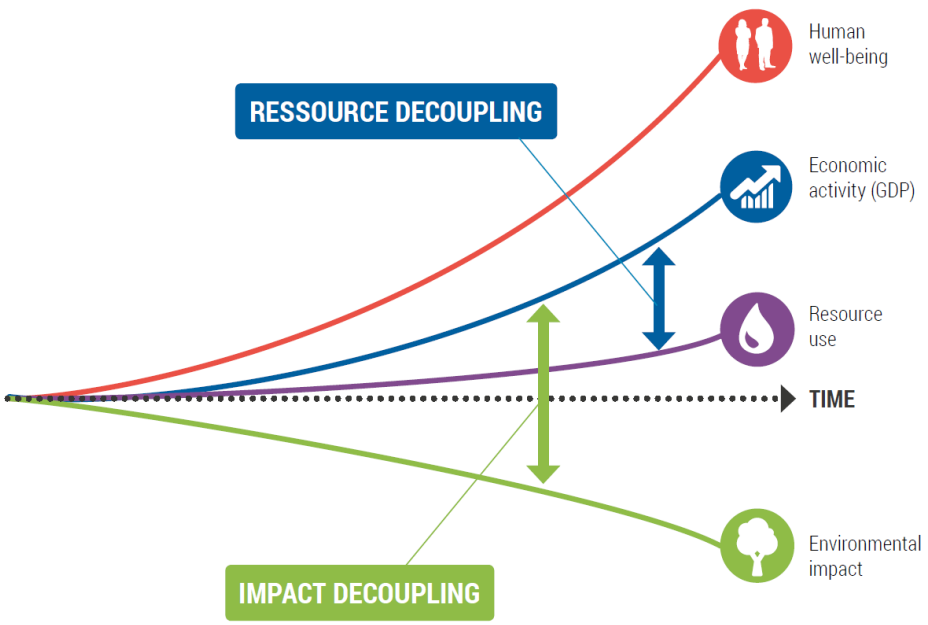

Figure 12: Claimed Decoupling of Natural Resources from Economic Activity

The embodied energy of many products and services can be reduced and their use of energy can also be reduced, but there are limits to what can be achieved. Use of materials to produce goods and services will always require the

use of energy to mine, process and recycle. There are also thermodynamic limits to level of efficiencies that can be achieved by any process.

The Jevons paradox or rebound effect occurs when greater efficiency in the use of resources results in greater consumption of that resource due to an increasing demand (Jevons 1865). Jevon's example is the increase in the efficiency of the steam engine in the 1800s which resulted in a greater demand for more steam engines. Although each new improved steam engine used less coal, the combination of more steam engines using less coal resulted in a greater consumption of coal. The rebound effect can take place when demand is unrestricted, such as in a growth economy

Relative decoupling of GDP from energy and materials is possible, but there is a limit as to how much is possible. For example, it is possible to use less energy and materials more efficiently to provide goods and services. Recycling helps to reduce the use of additional materials. But there are thermodynamic upper limits to the possible efficiencies of both energy use and recycling. With improved technology, we have already closely approached many of these upper limits. Photovoltaic panels and wind turbines are good examples.

In 2019, Timothee Parrique debunked the extent that decoupling has taken place in some countries in a comprehensive 872-page publication. Figure 13 shows an example of the extent that emissions of consumption within a country is based on both domestic and imported generation of emissions. Many countries have shifted their factories to China where factory production emits greenhouse gases to the atmosphere. The products are then exported from China to other countries for consumption. Reductions in both domestic and imported consumption within each country are necessary to mitigate the impact of climate change.

