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Road to Agenda 2030

CHAPTER 1

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1. Road to Agenda 2030

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Introduction

The world is becoming increasingly globalised and the political, corporate, and individual decisions taken in one part of the world often have a direct and/or indirect impact on the quality of the lives of people and environments in other parts of the world. Impacts can be both positive and negative: positive effects include rise of new industries and jobs while negative effects include environmental pollution and lack of decent working conditions and rights. Many decisions regarding the economic development of a given nation or region also influence the human rights of the people and the environment, the two main pillars of the Agenda 2030 and of the 17 United Nations Sustainable Development Goals (SDGs). In this introductory chapter we explore how and why the concept of sustainable development came about and why it is today the focus of the Agenda 2030.

To understand how the concept of sustainable development came about it is useful to put it into a historical context. First, we look at the call for increased protection of human rights after the Second World War (WW2), then how geopolitics and capitalism influenced the economic development after WW2 and finally how environmental protection became increasingly central in the development paradigm. While we still have far to go to find the equilibrium between social equity, economic growth and environmental protection, it is important to understand the evolution and interplay of these three concepts to make sure we take the right path to reach the goals of the Agenda 2030 on time.

1.1 We the peoples. The post-war grand design.

During WW2 (1939 – 1945), 71 million people died with an estimated 50 million of those being civilians. The extent of the destruction, genocide, hunger, and displacement of people resulting from WW2 had never been seen before and horrified the world. In reaction to this devastation came calls from across the globe for punishment of the perpetrators of these horrific crimes, for abolishing war and establishing peace and cooperation among countries, and for human rights standards to be established to protect citizens from abuses by their governments in the future.

A new "World Order"

To meet these demands, the United Nations (UN) came into being as an inter-governmental organisation, with the purpose of saving future generations from the devastation of international conflict.
On 25 April 1945, representatives of 50 nations, invited by the four main allied powers (the United States, the United Kingdom, the Soviet Union and China, then joined by France), assembled in San Francisco, US, and signed the United Nations Charter, the preamble of which reads: "We the peoples of the United Nations, determined to save succeeding generations from the scourge of war, which twice in our lifetime has brought untold sorrow to mankind, and to reaffirm faith in fundamental human rights, in the dignity and worth of the human person … and for these ends to practice tolerance and live together in peace … have resolved to combine our efforts to accomplish these aims.[1]"
The UN officially came into existence six months later, on 24 October 1945, when the Charter had been ratified by a majority of the founding members. Maintaining peace and security as well as promoting human rights were the top priorities.

Human Rights

Human rights had a long history in many countries pre-dating 1945. The first written statement concerning limitations to the arbitrary powers of a sovereign are observed in the Magna Carta, agreed to by King John of England on 15 June 1215, stating that "No freeman shall be taken or imprisoned … except by the lawful judgment of his peers or by the law of the land[2]". They were enunciated in the Declaration of the Rights of

[1] United Nations Charter: Preamble https://www.un.org/en/about-us/un-charter/preamble
[2] Magna Carta https://www.archives.gov/exhibits/featured-documents/magna-carta

Man and of the Citizen and voted by the French National Constituent Assembly in 1789[3]. They were developed into 10 amendments to the Constitution of the United States in 1797-98 to be regrouped into the Bill of Rights. But never had these rights been established on behalf of all the people living in the world, and now, after the horrific crimes perpetrated during WW2, a solemn proclamation was felt as a duty.

The Charter of the UN established the Human Rights Commission, which, under the chairmanship of Eleanor Roosevelt, drafted the Universal Declaration of Human Rights. The Declaration was drafted by representatives of all regions and religions of the world and was, and continues to be, the most universal human rights document in existence. It was adopted on 10 December 1948. From that day on, malicious acts by a government on its citizens became a matter of legitimate international legal concern, not just a domestic matter[4]. Trials have been conducted both before and after the adoption of the Universal Declaration of Human Rights, most notably the Nuremberg trials in 1945-46, all contributing to the building of international jurisprudence in matters of war crimes, crimes against humanity, and wars of aggression. Furthermore, human rights treaties and instruments have been adopted since 1945, further expanding the body of international law to protect vulnerable people: the conventions on genocide (1948), racial discrimination (1965), discrimination of women (1979) and rights of the child (1989). The UN Human Rights Council is charged with promoting and protecting human rights around the world by addressing human rights violations and responding to human rights emergencies.

The Universal Declaration of Human Rights is based upon the individualistic ideology of the Western world, and centres around rights which are enforceable by legal means. Such an individualistic ideology may differ somewhat from the focus in certain non-Western cultures where priority is given to the natural hierarchy of the family or the community, the tribe or caste, and "where it is the duty of the individual in the community to live according to the rite or the style of life ascribed to his status[5]". Yet, the Universal Declaration of Human Rights, based upon individual rights, may still be relevant in non-Western societies, as it is less about the specificities of the singular rights and more about the fact that all states must fulfil certain minimal physical and spiritual needs of human beings, and are accountable to the international community, now by law, for doing so. Herein lies the universality of the Declaration of Human Rights[6].

Since the adoption of the Universal Declaration of Human Rights in 1948, it has been adopted by, or influenced, most national constitutions. However, ratifying a declaration does not always equate to those rights, or certain minimal physical and spiritual needs, being met and protected in practice.

A long and hard path

Today, the UN with its 193 Government members, continues to play an important role in guiding our collective future. It strives to maintain peace and security, develop friendly relations among nations, achieve international cooperation, and be a centre for harmonizing the actions of nations.

Regarding human rights, significant progress has been made since 1948 in many countries (not all): think of voting rights, gender equality, racial equality and gay rights. Civil rights movements have, both before and after the adoption of the Universal Declaration of Human Rights, spearheaded the call for the protection of both individual and civil rights and liberties and continue to do so: Black Lives Matter, LBGTQ and the "me too" movements, as well as Friday for Future, Extinction Rebellion and many more.

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[3] Declaration of the Rights of Man and of the Citizen, https://www.elysee.fr/en/french-presidency/the-declaration-of-the-rights-of-man-and-of-the-citizen

[4] In order to be able to enforce the declaration, two Covenants were adopted in 1976, the International Covenant on Civil and Political Rights (ICCPR), which focuses on such issues as the right to life, freedom of speech, religion, and voting; and the International Covenant on Economic, Social and Cultural Rights (ICESCR) which focuses on such issues as food, education, health, and shelter. Together with the Universal Declaration, they are commonly referred to as the International Bill of Human Rights.

[5] Human Rights: A Non-Western Viewpoint, S. PRAKASH SINHA, Archives for Philosophy of Law and Social Philosophy Vol. 67, No. 1 (1981), pp. 76-91, Franz Steiner Verlag

[6] Human Rights: A Non-Western Viewpoint, S. PRAKASH SINHA, Archives for Philosophy of Law and Social Philosophy Vol. 67, No. 1 (1981), pp. 76-91, Franz Steiner Verlag

While a lot has been achieved over the past 75 years, no country can claim to meet all the human rights yet: some are not far off while others have a long way to go still. There is a broad variety among countries, and there is still a long road ahead before we can claim all rights are universally respected both in national legislation and in practice.

There may be hard choices to make among priorities. As stated in Article 29, limitations to the exercise of these rights may only be determined by law, and "solely for the purpose of securing due recognition and respect for the rights and freedoms of others and of meeting the just requirements of morality, public order and the general welfare in a democratic society"[7].

In fact, in many countries, public order has been and is considered to require restrictions on individual rights. Reference to what is determined "by law" implies reference to a legal system, and there is a variety of legal systems. The goal of allowing large parts of the population to have an exit from poverty has been considered as requiring limitations to individual freedom in many cases.

While the thirty fundamental articles of the human rights declaration form the basis for a democratic society, in the basic meaning of a society oriented to the interests of all and not of the few, the types of institutions that should accompany a country towards achieving this goal is an issue that allows for different solutions. Every country in the world has its unique setup of institutions. It is notable that, even in the presence of such different itineraries, the Universal Declaration of Human Rights and its guiding principles are present within all nation states. The Human Rights therefore represent ultimate goals by universal consensus, although the understanding of them and the timing for their implementation differ.

Progress is a never finished job. Societies are ever evolving and what constitutes a violation today may have been common practice some years back, while common practice today may not be acceptable in the future. Much progress has indeed been achieved in many countries since the end of WW2. Although progress is discontinuous and sometimes in some places we see steps backwards, in general human right standards continue to increase, and this is a good thing.

We must continue to stand up for those individuals and groups that do not yet benefit from the protection of human rights and make sure the next generations continue to build on the efforts of past generations towards achieving them.

1.2 Economic Development and International cooperation - worlds apart

Through transformations and conflicts, economic collaboration survived

The conclusion of World War II gave rise to an extended era of geopolitical tensions spanning from 1945 to the late 1980s, between the United States, the Soviet Union, and their respective allies. This era is widely known as the Cold War.

Along the same period most colonised countries gained independence from the rule of colonial powers that had been established in the previous centuries, a phenomenon commonly referred to as the decolonisation process.

The world was therefore commonly known to be split into "three worlds": the Western liberal world (First), the Eastern communist world (Second), and the Developing countries, often with a history of violent exploitative colonization, mostly in the southern hemisphere (Third).

The Cold War dominated the relations between the Western liberal and the Eastern communist worlds, with partial involvement of countries of the Third world with the one or with the other, while an effort to set up an alliance of "non-aligned" developing countries achieved some results.

[7] The Universal Declaration of Human Rights, https://www.un.org/en/about-us/universal-declaration-of-human-rights

This division was profound in the political, the cultural, the military and the economic sides of social life, yet it did not prevent a gradual build-up of commercial exchanges and of institutions dealing with and facilitating economic cooperation.

Capitalism and Global Economic Institutions

While capitalism can be traced as far back as medieval Europe, it was only really with the British industrial revolution in the 18th century that capitalism as we know it today took off. Technological breakthroughs such as mass-transport and electricity allowed for industrial capitalism to flourish relying on a combination of wage labour, access to cheap natural resources primarily from their colonies[8], production and competitive markets, which all together strived to supply an ever-increasing demand for a vast variety of specialised goods.

Similar to the concept of democracy, capitalism also lacks a singular, definitive model. Nevertheless, all forms of capitalism are rooted in the fundamental concept of utilising financial investment to generate additional wealth (capital). This capital can encompass various assets with monetary value, including properties (land, buildings, tools, machinery, or stored goods), human skills and capabilities (referred to as human capital), or market shares (referred to as financial capital). Competition is key to the capitalist model, and those that manage to drive down costs of production furthest stand to gain a larger share of the market and thus to make more profit: the main measurable goal of capitalism.

At the outset of capitalism in England there was little state regulation of the markets which allowed for swift growth based on low wages and no labour rights – also called free market or laissez faire or economic liberalism. By mid-20th century labour movements had gained ground which led to the founding of the modern welfare state, providing free healthcare and education to all, and thus improving the living conditions of many.

While the causes and motivations for WW1 and WW2 are many and highly debatable, the financial burden and economic impacts were enormous for the counties directly involved in the war, and they also were significant on countries on the side-line as they lost important trade partners.

To address the economic loss caused by the world wars, a number of global economic institutions and instruments were put in place in the immediate post-war years, under initiative of the US and Great Britain, built on the seminal notion that increased global trade based on the principles of capitalism would boost economic growth and development for all.

Coordination of trade and finance was based on the Agreement established in July 1944, well before the end of WW2, during a conference of all the 44 Allied nations held in the Bretton Woods resort, New Hampshire, USA. The so-called Bretton Woods System of institutions was successively joined by other nations.

The favourable economic conditions established after WW2, resulted in over 20 years of both economic growth, also referred to as “the golden age of capitalism”. Markets, including financial markets, were gradually subjected to regulation to guarantee labour rights, consumer safety, freedom of entry to new competitors, and respect of the environment.

The golden age came to an end in the 1970s because of soaring fuel prices and international competition from cheap labour costs in third countries and increasingly productive machines, which led to mass outsourcing and loss of traditional jobs, inflation and global economic recession. The economic “stagnation” of the 1970s was followed by a wave of neo-liberalism. With Margaret Thatcher (Prime Minister of the United Kingdom (UK) 1979-1990) in the UK at the lead, neo-liberalism supported increased privatisation, de-regulation, tax-cuts, and less spending in the social domain. This new capitalist model spread from the UK and from the US to most of the world, facilitated by increased globalisation, and reduced state and labour-movement intervention, and allowed the economy to recuperate some growth,

[8] Cotton, lumber, iron, tobacco, sugar etc. extracted and produced from colonies through slave labour

however often at the expense of the masses in the given country, with reduced welfare and increased income inequality.