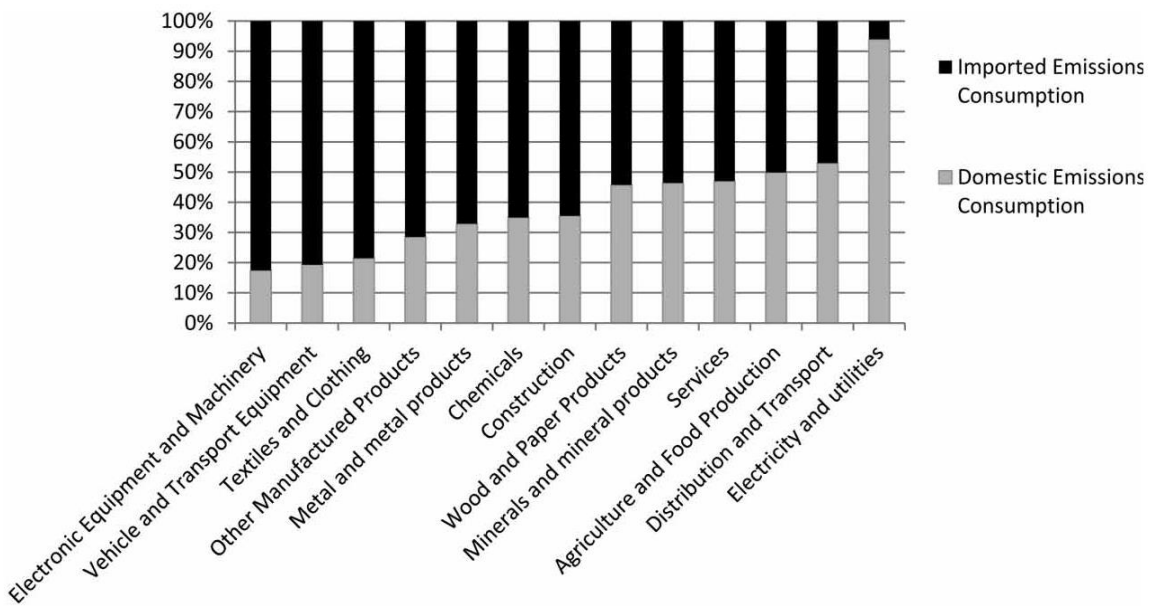

Figure 13: Percentage of GHG emissions in the UK associated with different groups (Barrett et al., 2011)

OUR CURRENT PREDICAMENT

In 1977, William Ophuls cautioned that the time for concern about the potential exhaustion of a resource comes when no more than 10% of the total has been used up. This applies especially when the rate of extraction of a resource is exponential.

There is an expression of “Don’t eat your seed corn” which refers to the age-old farmer’s strategy of saving some of the harvest of the current year as the seeds for the next. Our main energy sources have been fossil fuels, and they have produced very few seeds for the next harvest in the form of renewables. The inevitable peaking of fossil fuels has been ignored since cautions in the 1970s to make wise use of a proportion of fossil fuels to enable a smooth transition from fossil fuels to renewables.

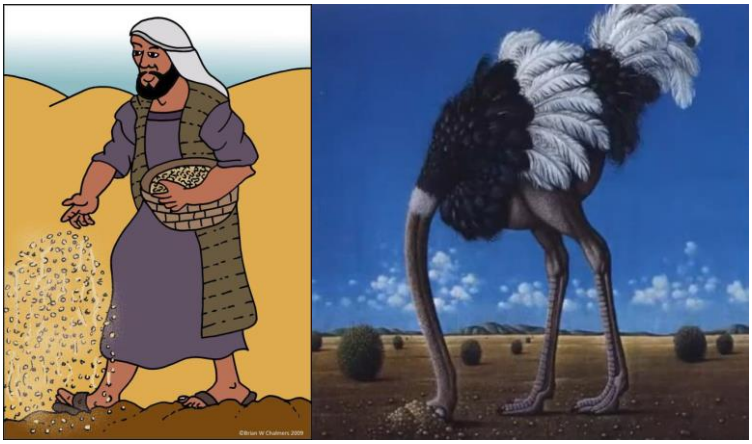

Figure 14: Early Warnings to Use Proportion of Fossil Fuels for Transition to Renewables Ignored

We now have a situation where the energy provided by the current limited scale of renewables such as photovoltaic panels and wind turbines is insufficient to manufacture more renewables. Current manufacturing of renewables requires the use of fossil fuels, but a transition from fossil fuels to renewables is now more difficult because the net energy of oil liquids, a convenient and key form of fossil fuels necessary for the production of renewables, is on the decline. The longer we delay in using what remains of net energy provided by oil liquids, the less likely we will be able to make a transition to renewables.

We face a future where there will be less energy per capita. Continued increases in consumption per capita will be impossible. Less energy per capita means less consumption per capita. Priorities as to what constitutes non-essential consumption over and above essential consumption need to be examined and revised.

We need to rapidly reduce our emissions of greenhouse gases, starting immediately, to mitigate the impact of climate change by reducing our use of fossil fuels. At the same time, we still need to use fossil fuels to enable a transition from fossil fuels to that of renewable energy and infrastructure (Seibert and Rees 2021). The only way out of this conundrum is to radically reduce our current levels of consumption and divert the use of fossil fuels away from extravagant and unnecessary consumption to a limited renewable energy system which can support a lower-energy society.

Reducing our consumption of fossil fuels means keeping most of our fossil fuel reserves in the ground to avoid exceeding critical climate change threshold (McGlade & Ekins 2014). Further exploration of fossil fuels would be a

waste of energy and reduce our budget of fossil fuels which we need to enable a transition. If we squander our limited budget of fossil fuels on foolhardy explorations for more fossil fuels and frivolous consumption, then we will lose our last chance to make a global transition to renewable energy and infrastructure.

It is logically impossible for perpetual economic and population growth to occur on a finite planet. Sustainable economic growth is an oxymoron and empirical evidence on resource use and carbon emissions does not support green growth theory (Hickel & Kallis 2020). Either we have a planned, orderly contraction (de-growth) of our economy or else a far more chaotic contraction will be forced upon us by nature, likely within a decade from now (Herrington 2021).

GLOBAL INEQUALITY OF WEALTH, INCOME, CONSUMPTION, AND GREENHOUSE GAS EMISSIONS

The standard of living in under developed nations is substantially lower than that in developed nations. There is an ethical issue here. If growth in material consumption were to cease in all nations, then under developed nations would be locked into a lower standard of living. There is undeniable empirical evidence of increasing global and national inequality. The share of the pie for the poor has substantially declined over the last 30 years. As of 2014, the top 1% of income accounts for 10% of the total income in advanced economies (Piketty, 2014). In the United States the top 10% has an income of close to nine times that of the bottom 10%.

Inequality is more dramatic when the wealth of the rich and poor are compared. Wealth is defined as the net worth of assets in the form of property and real assets less liabilities. In 2018, the richest top 10% of the world population owned 85% of global wealth and 64% of the world population owned only 1.9% of the global wealth (Shorrocks et al., 2018). Economic growth has improved standards of living, but has also resulted in greater inequality. On ethical grounds, material consumption per-capita should be shared equally between nations and within nations. Higher standards of living tend to be accompanied by lower total fertility. If the rich nations were to assist the poor nations to raise their standard of living, then the world population would grow more slowly on its path to Zero Population Growth

The mushroom graphic in Figure 15 below shows the disproportionate consumption by the wealthy. In 2015, the richest 10% of people in the world, and that includes New Zealanders, were responsible for 49% of CO_2 emissions, while the poorest 50% of people in the world were responsible for only around 10% of total lifestyle consumption emissions. An immediate 50% reduction in emissions by the richest 10% in the world would have reduced global CO_2 emissions to 75% of levels in 2015. A 75% reduction would have reduced global emissions to 62.5% of levels in 2015.

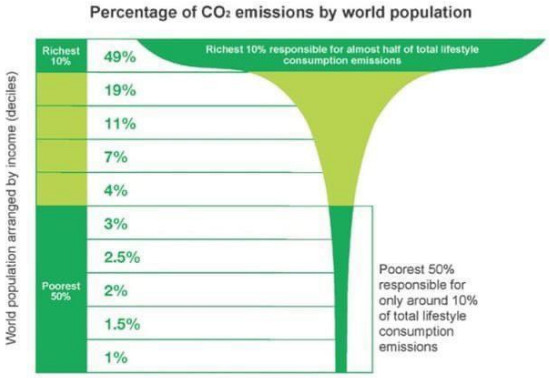

Figure 15: Disproportionate Consumption by the Wealthy (Oxfam 2015)

INEQUALITIES IN CONSUMPTION AND GREENHOUSE GAS EMISSIONS BETWEEN COUNTRIES

The extent of Inequalities in consumption and emissions of greenhouse gas equivalents (CO_2e) between countries is shown in Figure 16 below.

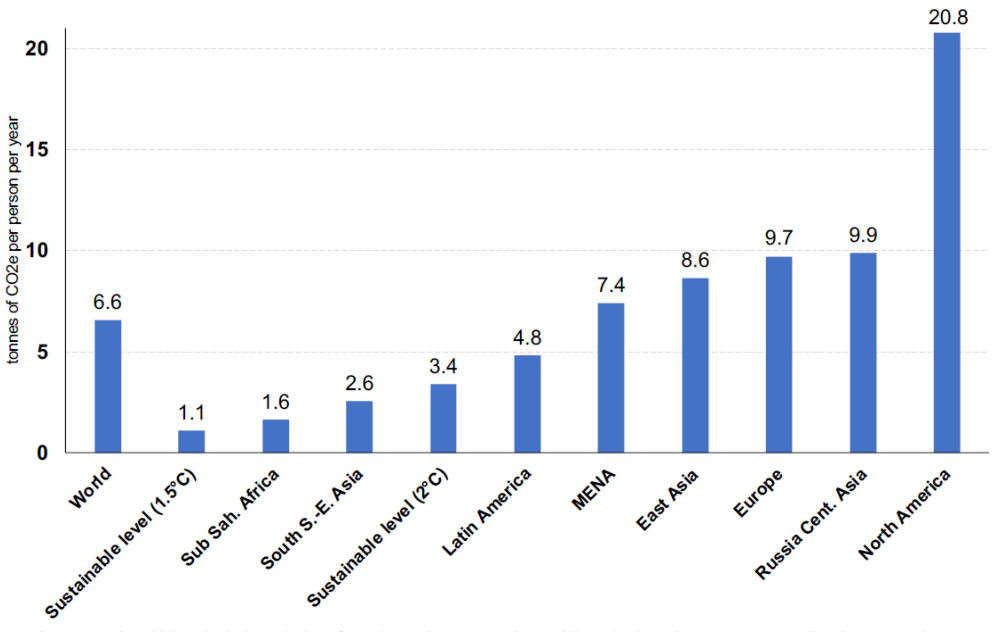

Figure 16: Average carbon emissions across the world in 2019 (Chancel 2021)