While the new Global economic model provided great opportunities for many, the playing field was unequal, and this had significant long-term effects on vast amounts of people as well as on the planet. It is worth looking at how the situation differed around the world.

The Western Economies

At the end of WW2, the immediate challenge in most war ridden Western economies was to deal with an unprecedented economic crisis. Since the economic Global Depression of the 1930s had been, according to most historians, a major contributing factor to the breakout of WW2, the Western allies were determined to avoid another depression by pursuing economic cooperation.

To support the war-torn Western European countries in their economic recovery and to prevent Communist Soviet Union from extending its rule over Europe, apart from activating the Bretton Woods Institutions, the US designed a financial aid package known as the Marshall Plan (officially the European Recovery Program, ERP) in 1948 which was key in reconstructing the European economies[9].

New collaborative initiatives were also adopted within Europe. Remembering that a conflict between Germany and France over the border regions rich in coal and iron ore had played a role in unleashing both World Wars, on 9th May 1950 the French foreign minister Robert Schuman proposed to establish the European Coal and Steel Community (ECSC), as a means to promote regional integration that would make war "not merely unthinkable but materially impossible"[10] [11]. The Community institutions were granted their own powers, and as such the ECSC was the first international organisation to be based on the principles of supranationalism[12].

In 1957 two more European Communities were set up, one for cooperation in atomic (nuclear) research and energy, the other for general economic cooperation. The three Communities have since evolved into what is now the European Union (EU), with membership increasing from the six founders (Belgium, France, Italy, Luxemburg, the Netherlands, and West Germany) to the present 27 member states. Not only has peace been assured among its members, but the EU is today the world's largest single market, implementing a free movement of goods, capital, services and labour, and an important promoter of peaceful agreements and cooperative development.

Since Capitalism strives to maximize profit, operations will naturally tend to migrate towards locations with lower labour costs, ensuring that the end product remains as competitive as possible in global markets. As a result, all western economies suffered some level of displacement of jobs and certain industries in the 1970s as newly industrialised countries emerged offering cheaper solutions. In some cases, workers were able to be re-skilled for new jobs, however this transformation left many unemployed. The 1973 oil crisis, combined with mass-unemployment and high inflation, led to economic recession and stock market crash, which was followed by the neo-liberal era of capitalism.

Altogether, the liberal international economic system that developed after WW2 facilitated international and regional trade. Cooperation in the Western capitalist system, European integration and post-war recovery of Japan led to one of the greatest economic expansions in world history from 1948-1973. This growth persisted throughout the century although at a slower rate and not without some bumps on the road.

[9] History, https://www.history.com/topics/world-war-ii/marshall-plan-1
[10] EU Consilium, https://www.consilium.europa.eu/en/70-schuman-declaration/
[11] European Union, https://europa.eu/european-union/about-eu/symbols/europe-day/schuman-declaration_en
[12] Bóka, Éva. (2012), The European idea of a supranational union of peace. Society and Economy. 34. p. 387-397.

The Eastern block

The Soviet Union incurred substantial human and economic losses during World War II. Following the war, it swiftly rebounded on both economic and political fronts, positioning itself as a global power. This resurgence was largely attributed to a forced rapid industrialisation strategy, spearheaded by Joseph Stalin through comprehensive state control. This approach involved an increasingly centralised, militarised, secretive, and punitive institutional rule which allowed a backlog of unexploited economic potential to be effectively exploited.

By 1948 the average Soviet income had climbed back to pre-war levels[13], and continued to increase for the next two decades. After the death of Stalin 1953, the new leader Nikita Khrushchev enabled a de-Stalinisation campaign[14], a series of political reforms marking a clear break with Stalin's oppressive regime and attempting to balance increasing liberal demands from the younger generations. Communist rule survived for a while, collapsed in the satellite countries[15] in 1989, and in the Soviet Union in 1991.

The new Russian Federation made a turn toward a market economy and opened its domestic markets to foreign trade and investment, implemented rounds of privatisation and obtained loans from the IMF. The transition proved difficult, and most of the Russian population saw their living standards drop rather than increase as expected, while a few super-rich oligarchs emerged. After 2000, a steady increase in the annual GDP has allowed many Russians to climb out of poverty, toward constituting a growing middle class. In 2012 Russia joined the WTO.

Many European countries who had been satellites of the Soviet Union have since joined the EU.

Decolonisation: steps to self-rule and finances needed for economic development

The starting point for colonised countries was very different, since sound economic development first and foremost requires stable governance and access to finances.

While the process of decolonisation had begun before WW2 through the League of Nations, in an attempt to prepare colonised countries for self-rule, it was only after WW2 that a drive to self-determination, affirmed in the Charter of the UN, became reality in most colonies.

Colonisation had produced economic gains on the side of the coloniser, more than often, through brutal exploitation of natural resources and subjugation of labour in the colonised countries. In addition, colonisation had often resulted in arbitrary boundaries and borders where none had existed before, dividing ethnic and linguistic groups and natural features, laying the foundation for the creation of numerous states lacking geographical, linguistic, ethnic, or political affinity.

There was no single process of decolonisation. Each colonised country had its unique history of exploitation, geographical delimitation, and oppressive external rule, often with severe political, economic, and social implications. As a result, for some the process of independence was achieved in a relatively peaceful and orderly manner while in other cases it was the result of long and painful revolutions, and for many it was somewhere in-between the two. Economic growth of many new states was slow, and many were ruled by dictators or military groups for decades. Some rulers were dedicated to the public good, others were more interested in personal power and wealth gains. Independence for many countries resulted in long periods of internal conflicts among ethnic groups.

To ensure economic and social development it is important not only to have stable governance but also to have access to adequate finance needed to ignite economic growth. This, in turn, requires capital and inevitably some debt. Bilateral loans (between two countries) and multinational grants and loans did make credit available to developing countries by making loans easier to obtain and cheaper to pay back. However, often such loans came with unrealistic rules and conditions (conditionality) which resulted in the

[13] Mark Harrison, 2010, The Soviet Union after 1945: Economic Recovery and Political Repression, University of Warwick
[14] Robert C. Tucker, (1957) The Politics of Soviet De-Stalinization, World Politics. Vol. 9, No. 4, pp. 550-578, Cambridge University Press
[15] A satellite country is formally independent but under heavy political, economic and military influence or control from another country.

piling up of external debt which has only further contributed to making the economies of many developing countries even more fragile.

Tragically, in many cases the grants and loans were not spent on projects that benefitted the populations at large as they were meant to do, but rather ended up in the pockets of corrupt government officials or used to pay back old debt. As a result, lack of investments in healthcare, education and infrastructure exacerbated conditions of poverty and resulted in continued high rates of malnutrition, illiteracy, and child mortality, making it impossible to escape the poverty trap.

Furthermore, during the 1970s, income growth degenerated in many Western countries, resulting in inflation. Central banks fought inflation by raising interest rates which damaged indebted companies, banks, and nation states, as they consequently had to pay a higher price for their loans, and was particularly disastrous for weak debtors, as many developing nations were.

The global financial institutions, trying to maintain conditionality in presence of debt that had become unsustainable, worsened the position of weak states, and forced them to cut needed social expenditure. In many cases debt had to be written off eventually, while social unrest fed political instability.

Despite facing multiple obstacles to economic development, closer contact and collaboration with developed countries implied importing their capitalist models of consumption and production as well as a globalised culture. Ethnic knowledge, culture and modes of consumption that had been passed down for generations, techniques that had been developed locally according to local needs and resources, were displaced, even when they could be maintained and fruitfully adapted. While more abundant food supplies help in combating famine, health conditions and traditional values are often damaged by sudden substitution of traditional local food, knowledge, and culture with the globalised homogeneous version.

Sub-Saharan Africa is the region that has had the most difficulties in installing the political and economic stability needed to get their rapidly increasing populations out of poverty. The reasons for the slow economic development of many sub-Saharan countries are numerous and complex and include elements linked to Africa's colonial legacy, ethnic divisions, particular geographical difficulties, and low life-expectancy but also to poor policies and institutions[16]. Despite signs of progress over the last decade, today the average poverty rate for sub-Saharan Africa stands at about 41 percent, and 27 of the world's 28 poorest countries are in sub-Saharan Africa[17].

Asian countries have been able to show the best results in terms of economic growth. Taking off after Japan and South Korea, China has become the new giant in the world economy.

India is following with high rates of economic growth. Also, Brazil is now in the top group for GDP, although showing slower growth recently.

The emergence of so many new independent states has changed the balance of power within world institutions. A united Global South has emerged, often standing together in the UN system and demanding that their voices be heard. Two thirds of the WTO's 164 members are from the 'global south', and as such should play an increasingly important and active role in the international governance system[18].

Inequality reduced and increased at the same time

While the liberal economic model opened exciting opportunities for many, it had differentiated impact on equality both within and between nations.

Where well-regulated and governed, the capitalist model can allow most of the population within a nation state to benefit, as we observed happening in many European countries in the years immediately after the

[16] Sources of Slow Growth in African Economies; Jeffrey D. Sachs and Andrew M. Warner; Harvard Institute for International Development; Journal of African Economies, Vol 6, Nr.3
[17] Poverty and shared prosperity: Piecing together the Poverty Puzzle, World Bank, 2018
[18] Inge Kaul (2013) The Rise of the Global South: Implications for the Provisioning of Global Public Goods, UNDP

end of WW2. When this happens, differences Gross National Income (GNI) and Human Development Index (HDI) between nations, and within nations, are reduced, and that is a positive thing. Nonetheless, in situations where state intervention is limited (as seen in neo-liberalism) within a specific nation-state, there is a potential for a rise in income and wealth inequality. This tendency is particularly noticeable within affluent countries, where certain entities are more adept at capitalizing on the market-driven economy, often at the detriment of others.

Consider, for example, a very large company with a distinct market dominance in terms of either its service or product. This company enforces the lowest possible wages and employment conditions on one side, while simultaneously raising prices for consumers and failing to enhance the quality of its product and services on the other side. Such a scenario could lead to significant portions of the middle class descending along the spectrum of income and social status. Meanwhile, at the top, a small percentage of the population accumulates an increasingly substantial portion of income and wealth.

Therefore, where policies of social equity are reflected in labour market rules, competition policies and quality regulations for products and services, increased inequality does not have to be the outcome. This has been observed in the Scandinavian model as well as in Japan and other European countries. It is possible to keep high social welfare levels and minimize inequality, provided there exists the necessary political determination.

Modern technology is another example that can open new and attractive horizons, but only to those who can master it. Here, a new social divide opens, between the upper social classes who can reach the higher levels of specialised instruction in digital tools for communication, computing, visual creativity, and the lower classes who cannot, and are disadvantaged whenever digital tools are used for education, culture, and training. This exacerbates pre-existing educational differences within nations and across social classes.

Finally, the Covid-19 pandemic, a consequence of a broken equilibrium between man and nature, is exacerbating the problems of inequality both within countries and between countries. While rich countries manage to provide their citizens vaccines and health care, compensations for loss of income and welfare support measures, populations in developing countries who live of tourism from or exports to rich countries, and depend on daily wages for minimal subsistence, have, in most cases, been left to their own devises with no or limited access to health care or vaccines and no compensation for loss of income. The Covid-19 pandemic has in fact reversed years of progress in the reduction of poverty, gender inequality, and in improved education for many developing nations.

Pre-existing inequalities were also exacerbated in developed countries as a result of the pandemic. In some of the richest countries in the world where access to healthcare is not guaranteed, the poorer segments of society, who cannot afford healthcare, as well as women who primarily cared for the young and the sick, suffered disproportionally[19].

The governance model, access to technology and the impact of pandemics all influence the degree of equality present in a country and highlight inequalities across societies, always hitting the most vulnerable hardest. We all live in a globalised world where fragile social systems pose massive challenges to the human rights progress, we have achieved over the past decades. Given the increased global interdependence, the lack of global solidarity between countries and regions as well as between social classes within given countries leaves us with the question of how we can build back better, not only for limited segments of society but for all segments of society throughout the world.