The world average CO_2e emissions in 2019 was 6.6 tonnes per capita compared to the average of 20.8 tonnes per capita in North America. According to Chancel (2021), the annual sustainable budget compatible with the 1.5°C limit is 1.1 tonne of CO_2e per capita. This value is about six times less than the current global average. The annual sustainable budget compatible with the +2°C temperature limit is 3.4 tonnes per capita.

Figure 17 shows historical emissions from 1850 t0 2020 for different global regions.

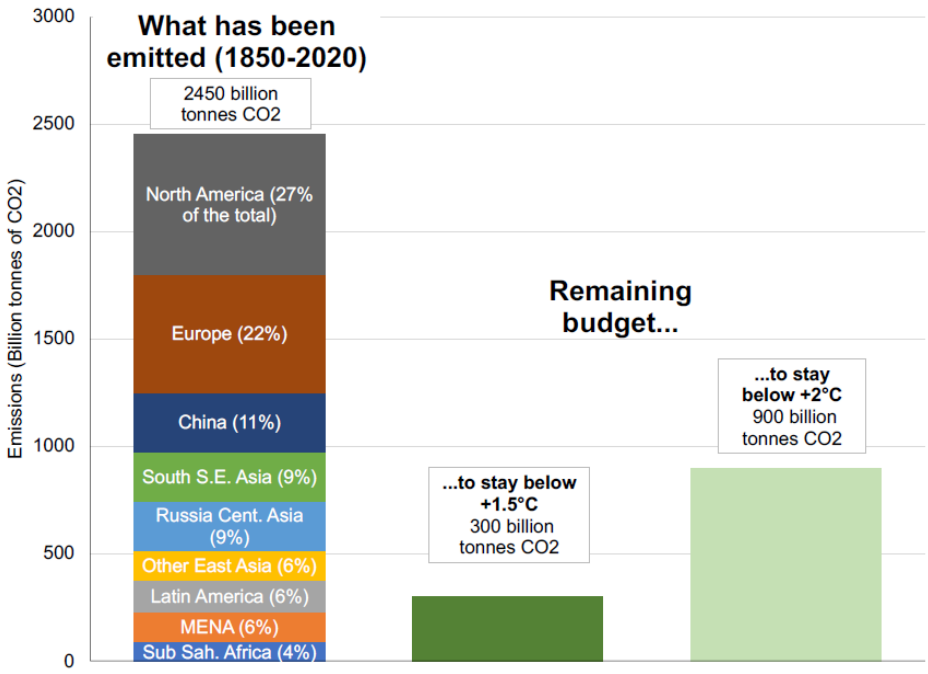

Figure 17: Historical emissions versus remaining carbon budget (Chancel 2021)

North America and Europe combined were responsible for almost 50% of all historical greenhouse gas compared to 11% for China. If historical responsibilities were taken into account, then many high-income nations would have no carbon budget left.

Higher per capita budgets incur a greater risk of runaway climate change. Taleb and colleagues (2014) summarise the Precautionary Principle as follows:

> "The precautionary principle (PP) states that if an action or policy has a suspected risk of causing severe harm to the public domain (affecting general health or the environment globally), the action should not be taken in the absence of scientific near-certainty about its safety. Under these conditions, the burden of proof about absence of harm falls on those proposing an action, not those opposing it."

The action of continuing to burn fossil fuels accompanied by greenhouse gas emissions to the atmosphere falls well within the category of applying the Precautionary Principle because failure to cease burning fossil fuels sufficiently quickly would result in an existential threat to all forms of life on Earth.

Figure 18 below shows the inequality of carbon emissions between individuals at the world level. In 2019, the global bottom 50% emitted on average 1.6 tonnes per capita and contributed 12% of the total emissions. The middle 40% emitted 6.6 tonnes on average, making up 40.4% of the total emissions. The top 10% emitted 31 tonnes (47.6% of the total emissions) and the top 1% emitted 110 tonnes (16.8% of the total emissions). Close to 50% of all emissions in 2019 were created by just 10% of the global population confirming Oxfam's mushroom graphic in Figure 16.