Economic cooperation in a multilateral world

Economic cooperation through trade has certainly allowed for unprecedented economic and human development. It has taken billions out of poverty and increased the quality of life of large parts of the world's population. It has survived times of conflict and times of crisis in the economic systems.

[19] National Geographic (2021) Why women have suffered more financially during the pandemic

However, such economic and human development has come at a certain price. First and foremost, it has been possible only because of exploitation of human labour, which has exacerbated inequalities within and between nations and regions. Secondly, it has also been contingent on the exploitation of natural resources, which has resulted in considerable environmental destruction (further explored in chapter 2).

World equilibrium is today a complex multilateral affair. Such complexity is a matter for concern as cooperation is not always granted by all. But all nations in the world have much to lose in breaking it. This is a reason for hope.

1.3 Sustainability - the environmental challenge

The long, unprecedented growth of the world economy carried a destructive side in its relation to the environment that has gradually been acknowledged and has been giving rise to a multifaced reaction: surprise, negation, awareness, research, mobilisation, negotiation, decisions.

Fast-paced industrialization was facilitated by a growing reliance on the combustion of fossil fuels, which released unprecedented amounts of greenhouse gasses (GHG) into the atmosphere, thus leading to climate change. Furthermore, to feed an ever-growing global population, intensive forms of agricultural farming facilitated by chemical fertilisers has led to the poisoning of land and water while deforestation has resulted in unprecedented loss of biodiversity and imbalance, even collapse, of many ecosystems.

The accumulated impact of these human activities - e.g., GHG emission, pollution, and deforestation - has reached levels that are threatening the Earth's ecosystems and climate. The results are already being felt in many regions of the world causing many to migrate away from their land, often towards cities in hope of finding jobs and better lives. The consequences of the collapse of Earth's ecosystems would be detrimental for humanity at large, and possibly even irreversible. (Further explored in chapter 2)

It has become increasingly clear that our present economic system is dramatically biased in the direction of short-sightedness, as its decisions are aimed at advantages reaped today without considering disadvantages of tomorrow, and narrow-mindedness, to maximise individual welfare and neglecting common goods.

The origins of the concept of sustainability

Rachel Carson was, with the publication 'Silent Spring' in 1962, one of the first to place human activities at the centre of environmental degradation. Using the specific example of pesticides and the negative impact they have on ecosystems; Carson highlighted the impact human society can have on nature. The Silent Spring conveys a message as pertinent today as it was back in the 1960s: human dependence on the living environment underscores the folly of neglecting its protection.

Carson's Silent Spring effectively generated widespread environmental interest and was without doubt of great inspiration to the participants of the United Nations Conference on the Human Environment held in Stockholm, Sweden, in 1972, and particularly to the follow-up World Commission on Environment and Development (WCED, known as the Brundtland Commission in recognition of its chair, the former Norwegian Prime Minister Gro Harlem Brundtland), which marked the formalisation of global concern for environmental development.

It was in fact the Brundtland Commission that in 1987 first popularized the concept of sustainable development, with the publication of the report entitled "Our Common Future", also known as the "Brundtland report". This report placed environmental issues firmly on the international political agenda and defined sustainable development as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"[20].

Carson and the Brundtland report initiated a shift in global environmental consciousness which has continued to evolve to this day. It has placed the paradigm of sustainable development as a guiding principle for development. Since then, it has no longer been possible to think of development without considering the impact it may have on the environment. Sustainable development has furthermore placed the health of the planet at the centre of intergenerational justice and argues that in our pursuit of better lives, we must make sure to avoid environmental degradation, over-exploitation or pollution that will have a negative impact on future generations.

[20] Report of the World Commission on Environment and Development: Our Common Future, 1987

Three fundamental components, as well as their interaction and interlinkages, are key to sustainable development: social equity, economic growth, and environmental protection. Social equity and economic growth dominated the concerns of political leaders after WW2, while environmental degradation and over-exploitation of natural resources have increasingly become concerns as our economies and population have grown, putting an increasing strain on our natural resources, and pushing natural boundaries to the brink of collapse. The response to environmental degradation has resulted in many international agreements addressing a wide range of issues, from the protection of the rainforests, wild flora and fauna, and marine environments to limiting air pollution and the emission of greenhouse gasses (GHGs).

1.4 Globalisation

Since the adoption of the Human Rights Declaration, the Bretton Woods System and the Brundtland report we have come far. In our present era, we inhabit a truly globalised world, characterized by a growing web of interconnections and interdependencies. This phenomenon stems from various intricate processes, notably the escalation of trade and the exchange of cultures, both greatly aided by modern advancements in transportation, technology, and financial systems. Consequently, this has spurred heightened integration among individuals and communities, as well as among businesses and governments on a global scale.

Though many scholars place the origins of globalisation in modern times to the 17th and 18th century, others trace its history back to the third millennium BC Mesopotamia where the first systems of commercial banking as well as trade of goods and exchange of language and ideas between central Asia and Europe first became a reality[21]. However, large-scale globalization as we know it today only began in the 1820s, with industrialisation leading, after WW2, to a massive increase of networks of worldwide interdependence and increased economic interaction. The expansion of capitalism to a global scale has ushered in optimised trade relations, streamlined the movement of labour and capital, and equipped this dense world-wide network with improved technology, efficient transport, and seamless communication channels.

Modern globalisation is defined by Martinelli as "a set of related processes that involve a stretching of economic, social, cultural and political activity and interconnect the individuals, groups, communities, states, societies, markets, corporations, international governmental and non-governmental organisations in complex webs of social relations, intensifying their interdependence and increasing the consciousness of what is happening … the growth of networks of worldwide interdependence"[22]. In the past, local communities would have distinct cultural, economic and social realities, today we find the same high-street shops and services across nations, regions and continents (Starbucks, IKEA, HSBC Bank etc.) and the social, cultural and political opinions of the individual and local communities are instantly and continuously connected and influenced by the rest of the world through the internet, smart technology and migration, creating an increased opportunity for learning and sharing across cultures, yet often leading to homogenisation and some form of cultural hybridisation. Globalisation is therefore a multi-faceted process with far-reaching consequences for the lives of all women and men, imposing constraints, and opening opportunities for individual as well as collective action[23].

Global Governance

Today we are living in a transnational civil society with an international public space and a growing awareness of our common fate as human beings, but does this mean that a sense of global community is developing, i.e., that we can identify some form of global unity and civic consciousness resulting in shared global responsibilities and solidarity? And if so, who has the mandate to govern such collective responsibilities?

[21] Andre Gunder Frank, 1998, ReOrient - Global Economy in the Asian Age
[22] Martinelli A, 2005, Global Modernization – Rethinking the project of Modernity
[23] Martinelli A, 2005, Global Modernization – Rethinking the project of Modernity

In our current form of global society, there is no Global authority with the right to establish and enforce the rules of the game, and where needed, sanction illegal behaviour on the global stage in the same way that our nation states are mandated to do so. Furthermore, there exists no democratic governance structure at the global level wherein exploited or disadvantaged social groups could effectively amplify their voices through voting rights. Such groups could then influence political decision-makers who vie for their support, allowing them to trade their allegiance to democratic institutions for equitable rights encompassing legal, political, and social citizenship.

Globalisation therefore raises the question of global governance, that is, the definition of a complex set of global norms concerning the entire world as a single system in various ways, i.e. planet Earth as an ecosystem; humanity as an endangered species, with the related concerns for the lives of future generations; the peoples of the world as a single constituency of individuals entitled to equal rights and responsibilities to whom decision-makers must be accountable; the world market as an economic space regulated by international law which can guarantee the rights not only of investors, but also of workers, consumers and communities[24].

While the nation state continues to hold a pivotal role in establishing the necessary institutional and legal frameworks for guiding and shaping the country's trajectory based on established national interests and policies, it is becoming evident that nation states are concurrently becoming more interconnected on a global scale. This interconnectedness is manifested through the swift movement of goods, services, money, people, knowledge, news, and pollution across national borders. Alongside these dynamics emerges a gradual erosion of the sovereignty traditionally associated with the nation state. In reality, because of the multifaceted impact of globalization, nation-states are undergoing a deep transformation, as their functions and powers are rearticulated and re-embedded in complex transnational and regional networks.

Indeed, we are witnessing the consolidation of a multileveled form of global governance that comprises a plethora of international regimes and supranational institutions of governance at the world (UN) and regional level (EU) [25]. The latter are based on the principle of subsidiarity and result in both voluntary and compulsory national commitments and increased harmonisation of national law. We are also observing the emergence of a transnational civic society and an international public space, where likeminded people come together independently of national borders and stand stronger in unity giving a “mandate” for increased supranational authority on various global issues i.e., youth on climate issues. We are therefore observing both top-down and bottom-up processes that are mutually reinforcing and increasing global governance of global issues and are contributing to a more peaceful world with greater individual freedom, social justice, and respect for cultural diversity for all.

It is within this multi-layered global governance structure, that increased co-dependence and a growing awareness of our common fate as human beings is being acknowledged and that the UN members granted support to the United Nations Millennium Development Goals (MDGs) adopted in 2000, and the subsequent Sustainable Development Goals (Agenda 2030) adopted in 2015.

1.5 Millennium, the new beginning

At the turn of the century (and millennium), the pervasive effects of globalisation made it clear that the organisation of the world economy, and with it the social and ethical norms that had been shaped, accepted, and implemented after WW2, needed a radical adjustment in order to assure satisfaction of the basic needs of all humans on Earth. A new awareness of collective responsibility toward universal issues, universally shared values, and the recognition of human rights was the spirit that guided the drafting of the MDGs.

[24] Martinelli A, 2005, Global Modernization – Rethinking the project of Modernity

[25] The principle of **Subsidiarity** holds that, any social or political issues should be dealt with at the most immediate (or local) level that is consistent with their resolution

In 2015 when the deadline of the MDGs was approaching, the emergence of much larger environmental risks was becoming evident as were the causes for them. The new SDGs were put in place to address both human and environmental issues in the Agenda 2030. Differently from their predecessors, the latter were not only striving for major action in development policy in and for the Global South, but also emphasized the urgency of innovative policies needed in the Global North to achieve sustainable development. The SDGs offer major improvements on the MDGs, as the new framework addresses key systemic barriers to sustainable development that the MDGs neglected or did not stress sufficiently, such as inequality, unsustainable consumption patterns, weak institutional capacity, and environmental degradation.

It was no longer satisfactory to just affirm rights in a world where rights were in fact denied and were bound to be further compromised as a result of the worrying economic and environmental trends. It was clearly a duty to act together and create new conditions.

Millennium Goals

The Millennium Summit took place in New York City in 2000 and brought together world leaders with the overarching goal of defining the role of the United Nations at the turn of the century.

189 Member States of the United Nations agreed to help citizens in the world's poorest countries to achieve a better life by 2015. They signed a Millennium Declaration affirming collective responsibility to uphold the principles of human dignity, equality, and equity at the global level and to ensure that globalisation may become a positive force for all the world's people.

The framework for this progress was outlined in the Millennium Development Goals (MDGs) which should have been achieved by 2015:

1. To eradicate extreme poverty and hunger
2. To achieve universal primary education
3. To promote gender equality and empower women
4. To reduce child mortality
5. To improve maternal health
6. To combat HIV/AIDS, malaria, and other diseases
7. To ensure environmental sustainability
8. To develop a global partnership for development

It is not a simple task to evaluate the success of the MDGs. While unprecedented progress was achieved from 2000 to 2015 in poverty reduction, access to education and improvements in child and maternal health, they failed to adequately address socio-economic inequality and environmental degradation.

One of the main criticisms to the MDG framework highlighted the inefficacy in addressing the structural causes of poverty, which resulted in leaving too many behind. As the former UN Secretary General Ban Ki-moon claimed: "The MDGs helped to lift more than one billion people out of extreme poverty, to make inroads against hunger, to enable more girls to attend school than ever before". He then went on to say that: "Yet for all the remarkable gains, I am keenly aware that inequalities persist, and that progress has been uneven."[26]

Indeed, it is widely acknowledged that the success of the MDGs was largely possible due to huge progress at all levels in two main countries, namely China and India, and that, at the end of 2015, there were still many unresolved problems in other parts of the world, especially in sub-Saharan Africa and in many countries afflicted by war.