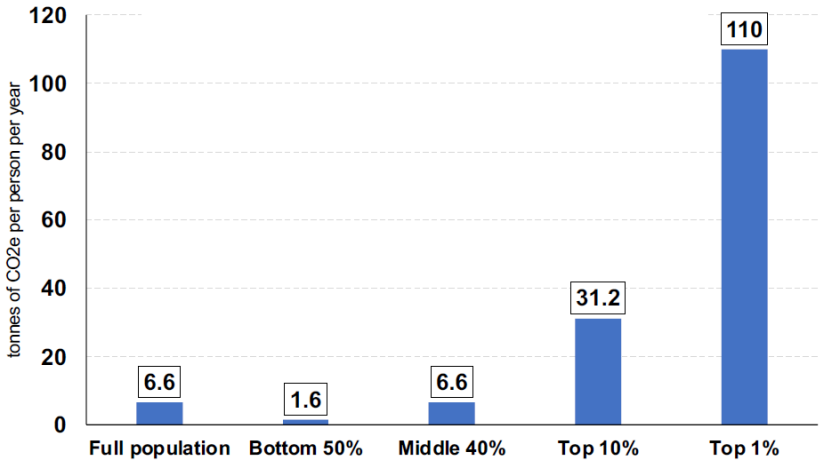

Figure 18: Average per capita emissions by group in 2019 (Chancel 2021)

INEQUALITY OF CONSUMPTION AND GREENHOUSE EMISSIONS WITHIN NATIONS

Inequality also exists within nations. Figure 19 shows per capita emissions by income group in the United States as an example.

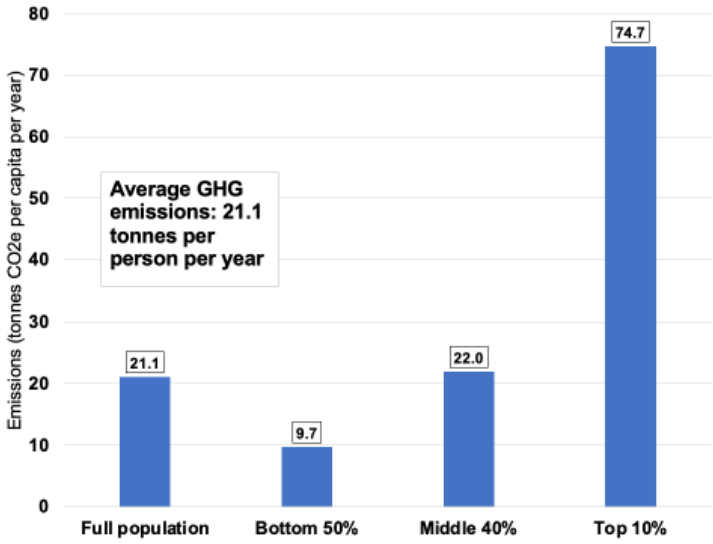

Figure 19: Emissions inequality and per capita emissions in the US 2019 (Chancel 2021)

In 2019, the top 10% by income group in the United States emitted almost 8 times as much tonnes of CO2e per capita than the bottom 50%.

Social inequalities within countries were on average lower across the globe than they are today. An example is New Zealand. The Gini index measures the extent to which the distribution of income or consumption expenditure among individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of 0 represents

perfect equality, while an index of 100 implies perfect inequality. Figure 20 shows the increase in household inequality in New Zealand from 1982 to 2016 using the Gini index.

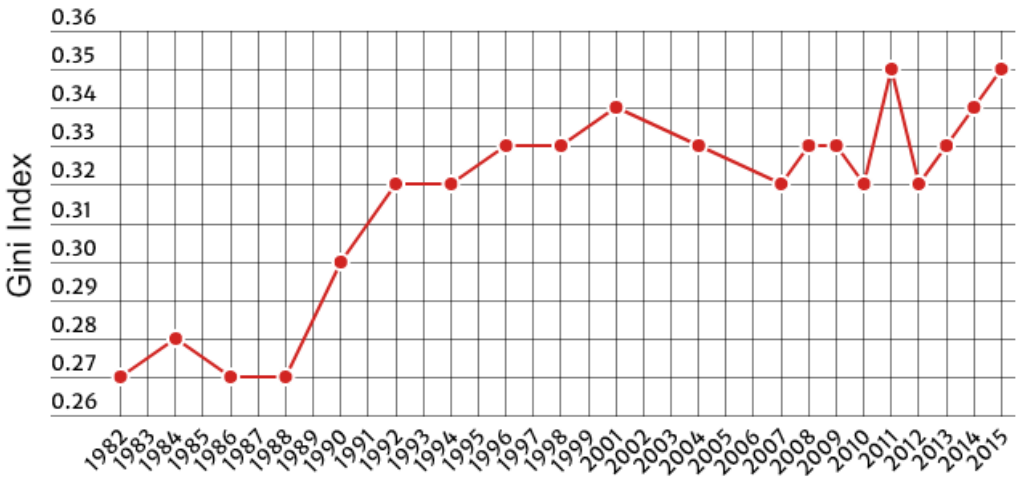

Figure 20: Gini index measure of household inequality in New Zealand 1982-2015 (https://www.stats.govt.nz)