[26] The Millennium Development Goals Report, UN, 2015

Sustainable Development Goals

In 2015, the 193 member states of the UN General Assembly adopted the 2030 Development Agenda titled "Transforming our world: the 2030 Agenda for Sustainable Development" which includes 17 Sustainable Development Goals with a total of 169 targets.

The SDGs were developed to succeed the MDGs and incorporated important lessons from the failures of the MDG. First, these new goals aim to drive change in both developing and developed countries. They call for the participation of not only all Member States but also international organizations, businesses, local authorities, the scientific community, and civil society -an authentic call for action that aims to engage the entire global community. Second, the SDGs put emphasis on key systemic factors, previously neglected, that hinder sustainable development, such as inequalities between countries and within them, environmental degradation, unsustainable consumption models, the weakness of institutions and governance models[27]. Finally, the SDGs identifies 17 distinct areas in which progress shall be achieved and emphasises the importance that solutions and actions should be tackled in their interconnection to achieve the highest impact.

The preamble of the official 2030 Development Agenda identifies five P's that are at the centre of the 2030 Agenda and highlight how the SDGs form part of an intertwined framework instead of a group of siloed goals. Progress on all five P's, with focus on their interconnectedness, is necessary to ensure sustainable development for all.

People - end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment.

Planet - protect the planet from degradation, through sustainable consumption and production, sustainable management of natural resources and by taking urgent action on climate change, so that the planet can support the needs of present and future generations.

Prosperity - ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social, and technological progress occurs in harmony with nature.

Peace - foster peaceful, just, and inclusive societies, which are free from fear and violence. There can be no sustainable development without peace and no peace without sustainable development.

Partnership - implement the UN's 2030 Development Agenda through a global partnership, based on a spirit of global solidarity, focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries, all stakeholders, and all people.

The Sustainable Development Goals (SDGs) encompass the three fundamental dimensions of sustainability, namely: social equity, economic growth, and environmental protection. With 17 interconnected goals and 169 targets, these dimensions work harmoniously to reinforce each other. However, it's not unexpected that governments and other stakeholders often face challenges in prioritising these goals, as conflicts can arise between the policies, interests, and ideologies of different parties. This complexity can lead to trade-offs that require careful consideration. Goals and targets can furthermore contradict each other, and difficult choices must be made for example when the increase of agricultural production needed to feed a growing population requires increased energy consumption which contributes to climate change. The inevitable trade-offs become even more complicated when they also take the form of inter-state conflicts[28].

Given the wide-ranging issues tackled by the SDGs it is evident that the Agenda 2030 serves as a global framework intended to steer relevant stakeholders towards achieving sustainable development. The specifics of achieving each distinct goal and target were designed to be discussed in diverse supplementary agreements and forums. The Agenda 2030 calls attention to priority issues of common interest,

[27] Martinelli A., (2021) GLI OBIETTIVI DI SVILUPPO SOSTENIBILEDELLE NAZIONI UNITE 2015-2030
[28] Martinelli A., (2021) GLI OBIETTIVI DI SVILUPPO SOSTENIBILEDELLE NAZIONI UNITE 2015-2030

recommends appropriate strategies to address them and cautions against counterproductive actions that could hinder progress. As such it is in fact a brilliant compromise between the need for global governance and the defence of national sovereignty[29]. An example of this is the climate goal SDG13, and the subsequent Paris Agreements, that have been turned into binding policy in the recently adopted EU Green Deal.

The adoption of the Agenda 2030 has therefore started the process of embracing a new paradigm of sustainable and inclusive global development, a process that needs the active involvement of all sectors of society. It is a framework that aims to instil a new mindset in the population at large, to design new sustainable business models for the future and to promote research and innovation in the transformative, and possibly disruptive, technologies necessary to achieve the ultimate objectives.

[29] Martinelli A., (2021) GLI OBIETTIVI DI SVILUPPO SOSTENIBILEDELLE NAZIONI UNITE 2015-2030

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Our Planet at Risk

CHAPTER 2

Alessi, Pia Lovengreen

SEPTEMBER 2021 | LET'S ACT ERASMUS PLUS PROJECT

2. Our Planet at Risk

Introduction

2.1 Humanity at a crossroad between Holocene and Anthropocene
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2.5 Concluding remarks

Introduction

The planet is at risk of becoming less and less inhabitable because of modern industrialisation and consumer capitalism. As a result, global environmental threats loom, such as climate change, pollution of the atmosphere, acidification of the seas and rising sea levels, desertification, land degradation and loss of biodiversity.

Human behaviour stands at the root of many of these threats, and it also holds the keys for reversing the trend. Action includes a combination of change in individual and collective behaviour, changed policy and governance as well as scientific and technological developments which combined can open promising opportunities for a better life. Adoption of new materials and sources of energy, global communication and clean mobility may allow people in the future to enjoy better lives than any time in the past, all while being part of a global sustainable community.

Contrasting scenarios can be, and are indeed, being built. At the root of the difference between doom and hope stands human action (or inaction) at all levels. Public and corporate action count, as does citizens action backed by knowledge, understanding, awareness and engagement. Only together can we make the difference needed. For some, the impact of climate change is already a reality in everyday lives, for others it is somewhat removed. However, sooner or later it will affect us all directly.

2.1 Humanity at a crossroad between Holocene and Anthropocene

The Holocene is the name given to the geological epoch which started at the end of the last glacial period and has lasted for approximately 12.000 years. The Holocene has observed a slightly warmer and stable climate than previous periods which has allowed for human civilization, as we know it today, to thrive and develop.

Without pressure from humans, the Holocene was expected to continue for at least several thousands of years. However, some scientists believe we are finding ourselves at a crossroad between the Holocene and a new age, usually referred to as the Anthropocene.

Anthropos is the Greek word for human, and the Anthropocene refers to the beginning of a new geological epoch, an epoch where human exploitation has reached such a magnitude that it has a dominant impact on the natural geology of Earth.

In this chapter we will explore how and why the favourable conditions of the Holocene are under threat from human exploitation, and what must be done to reverse such threats to assure humanity's long-term goal of "meeting the human rights of every person within the means of our life-giving planet"[1].

Modern civilizations flourished during the Holocene

Earth has experienced substantial variations in the climate over the past millions of years moving between glacial periods (ice-age) and interglacial periods (Fig 1). However, over the past 12.000 years, Earth has experienced an unusually stable and slightly warmer environment than the previous 110.000 years, which allowed human civilizations rise, develop, and thrive[2]. This period is called the Holocene. The unprecedented stability of the environment of the Holocene (+- 1c°) is the result of the particularly circular orbit that Earth is currently making around the sun[3] combined with many

[1] Kate Raworth, Doughnut Economics, 2017
[2] Johan Rockström et al, A safe operating space for humanity, 2009
[3] Berger, A. & Loutre, An Exceptionally Long Interglacial Ahead?, 2002

interdependent natural systems that help regulate the climate including the rainforests and temperate forests, oceans, the large permafrost regions, and the savannahs[4].

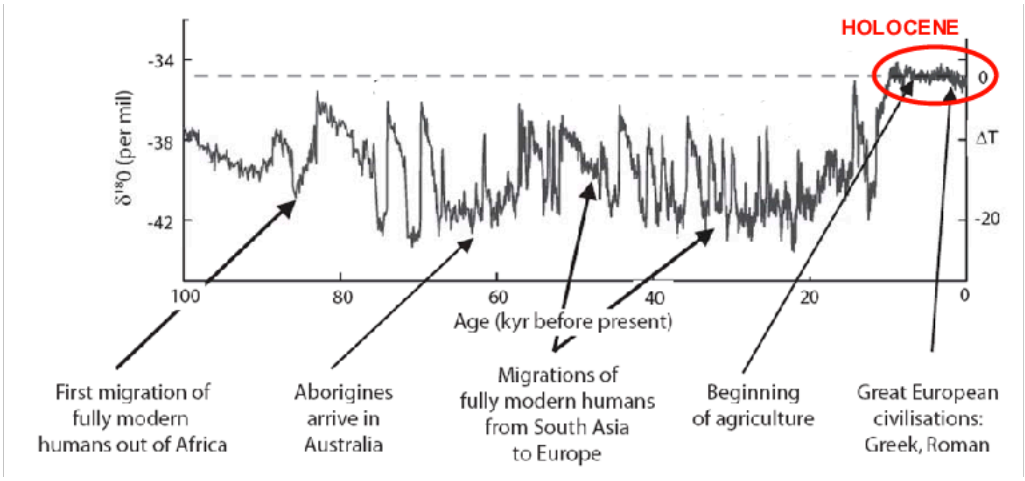

Fig 1: The last glacial cycle (indicator of temperature) and selected events in human history. The Holocene is the last 10,000 years. Adapted from Young and Steffen (2009), Principles of Ecosystem Stewardship, New York, Springer[5]

During the Holocene, primary resources such as water, land or fossil-fuels have been plentiful, and the world's ecosystems have been able to absorb the waste of human activity resulting in stable and predictable temperatures, freshwater availability and biogeochemical flows all stayed within a relatively narrow range which allowed for a stable environment that provided optimal conditions for human development.

Anthropocene

Since the industrial revolution, especially since the post war boom from the 1950s onwards, human activity has had a dramatic impact on earth. Human exploitation of natural resources in the quest of increased production and consumption powered by fossil fuels has led to a massive increase in the emission of Greenhouse Gasses (GHGs), while intensive forms of agricultural farming facilitated by chemical fertilizers and land-use conversion, to feed an ever-growing and increasingly affluent global population, have been putting massive pressure on the environment and the many interconnected systems that assure the stable environment of the Holocene.

The impacts of human activities have led to the loss of biodiversity, imbalance of ecosystems and climate change, all of which enhanced each other, resulting in associated systems being more unstable. The impact has reached such levels that could damage the systems that keep Earth in the desirable equilibrium state and the result could be detrimental, even irreversible in some cases, leading to abrupt environmental change and a new state less conducive to human development[6].

This new state, also called the Anthropocene, represents a globalised phase of environmental change, as local environmental changes can no longer be separated from the global. Activities in one place of the Earth can influence far-removed places on Earth as well as have an effect on global scale[7]. Think of the melting ice sheet in Greenland or the deforestation of the Amazon Forest. This new globalised phase of environmental change is having an increasing effect on our climate, often with a dramatic increase in natural disasters such as hurricanes, flooding, drought, forest fires

[4] Johan Rockström et al, A safe operating space for humanity, 2009
[5] https://www.researchgate.net/figure/The-last-glacial-cycle-of-18O-an-indicator-of-temperature-and-selected-events-in-human_fig1_42766179
[6] Steffen, W. et al. Global Change and the Earth System: A Planet Under Pressure, 2004
[7] Steffen, W., Crutzen, P. J. & McNeill, J. R., The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?, 2007

and other natural events, which in turn can have a significant impact on economic and human development everywhere in the world, especially in the poorer regions. If not addressed adequately, this could see human activities push the earth system outside the stable environmental state of the Holocene, with consequences that can be detrimental or even catastrophic for large parts of the world[8].

Without pressure from humans (CO2 emission, loss of biodiversity and imbalance of ecosystems, pollution and more), the Holocene would have continued for at least several thousands of years[9]. According to Johan Rockström and colleagues, there is now sufficient scientific evidence to document that humanity stands at a crossroad: one road takes us further into disequilibrium and loss of stable living conditions in large areas, and the other can largely save the stable state of the Holocene. Precaution should be the guiding principle at this crossroad, and actions towards sustainable development is paramount on this voyage.

To help us steer in the right direction, striving for Holocene like conditions, it is important to understand two fundamental elements:

1. Which are the rising human pressures on ecosystems and the planetary system that are putting the Earth at risk,
2. How does nature and the Earth system respond to such pressures (Earth resilience and tipping points).

Only then do we have the knowledge needed to be able to start identifying the solutions and technologies that are adequate, and only then can we design economic instruments and global governance systems that are fit for the task and identify the individual actions needed by all.

The Great Acceleration

Why have we landed in this unprecedented situation standing at such an important crossroad for humanity? According to many scientists[10] [11], planet Earth is being squeezed on multiple fronts simultaneously, a squeeze which has been significantly amplified in the last 50 years, exemplified by the exponential rise in terms of welfare and development, from population and economic growth to paper and water consumption and telephone use, as well as mass tourism and production of motor vehicles[12] (Fig 2).

What evidence do we have to suggest we have entered the Anthropocene? The Great Acceleration graphs (Fig 2) helps document how human activity, predominantly the global economic system, is now the prime driver of change in the Earth System, including its geology and ecosystems. While the Great Acceleration graphs start around the Industrial Revolution, the acceleration only really begins in the post-war are of the 1950s and continues thereafter.

The Great Acceleration graphs trace the evolution of socio-economic trends, like population growth, GDP and primary energy use, as well as linked Earth System trends, like carbon dioxide, surface temperature and ocean acidification, and suggests these are in fact interlinked and together putting increased pressure on planet Earth.

[8] Johan Rockström et al, A safe operating space for humanity, 2009
[9] Berger, A. & Loutre, An Exceptionally Long Interglacial Ahead?, 2002
[10] Steffen, W. et al. Global Change and the Earth System: A Planet Under Pressure, 2004
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[12] Steffen, W., Crutzen, P. J. & McNeill, J. R., The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?, 2007

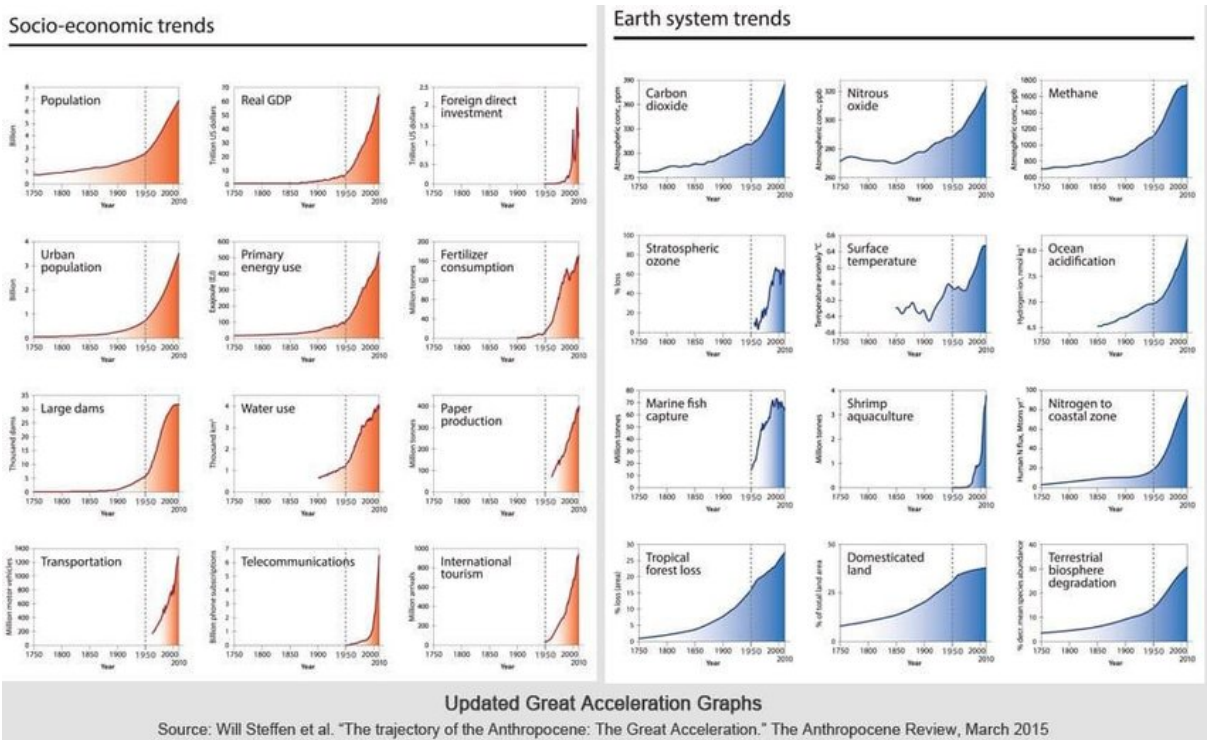


Fig 2: Great Acceleration, Will Steffen et al., The trajectory of the Anthropocene, The Anthropocene Review, 2015[13]

It is useful to highlight three particular categories that have put significant pressures on Earth

1. human population pressure: growth and affluence,
2. human caused climate change,
3. ecosystem crises and regime shifts

1. Population Growth and Increased Affluence

The first pressure refers to the fact that over the last 120 years the world population has exploded, growing from 1,6 billion in 1900 to 3 billion in the 1950s, 7.7 billion in 2019 and with the UN predictions for 2050 being 9.7 billion with a continued increase and reaching a peak of around 10.4 billion at the end of the century[14].

The increase in population, living standards and affluence has resulted in an exponential increase in consumption and production which has and continues to put an increased strain on primary resources. This, in turn, has put an increased strain on Earth's climate and ecosystems.

The "hockey stick" graph (Fig 3) documents the increase of the world population over the past 12.000 years. The population on Earth was relatively stable until the 15th century, after which it started to grow at unprecedented rates, reaching just under one billion in 1800 and then growing at exponential rates until today and is expected to peak at 10.4 billion by the end of the century.

[13] https://www.researchgate.net/figure/The-Great-Acceleration-Steffen-et-al-2015b_fig5_326295135
[14] UN, World Population Prospects, 2019

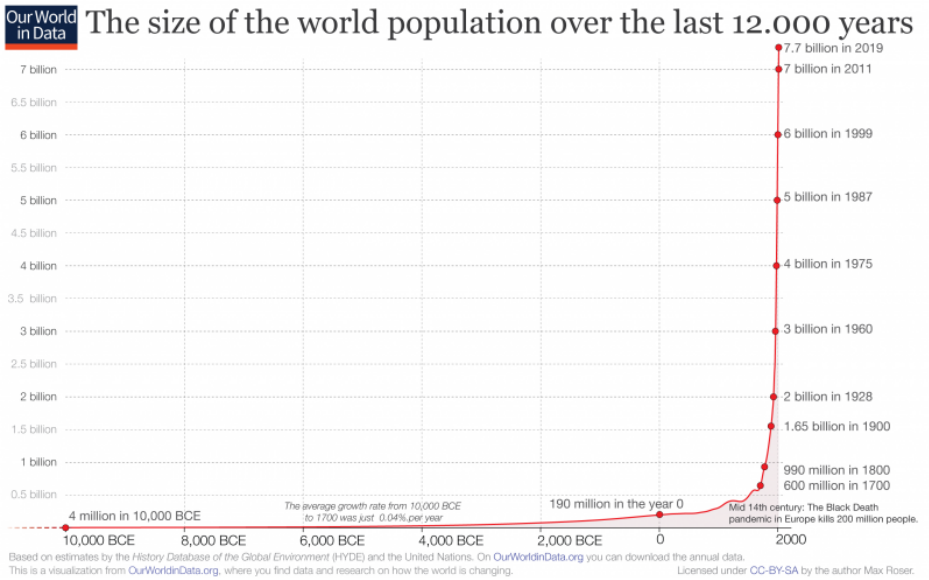


Fig 3: The Size of the world population over the last 12.000 years, Our World in Data[15]

Population growth is, however, a temporary phenomenon. It is the result of being in the middle of a demographic transition. This is where better living conditions lead to lower mortality rates while fertility rates remain high. Eventually, the fertility rates also come down, and population growth will stabilise again. In some of the first industrialised countries, the demographic transition took around 100 years, however some newly industrialised countries have achieved stable demographic growth in as little as ten years. Explore the five stages of the demographic transition (Fig 4) to visualise the demographic transition and why population growth is a temporary phenomenon.

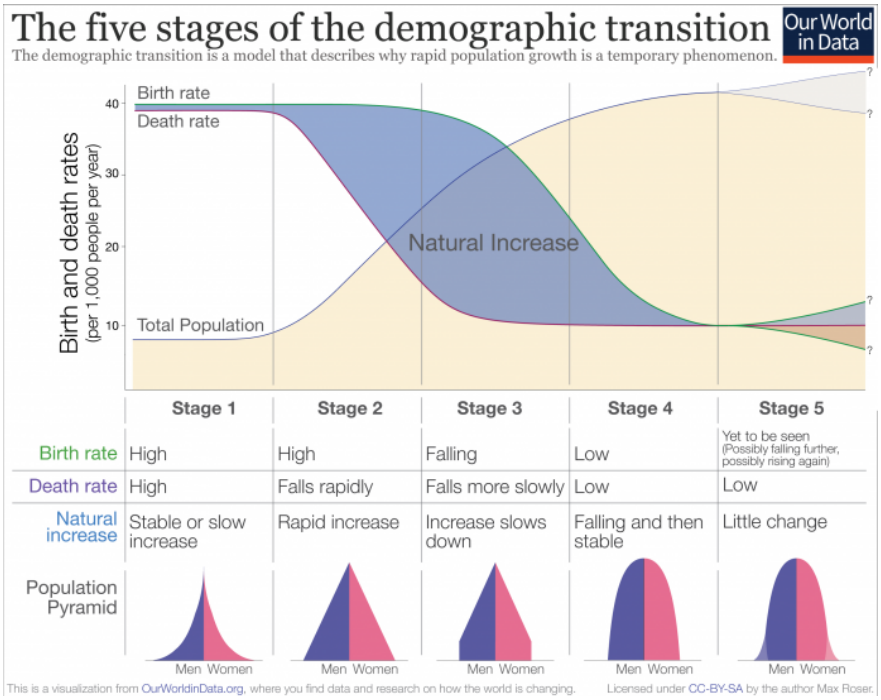


Fig 4: The five stages of demographic transition, Our World in Data[16]

The UN expects the global population to peak at around 10.4 billion people at the end of the century. After this, it will start declining. Predictions about population growth are dependent on the

[15] https://ourworldindata.org/uploads/2018/11/Annual-World-Population-since-10-thousand-BCE-for-OWID-800x498.png
[16] https://ourworldindata.org/world-population-growth

speed of the demographic transition, which depends on 1. individual choices, 2. level of education, 3. culture and policies, 4. availability of adequate healthcare services to meet individual choices.

Just like all individual countries will go through this transition, so will the world as a whole go through this transition.

Global fertility has more than halved in the last 50 years. In the 1960s, women had, on average, five children. Today this global average is below 2.5. This means that the world is well into the demographic transition, and the global population growth rate peaked half a century ago. As can be observed in Fig 5, the global demographic transition that the world entered more than two centuries ago is then coming to an end. A new balance will prevail, where low mortality rates will be accompanied by low fertility rates resulting in population changes.

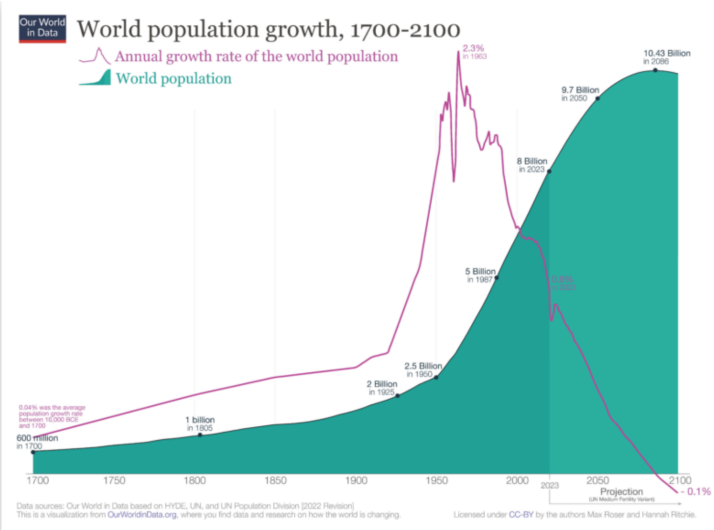


Fig 5: World population growth, 1700-2100, Our World in Data[17]

What are the changes expected for the future? As can be observed in Fig 6 Asia has experienced rapid population growth over the past 50 years. Today, its population stands at around 4.7 billion and is expected to rise to 5.3 billion by 2050. After that we find a significant shift as it is expected to fall in the latter half of the century, and by 2100 is projected to fall almost back to levels we see today.

Where the most significant population growth will occur over the coming years is in Africa. Today, its population is around 1.4 billion and by 2100 it is projected to reach just under 4 billion. As can be observed in Fig 6, today, Africa has today around 18% of the global population and by 2100 this is projected to rise to 38%. In contrast, today Asia has around 60% of the global population which will fall to around 45% in 2100.

At the end of the century, more than 8 out of every 10 people in the world will live in Asia or Africa.