Figure 21 shows global carbon inequality between countries and within countries from 1990 to 2019

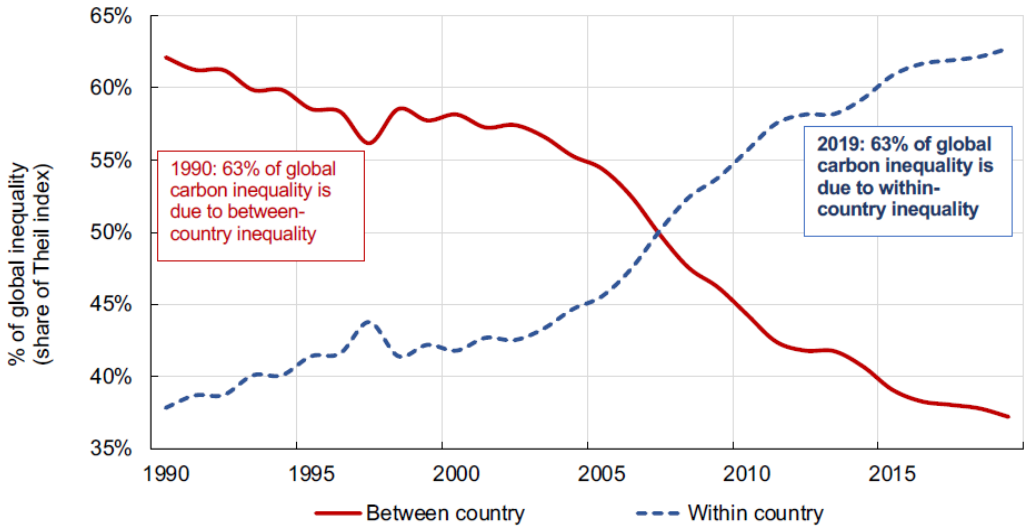

Figure 21: Global carbon inequality between countries and within countries 1990 to 2019 (Chancel 2021)

The vertical Y-axis show the percentage of global inequality using the Theil index which is used to measure economic inequality. The Theil index measures a distance away from the ideal egalitarian state of everyone having the same income. Greater levels of inequality are indicated by higher percentages of the Theil index. In 1990, most global carbon inequality (63%) was due to differences between countries.

Carbon emission pledges made at the 2015 Paris Agreement are typically expressed in aggregate emissions percentage reductions from a base year. These pledges can be expressed in terms of emissions per capita at a certain time to make better sense of what they imply. These targets do not represent what must be done in order to keep emissions below 1.5 or 2°C. Official commitments do not add up to meeting the 2°C objective, much less to meeting the 1.5°C target.

All actions to reduce our greenhouse gas emissions involve reductions in consumption. Those on low incomes have less ability to further reduce their carbon footprints than those on higher incomes.

The United States pledge amounts to a 53% reduction by 2030 of its 2019 per capita emissions. This equates to an average target emission of 3.0 tonnes of CO2e per capita by 2030.

Figure 22 shows an example of necessary reductions in consumption and emissions of CO_2e by income group to stay within this target.