[17] https://ourworldindata.org/future-population-growth#:~:text=Towards%20the%20end%20of%20the,the%20population%20dynamics%20beyond%202100.

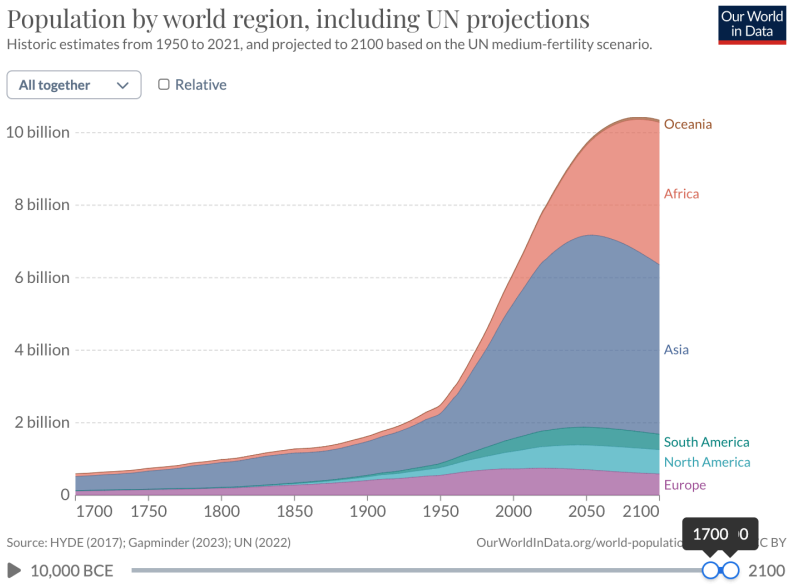


Fig 6: Population by world region, including UN projections, Our World in Data[18]

The increase in number of people on the planet has been accompanied by a necessary increase in the production of food which certainly has had an important impact on ecosystems around the world as many wild habitats have been converted to agricultural land. However, the more substantial impact on Earth only materialized in the very recent past, when large segments of the world population, especially in South-East Asia (Fig 7), entered the middle-class, where they are experiencing fast economic and human development, and with that join the increasing group of mass-consumers[19].

Mass-consumers do not only demand sufficient food every day, which can often be provided by local traditional agriculture, but also want the same elaborate foods, goods, services, and experiences as people in other more developed nations (transport, consumption, housing, tourism etc), following habits proposed by worldwide advertising, and with that have much higher ecological footprints on Earth. Rapid urbanisation is the result of all segments society striving for improved jobs and lifestyles. More than half the world's population today live in cities, and another 2.5 billion people are expected to join them by 2050. Urban centres worldwide, especially in developing countries, often have characteristics that make them and their inhabitants especially vulnerable to the adverse impacts of climate change and other natural and anthropogenic hazards and need specific risk reduction strategies[20].

[18] https://ourworldindata.org/grapher/world-population-by-region-with-projections?time=1700..2100
[19] Our World in Data: Income inequality, 2016
[20] UN FCCC, 2017, Initiatives in the area of human settlements and adaptation

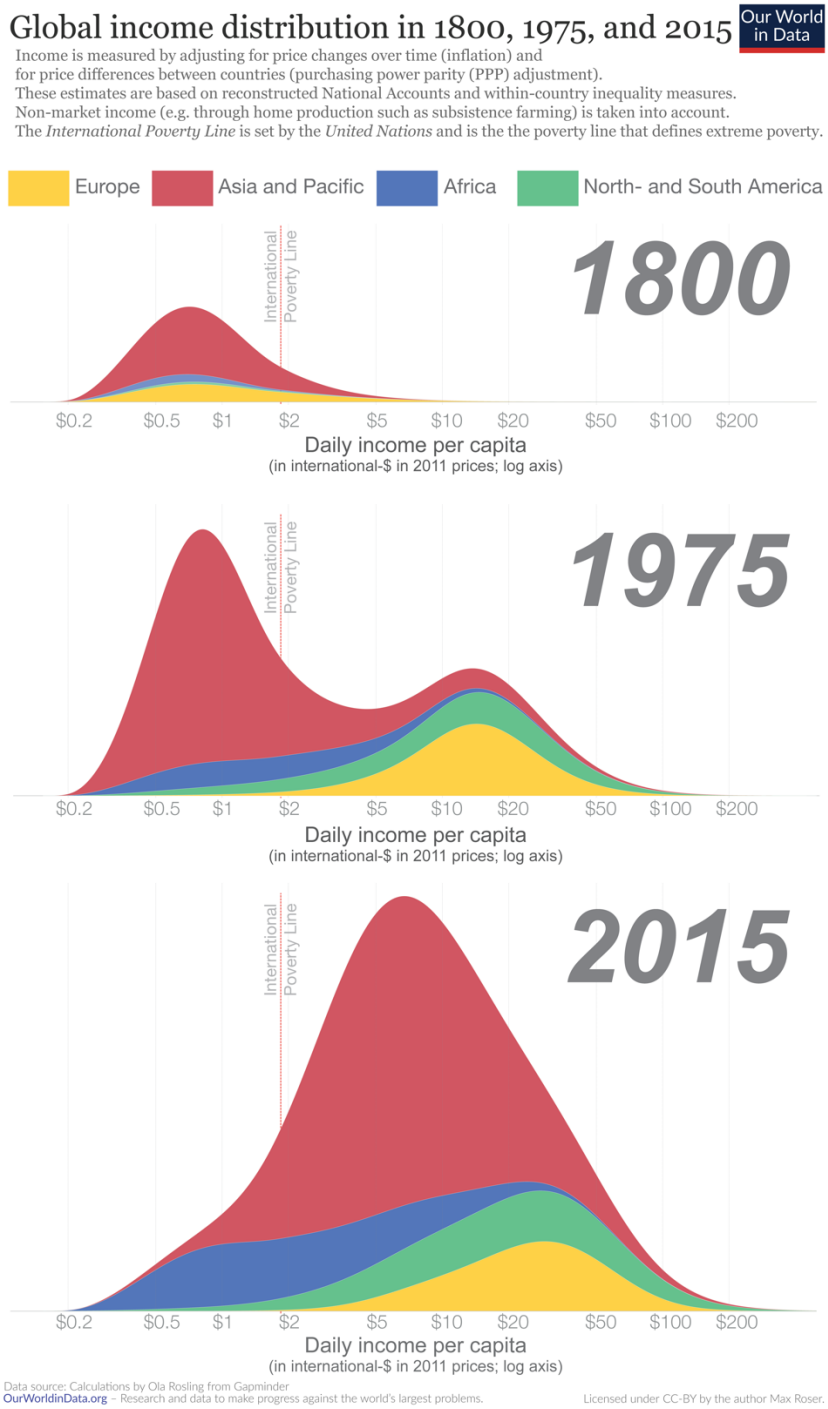


Fig 7: Global income distribution in 1800, 1975, and 2015, Our World in Data[21]

The global middle-class is expected to grow and reach 5.5 billion by 2030 and with that comes significant increase in middle-class spending, expected to account for one third of GDP growth mainly in emerging economies[22]. While the increase in economic and human development of the world's poorest populations is a phenomenon to be welcomed, as it will take millions out of poverty and give them the education, health, and job prospects that we all deserve, it also poses an enormous challenge if the growth and consumption of the entire middle-class and especially upper-class continues to be unsustainable[23].

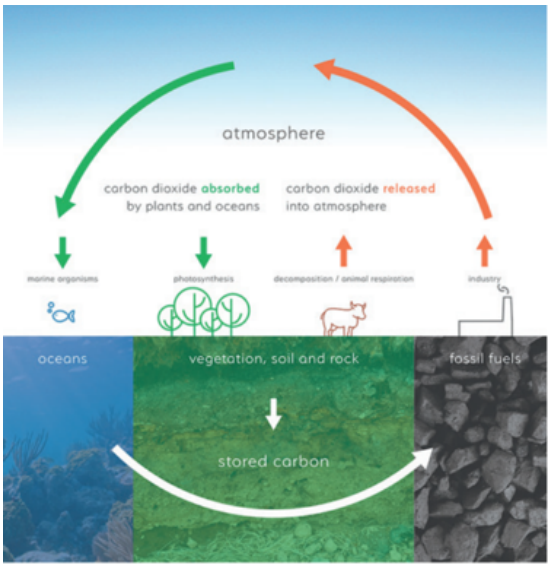
[21] https://ourworldindata.org/income-inequality
[22] European Commission, Developments and Forecasts of Growing Consumerism
[23] Our World in Data: World Population, 2019

2. Climate Change and Carbon Cycle

The second pressure is human-induced climate change, which is caused by an increased release of Carbon Dioxide (CO2) and other Green House Gasses (GHG) into the atmosphere.

Carbon is an essential element for all life forms on Earth. Carbon is used by plants to grow leaves and stems, which in turn are digested by animals to grow. Carbon is also stored in oceans and allow many types of marine organisms to form shells and skeletons. Most of the carbon on the planet is however contained within rocks, minerals, and other sediments buried beneath the surface of the planet. In the atmosphere, carbon is stored in the form of gases such as CO2 and when increasing in quantity, they accumulate to form an isolating layer which has a green-house effect on the planet.

The amount of carbon in the system never changes as Earth is in a locked system, however it can and does constantly change location, also known as reservoirs, through a variety of processes including photosynthesis, burning of fossil fuels, and simply by breathing[24] - also known as the carbon cycle.



Source: Forest products commission, Western Australia

Fig 8: The carbon cycle, Forest products commission, Western Australia

In the Holocene, the natural carbon cycle has remained in balance, meaning that the amount of carbon naturally released from reservoirs has been equal to the amount that has been naturally absorbed by plants and oceans. This balance contributed to Earth's stable climate.

Industrialisation has been fuelled by the burning of fossil fuels which has released an exponential amount of otherwise trapped carbon into the atmosphere. This carbon release has been absorbed by other reservoirs, approximately 25% has been absorbed by plants and trees on earth and another 25% absorbed by oceans, leaving 50% to be released into the atmosphere[25] which has resulted in more CO2 in the atmosphere than usual (Fig 9). This additional carbon and other GHG gets trapped in the atmosphere, resulting in the planet heating up and causing the climate to change.

[24] National Geographic, ENCYCLOPEDIC ENTRY: The Carbon Cycle
[25] National Oceanic and Atmospheric Administration (NOAA)

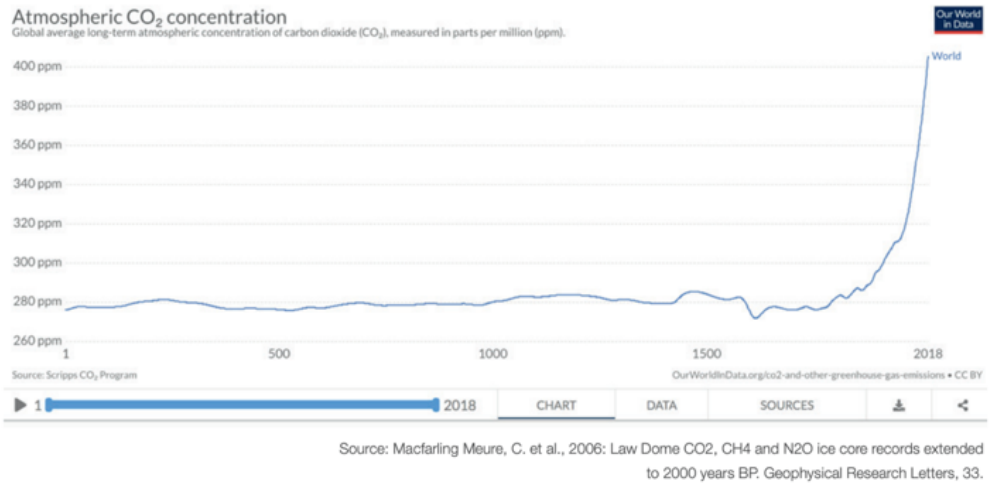


Fig 9: Atmospheric CO2 concentrations, Our World in Data

GHG emissions comes from several sources, including the production of electricity from fossil fuels (27%), transportation including passenger cars, aviation, and shipping (total 16%), agriculture including animal feedstock (19%), energy use in buildings including heating and cooling (7%), and manufacturing including production of cement and steel (31%)[26] [27]. All sources must be reduced for us to be able to stabilise the temperature increase and associated climate change, the ways in which to do this will be further explored in Chapter 3.