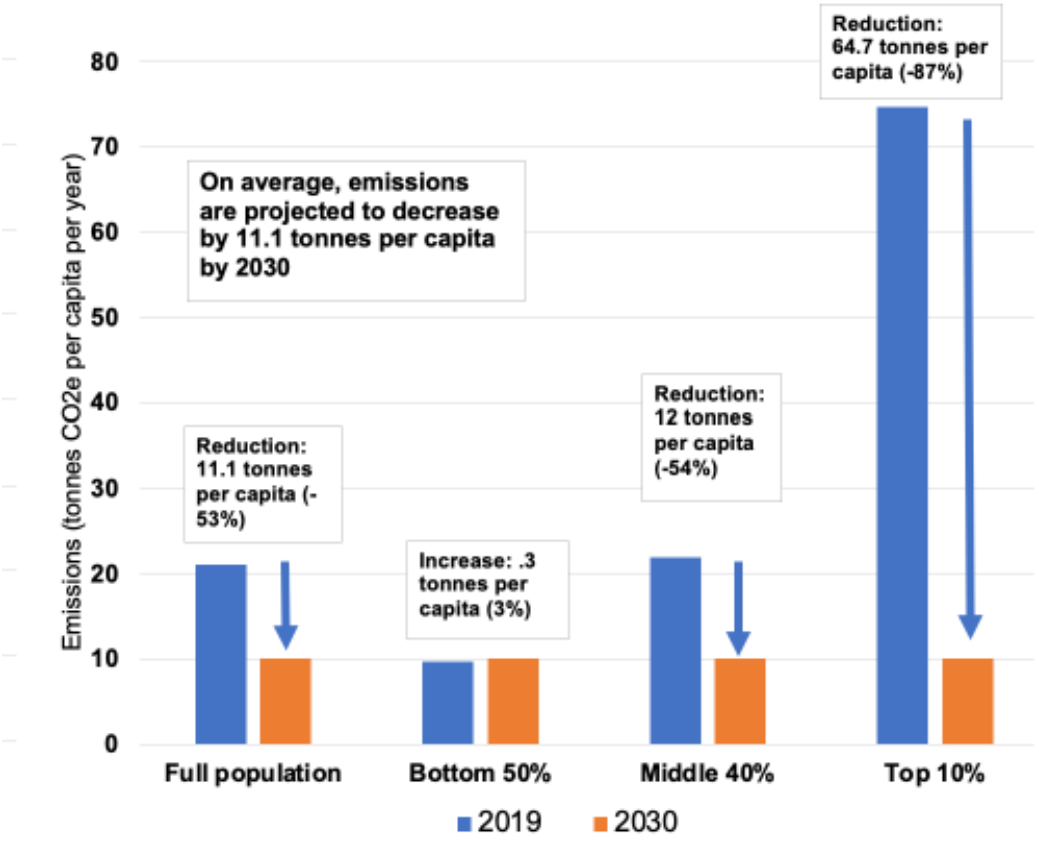

Figure 22: Emissions by group versus a 3.0 tonne CO_2e per capita climate target by 2030 in the US (Chancel 2021)

The bottom half of the population in the United States is already 3% below the target. The middle 40% and top 10% would need to reduce the CO2e emissions by 54% and 87% respectively to achieve the target of 3.0 tonnes of CO2e emissions by 2030. The bottom 50% of other rich countries are already below a 2030 target of 3.0 tonnes of CO2e per capita, or close to it.

GNP AND QUALITY OF LIFE

Higher levels of material production and consumption in any nation enable higher standards of living and initially higher levels of wellbeing and life expectancy.

Figure 23 shows happiness and satisfaction with life for people within each country plotted along the Y-axis ranging from 30% to 100% of the population with GNP plotted along the X-axis in United States 1995 dollars. About 88% of New Zealanders are happy and satisfied with life with a GNP per capita of $16,000 compared to about 90% of those

in the United States with a GNP per capita of $27,00. About 78% of Brazilians are happy and satisfied with life with a GNP per capita of only $3,000. It is possible to live well on a reduced level of consumption (Inglehart & Kingman 2000).