3. Ecosystem crisis

The third pressure refers to the increasingly critical state of many of Earth's ecosystems. An ecosystem is a community or group of living organisms that live in and interact with each other in a specific environment, and they have an important role in Earth's overall capacity to regulate the climate and maintain the stable conditions that have enabled human development over the past 10.000 – 12.000 years. Increased agricultural production, deforestation, and land-use change account for significant GHG emissions[28] and are amongst the biggest drivers of biodiversity loss[29] [30].

Many of the Earth's ecosystems are currently under great pressure due to increased human activity and domination. Marine ecosystems are increasingly at threat of pollution and CO2-induced acidification causing rapid extinction of hundreds if not thousands of species on a yearly basis; rainforests are at threat of deforestation from palm oil production, soybean farming, livestock farming, wood smuggling and legal and illegal mining as well as experiencing increased wildfires all of which is releasing tons of CO2 into the atmosphere rather than absorbing it. Temperate forests in the Northern Hemisphere are increasingly threatened by destruction caused by fungi, beetles, and fires as droughts are becoming more common; the Artic and Antarctic are increasingly warming up reversing their otherwise positive cooling effect on Earth[31].

Furthermore, the increased use of chemical fertilizers and pesticides to increase agricultural production has resulted in the degradation and pollution of soil and water and as a result both are suffering from becoming increasingly toxic to all living beings, also having a negative impact on many ecosystems.

[26] Bill Gates, How to avoid a climate disaster, 2021
[27] https://ourworldindata.org/ghg-emissions-by-sector
[28] IPCC, 5th Assessment Report (AR5), Synthesis Report, 2014
[29] Andrew Hansen, Ruth S. Defries, Woody Turner; Land Use Change and Biodiversity, 2004
[30] Tim Newbold et al, A global model of the response of tropical and sub-tropical forest biodiversity to anthropogenic pressures, 2014
[31] Johan Rockström, SDG Academy, Planetary Boundaries and Human Opportunities, online course

While natural carbon sinks like the oceans, peatlands and forests can go some way in reducing overall global emissions, nature-based solutions, such as protecting and restoring forests, wetland, and coastal ecosystems, can also help humanity adapt and build resilience in the face of climate change, lead healthy and productive lives, and stimulate economic development. A transition to use land and other natural resources more sustainably is therefore vital and urgent.

Diminishing Earth's natural biodiversity and ecosystem functions and services, puts us all in an increased fragile situation and increases pressures on "ecosystem boundaries", also referred to as "tipping points", which when passed often lead to ecological regime shifts, from which it is difficult, often impossible, to return to the previous state[32].

2.2 Planetary boundaries and tipping points

While we are increasingly altering life on Earth, we are also fundamentally dependent on life on Earth to supply us with food and water as well as a range of ecosystem services like pollination, recycling and the regulation of the climate with the help of marine systems and forests.

The globalised phase of environmental change is caused by humans and is not only having an impact on local and global environments, but also across various sectors, such as the economy, health, government, and are therefore influencing every aspect of human life from income and health to quality of life and safety.

It is important to understand how the ecosystem and climate crisis is threatening the Earths resilience. Exploring the planetary boundaries and tipping points will help us understand how we can navigate back to conditions that will keep supporting human flourishment.

Tipping points

Releasing an increased amount of GHG into the atmosphere while diminishing Earth's natural biodiversity and ecosystem functions and services, has put great pressure on Earth's resilience which puts us all in an increased fragile situation. This increased pressure on Earth's ecosystem boundaries is also referred to as "tipping points". Surpassing tipping points may lead to ecological regime shifts, from which it is difficult, often impossible, to return to the previous state[33].

Such shifts have important impact on the local environment and often also have an important and often permanent impact on humans living within these local environments. Example of a regime shift is when a rainforest turns into drylands or when a coral reef is bleached and dies off. Such changes have local as well as global implications, the extent of these are often difficult to quantify especially on the Global scale[34]. Healthy coral reefs have a rich fish population and the ability to sustain a series of income generating activities for the local population such as fishing and tourism and the reef also protect the coast from storms. Many of these coral reefs have sadly seen ecological regime shifts and the corals are now bleached and dead with a less diverse range of fish, often only much smaller fish, and only a limited community of plants and living organisms. Such change will have a big impact for both the ability of local people to continue to sustain themselves through fishing and tourism as well as a noteworthy impact on the conservation of nature.

The fact that humans are putting exponential pressure on Earth is unquestionable. There is no piece of nature left anywhere in the world that is not influenced by and interconnected with human

[32] Johan Rockström et al, A safe operating space for humanity, 2009
[33] Johan Rockström et al, A safe operating space for humanity, 2009
[34] Johan Rockström, SDG Academy, Planetary Boundaries and Human Opportunities, online course

activity. That is why many scientists no longer talk about environmental systems and social systems, but instead talk of social-ecological systems[35].

Acknowledging the impact human activity has on social-ecological systems is the first step needed for humanity to take responsibility of reversing current trends and restoring the safety of the Holocene like conditions.

Global social-ecological interconnection

To understand how the Earth responds to various pressures and how resilient it is, we must understand that we live in a totally interconnected social-ecological global system, where changes in the climate system affects ecosystems, which together influences human health, economics, and development at large. These effects have cross-scale interactions, i.e., how diminishing the forests in one part of the world will influence rainfall in another part of the world, and how the local, regional and global is interconnected.[36] In this hyper-connected world, we must perceive risks in a different way, as never before has environmental risks had such a direct impact on economic, social and human well-being and vice-versa[37].

One recent example of how interconnected humans and the ecosystems have become in the Anthropocene is the Covid-19 pandemic. The virus can likely be sourced to a wild animal and fish market in Wuhan, China, and as humans are globally interconnected, this virus emanating from some local ecosystem in China and yet resulted in a global pandemic with detrimental consequences for human health and the economy globally. As the global wildlife trade continues and development projects expand deeper into tropical forests, humans are increasing their exposure to wild animals and the diseases they may carry. 60% of known infectious diseases in humans and 75% of all emerging infectious diseases are zoonotic i.e., a type of disease that transmits between animals and humans[38], and while these appear in a local environment, they now have the potential of having a truly global effect.

Earth's Resilience

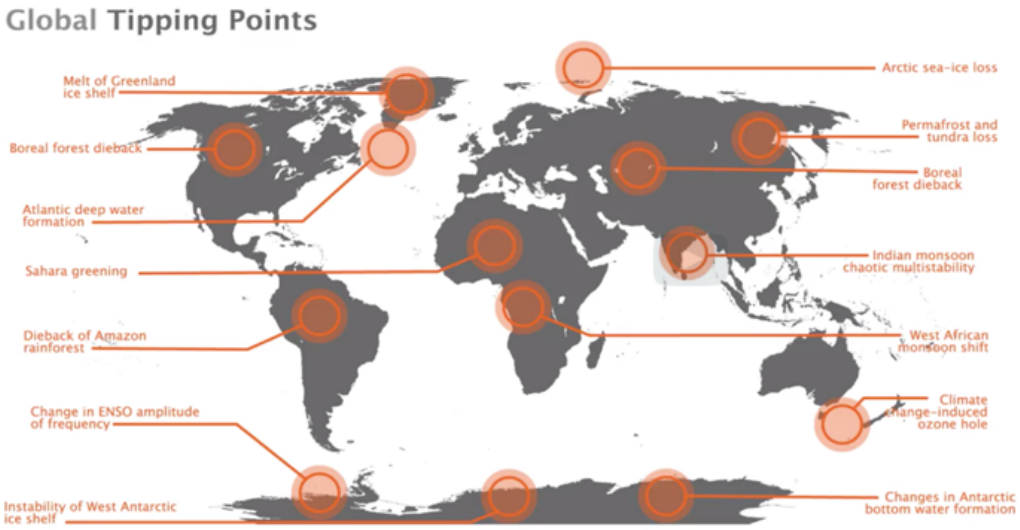
Resilience is the capacity to be able to deal with change, not only predictable incremental change but also sudden change such as shocks and crisis.

Earth's system is continuously regulating itself; this can be observed by the fact that much (approximately 50%) of the excess CO2 emitted over the past years have been absorbed by Earth's natural sinks such as the oceans and forests[39]. Earth is therefore continuously proving its resilience by adapting to new conditions.

However, the resilience of Earth's systems may become unstable when reaching its limits. Scientists have been mapping out the systems which are of key importance to Earth's resilience and if certain limits, or tipping points, are reached, they are likely to have detrimental effect on Earth as a whole[40]. We must try to predict the limits to ensure we do not surpass them. One example of a system that is being surpassed is the ice sheet in Greenland. Throughout the Holocene the Greenland ice sheet has been functioning as a permanent cooling element on Earth as the white ice sheets have reflected sun away from Earth. As Earth is warming, the ice in Greenland is increasingly melting, and the darker surface areas on the ice, resulting from dark pools of melted water as well as windblown dust

[35] Johan Rockström, SDG Academy, Planetary Boundaries and Human Opportunities, online course
[36] Will Steffen et al, The Anthropocene: From Global Change to Planetary Stewardship, 2011
[37] Johan Rockström et al, A safe operating space for humanity, 2009
[38] UNDP, Preventing the next Pandemic, 2020
[39] National Oceanic and Atmospheric Administration (NOAA)
[40] Johan Rockström, SDG Academy, Planetary Boundaries and Human Opportunities, online course

and other particles darkening the bare ice, absorbs more sunlight and accelerates melting[41]. This process is reversing the cooling ability which increases the speed at which Earth as a whole is heating up.



Global Tipping Points

Fig 10: Identifies a number of earth systems that support the earth's resilience. As with the ice sheet in Greenland, it is fundamental that these systems do not surpass their tipping points and lead to ecological regime shift from which it is difficult, if not impossible, to return from.

Scientists have identified a number of key Earth systems that contribute to overall resilience of Earth. Changes in any of these systems will have a global impact and will not only affect other ecosystems on the planet, but will also impact human health, economics, and development at large (Fig 10). These effects have cross-scale interactions, i.e., how diminishing the forests in one part of the world will influence rainfall in another part of the world, and how the local, regional and global is interconnected.[42] In this hyper-connected world, we must perceive risks in a different way, as never before has environmental risks had such a direct impact on economic, social and human well-being and vice-versa[43].

We must connect the impact of local action on these systems on a planetary scale and acknowledge that we are collectively responsible and contributing to such system changes i.e., it is not the action of the Inuit people on Greenland that have caused the ice to melt, that is the result of accumulated Global GHG emissions especially by the more affluent middle-class population.

[41] https://www.climate.gov/news-features/understanding-climate/greenland-ice-sheet-getting-darker
[42] Will Steffen et al, The Anthropocene: From Global Change to Planetary Stewardship, 2011
[43] Johan Rockström et al, A safe operating space for humanity, 2009

Fig 11: WEF 2011

We have explored ecological regime shifts and looked at how independent ecosystems, when put under certain external threats, may be pushed into a regime shift. We have also observed how interconnected the world is, and how the local environment and the changes that may occur within it, may have an impact on the regional and global environment and how it will also have an impact on many other parts of our lives such as health and economic well-being (Fig 11). Now we will explore how resilient Earth is to external pressures and identify the risks of pushing the entire earth system outside its stable state.

To be able to navigate sustainable development in the Anthropocene, we need to understand both the pressures and tipping points of systems, and together this allows us to explore the safe operating space for development.

Planetary boundaries

To avoid reaching global tipping points, and the risk of pushing the entire earth system outside of its current stability domain, we must identify the environmental processes, that have an impact on these systems.

Identifying these environmental processes has been the task of Johan Rockström and colleagues at the Stockholm Environmental Institute and the Potsdam Institute for Climate Impact Research, with support from the scientific community, in their framework based on 'planetary boundaries'. For the first time, scientists are identifying the environmental processes that are fundamental in regulating Earth's stable state and quantifying the safe limits outside of which the Earth system cannot continue to function in a stable, Holocene-like state, and as such define the safe operating space for humans[44]. The objective of the framework is to identify and deepen the understanding of the key environmental processes for Earth to stay in stable conditions. It is important to note that these are highly complex models that are continuously evolving as new scientific evidence is presented and knowledge gaps remain. As such the framework must be understood as a proposed step towards better understanding Earths carrying capacity, and not as complete and conclusive scientific evidence.