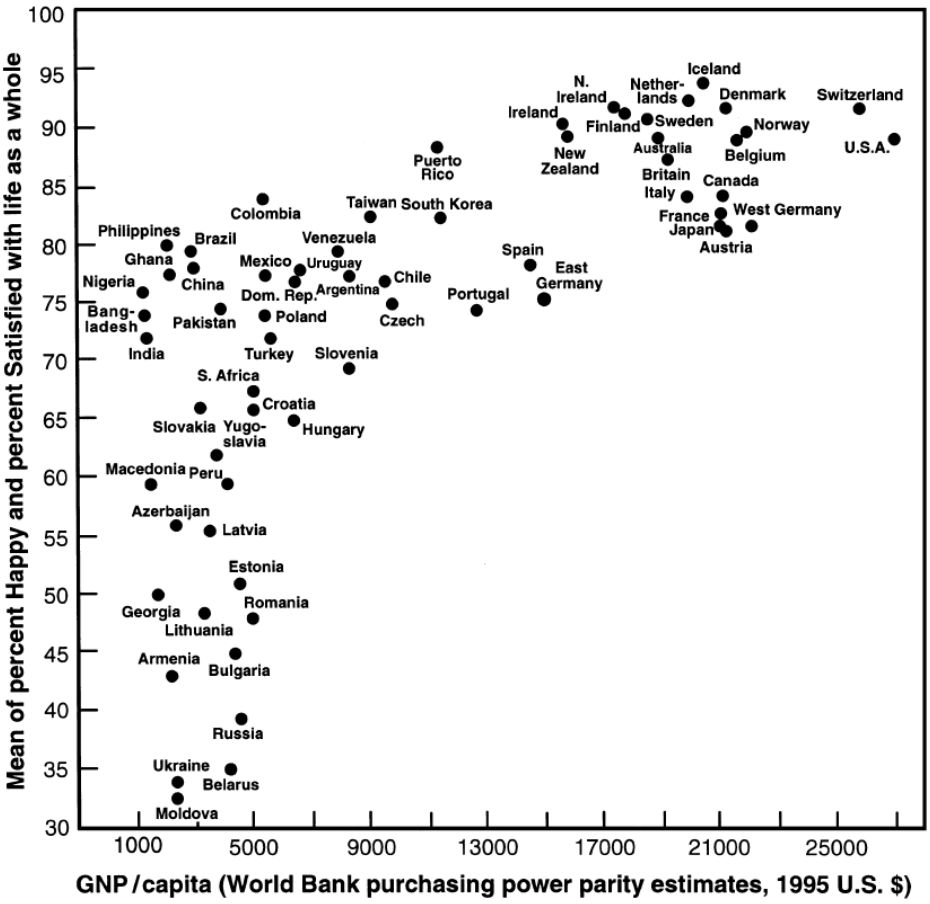

Figure 23: Happiness and GNP (Inglehart & Klingmann 2000)

When a nation has reached a certain standard of living as indicated by average per-capita income, additional per-capita income does not necessarily result in greater wellbeing or happiness and nor does it result in greatly extended life expectancy.

Figure 23 above shows graphically that the key to global reductions in greenhouse gas emissions is for all citizens of the world to participate equally. If those on higher incomes do not participate, then the efforts of all others will be in vain. Participation can be voluntary or enforced by our institutions. Failing that, nature itself in due course will enforce a reduction in consumption.

CONCLUSION

After 200 years of unabated growth in populations and consumption per capita enabled by burning fossil fuels, we now face a wicked problem that has no easy solution. We need to drastically reduce our use of fossil fuels in order to mitigate the impact of climate change and avoid the risk of triggering tipping points which would result in an irreversible cascade of climate change leading to a hot-house Earth.

In an industrial society, we are totally reliant on high-grade energy for our survival, so we need to transition from fossil fuels to high-grade sustainable energy sources and infrastructure. Reducing our use of fossil fuels is imperative in order to mitigate the impact of climate change. We therefore have no choice but to divert use of fossil fuels from unnecessary and frivolous consumption to investments in sustainable energy sources and infrastructure within a limited and reducing budget of fossil fuels. This applies especially to the well-developed countries like New Zealand.

Sustainable energy sources cannot scale up to the same energy levels per capita that we currently enjoy in the well-developed countries. We have already mined the low hanging fruit of highly concentrated minerals. Photovoltaic panels, wind turbines, and battery storage requires the use of increasingly scarce minerals which require progressively more energy to mine. We will need to learn how to live well on a much-reduced budget of energy during and after a transition from fossil fuels to sustainable energy sources and infrastructure. It is possible to do this because excessive consumption of energy used in the production of goods and services does not lead to greater well-being. What is possible will not happen unless we face up to realities and respond to the urgent need to reduce our greenhouse gas emissions without delay by reducing our current production and consumption of frivolous and unnecessary goods and services.

It is as supportive localised communities that we can continue to thrive, but everyone needs to participate equally in reducing their consumption. If those on current high carbon footprints do not participate, then the efforts of all others will be in vain. Those on higher income will have a greater surplus than others should they participate equally in our global efforts to mitigate the impact of climate change. Any surpluses should not be used on frivolous and unnecessary consumption but instead used to invest in long-term reductions in CO2e emissions while remaining within our global carbon budgets.

Our total supply of energy from renewables/renewables per capita will be limited in the future and communities can ill afford a minority of citizens from squandering the following resources on private transport - consumption of electricity, embodied energy, materials to construct the heavyweight EVs, and scarce materials for batteries - when the community has a greater public need and use for the same energy and materials. It is physically impossible for everyone to replace their ICE car with an electric car. There are, however, less energy intensive options available - walking, bikes, electric bikes and scooters, community shared electric cars, and public electric transport.

Excessive claims on resources need to cease. There are ways and means of doing this. The most effective and equitable way is rationing. An example is Tradable Energy Quotas (TEQs). Relying on Carbon Taxes and the market place alone to restrict consumption does not prevent those on higher incomes from continuing to contribute the highest CO_2e emissions per capita. Progressive Taxes on high incomes would help to reduce consumption by those on higher incomes. Alternatively, some people who are able to generate income at a higher rate per hour could choose to work fewer hours and convert their potential greater surplus into more leisure time.

Those on higher income will have a greater surplus than others should they participate equally in our global efforts to mitigate the impact of climate change. Part of this surplus could be used to invest in personal further long-term reductions in CO_2e or gifted to community projects which develop renewables. Some people on extreme high incomes would have much greater surpluses which, if spent on goods and services, would result in further greenhouse gas emissions.

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