The framework defines nine independent, yet extremely interlinked, processes for which they believe it is possible to define planetary boundaries: climate change, biogeochemical flows (nitrogen and phosphorus), land-system change, freshwater use, aerosol loading, ozone depletion, ocean acidification, loss of biosphere integrity including biodiversity, and introductions of novel entities

[44] Johan Rockström, SDG Academy, Planetary Boundaries and Human Opportunities, online course

such as toxic chemicals and plastics.[45]. The analysis suggests that today, four of the Earth-system processes have already transgressed their boundaries: climate change, loss of biosphere integrity, land-system change, altered biogeochemical cycles. This does not mean they have crossed the tipping point, but that they are in a zone where there is potential for the tipping points to occur[46].

Fig 12: The nine Planetary Boundaries (graphic: J. Lokrantz/Azote based on Steffen et al. 2015)

The planetary boundaries system quantifies the limits and potential tipping points of Earth's systems independent of human activity. Once these limits have been quantified, human activity and ingenuity can be added. The system identifies the limits to respect to stay in the desired Holocene state, as well as identifies the impact of human activity on each of the boundaries and thus where we should act faster.

2.3 Human action/inaction is fundamental

While there are lots of factors contributing to climate change, scientists agree that the temperature increase over the last 50-100 years is without doubt a result of the overall increase in anthropogenic GHGs[47] in the atmosphere caused mainly by two interlinked elements:
1. An increase in the emission of GHGs into the atmosphere combined with
2. A progressive destruction of Earth's natural sinks and with that their ability to absorb CO2[48].

Human activity has therefore not only unleashed a large amount of stored carbon that would not have otherwise naturally been released (e.g., the burning of fossil fuels for energy), it has also reduced nature's ability to absorb CO2 (e.g., deforestation and other changes in land-use). We urgently need to reverse both trends.

Reducing GHG emissions

There are two main sources of GHG emissions, natural emissions from natural systems and anthropogenic emissions from human activities. GHG emissions from natural systems include forest fires, oceans, wetlands, permafrost, mud volcanoes, volcanoes, and earthquakes. GHG emissions

[45] Steven J. Lade et al, Human impacts on planetary boundaries amplified by Earth system interactions, Nature Sustainability, 2020
[46] Johan Rockström, SDG Academy, Planetary Boundaries and Human Opportunities, online course
[47] IPCC, 5th Assessment Report (AR5), Synthesis Report, 2014
[48] Climate Council, LAND CARBON: No Substitution for action on fossil fuels, 2016

from human activity include fossil-fuel combustion for energy production, land-use change and cattle and sheep rearing.

While the science of measuring GHG still has certain levels of uncertainty and must be improved, there is broad scientific agreement that the global annual GHG emissions range approximately between 54 and 75 Gt CO2-equivalent, with the percentage of anthropogenic GHGs emissions being only slightly higher than the natural emissions[49]. The ability of Earth systems (ocean and terrestrial ecosystems) to absorb GHG emission is estimated to be around 26.5 Gt CO2-eq, roughly the same as the level of natural system GHG emissions. This finding suggests that the GHG emissions generated by human activity exert extra pressure on what is otherwise a self-balancing Earth system[50].

Despite the level of uncertainty in measuring and distinguishing between natural and anthropogenic sources of emissions, there is no doubt that the anthropogenic GHG emissions (CO2 included) have substantially increased since 1900, and even more so since 1950, as can be observed in Fig 13. The primary reason for the increase in GHGs is the increase in burning of fossil fuels for the production of electricity and heat in homes, in industry and for transportation of persons and goods in an increasingly globalised world (Fig 13).

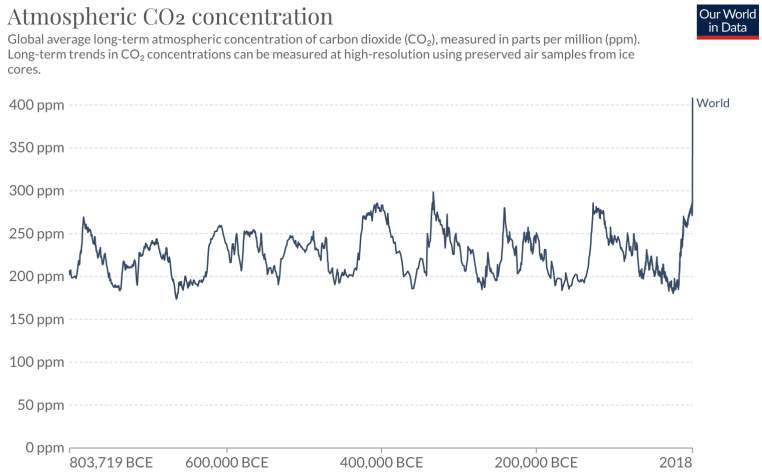


Fig 13: Atmospheric CO2 concentrations, Our World in Data
https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

Atmospheric GHG and CO2 concentrations are measured in “parts per million” (ppm) and scientists are in broad agreement that 450 ppm, is the point beyond which we risk very damaging and even dangerous temperature rise[51]. Atmospheric CO2 measured at Mauna Loa Observatory by the National Oceanic and Atmospheric Association (NOAA) indicates that 400 ppm were reached in 2014 and this increased to 414,7 in 2019[52]. We are getting dangerously close to the 450-ppm mark that would put Earth in a danger zone (see Fig 13). The Planetary Boundary framework, applying the precautionary principle, sets the **boundary at 350 ppm** as the limit of our safe operating space[53].

[49] Xi-Liu YUE, Qing-Xian GAO, Contributions of natural systems and human activity to greenhouse gas emissions, Advances in Climate Change Research, Volume 9, Issue 4, 2018
[50] Xi-Liu YUE, Qing-Xian GAO, Contributions of natural systems and human activity to greenhouse gas emissions, Advances in Climate Change Research, Volume 9, Issue 4, 2018

[51] IPCC, 5th Assessment Report (AR5), Synthesis Report, 2014
[52] National Oceanic and Atmospheric Association (NOAA), 2020
[53] Johan Rockström et al, A safe operating space for humanity, 2009

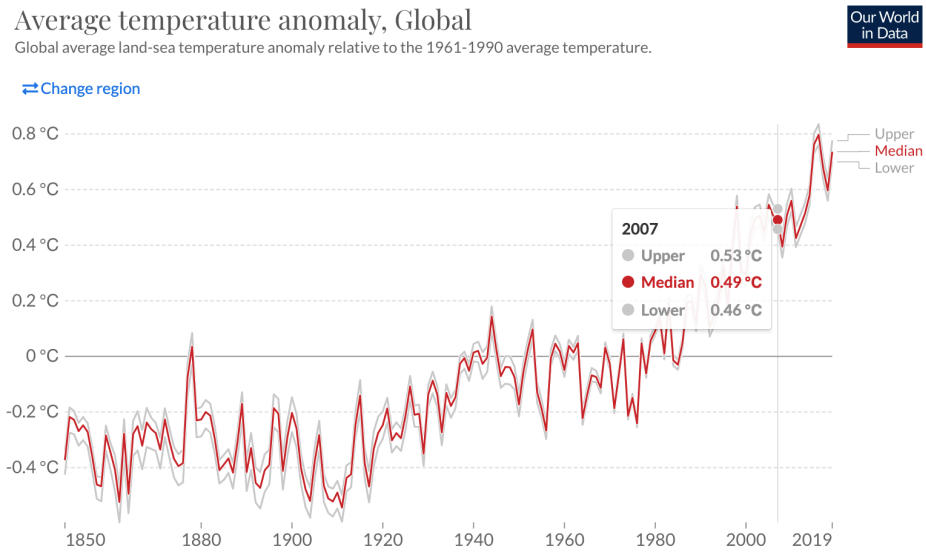


Fig 14: Average temperature anomaly, Global, Our World in Data

According to IPCC's leading scientists, there is unequivocal agreement that the increase of anthropogenic GHG emissions in the atmosphere are warming Earth (Fig 14), and that this warming will continue as we keep emitting GHGs into the atmosphere. They warn that it is fundamental to keep the global temperature rise below 1,5C° as it is the only way to avoid the worst impacts of climate change. Every fraction of a degree makes a difference in our quest to reduce extremes weather events such as heatwaves, heavy rainfall, and droughts, as well as long-term impacts and the risk of crossing tipping points of the Earth System.

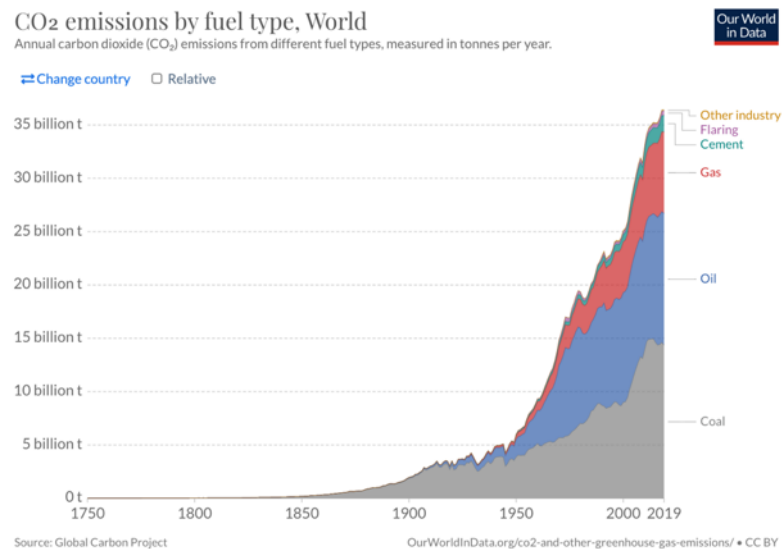


Fig 14: Our World in Data, CO2 emission by fuel type, World, Our World in Data

The increase in atmospheric CO2 and temperature increase goes hand in hand with humanity's increase of consumption of fossil fuels (Fig 14). Unless we reverse the trend of emitting GHG and CO2 from the combustion of fossil fuels we will certainly pass the 450-ppm that will put Earth in a danger zone very soon.

If, however, we continue business as usual, then global emissions will continue to rise leading us far off the 450-pmm and the 1,5C° goal. To avoid this, we must develop and implement effective

strategies and technologies that not only reduced GHG emissions but also implement methods and technologies that remove CO2 from the atmosphere.

Differentiated approach and responsibility for GHG emissions

Predictions by the International Energy Agency suggest that to meet the Sustainable Development Goals and the Paris Agreements on climate, global primary energy demand must decline by around 7% between now and 2030, with demand in advanced economies falling by more than 15%, while in emerging and developing economies it must stabilise. This overall decline must occur despite strong economic growth as the result of energy efficiency measures and increased electrification of end-use sectors.

In advanced economies this entails facing out coal by 2030, a gradual reduction of oil and natural gas with an increase in renewables and bioenergy as energy sources, and electricity taking the place of combustion in many sections of the final energy consumption such as in cars.

In emerging and developing economies the increase in demand for energy will be partially offset by energy efficiency and electrification, and thus overall primary energy demand will remain relatively unchanged. All fossil fuels will be gradually phased out, even if not totally by 2030, being replaced by electricity which will increasingly be generated from renewables[54].

Strengthen biodiversity and ecosystems

Biodiversity, also called biological diversity, is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems"[55]. Biodiversity is the result of 3.5 billion years of evolution[56], and comprises microorganisms, plants, animals, and ecosystems, such as coral reefs, forests, rainforests, deserts, etc. and it refers to the number or abundance of different species living within a particular region.

Biodiversity is fundamental for healthy ecosystems, and both are important to human life on earth as they provide us with many essentials such as food and water, medicine, clothing and shelter, and services that helps regulate climate, control of local rainfall, filters air and water, and mitigates the impact of natural disasters such as landslides and coastal storms[57].

While natural carbon sinks like the ocean, wetlands and forests contribute to the reduction of global CO2 emissions, nature-based solutions, such as protecting and restoring forests, wetland, and coastal ecosystems, can also go a long way to help humanity mitigate, adapt and build resilience in the face of climate change. A transition to more suitable land use is vital and urgent as is reducing the negative impact on Earth's most important natural sinks[58].

A recent innovative and encouraging example of how to use natural carbon sinks is the city of Milan's ambitious decade-long urban forestry project called "Forestami", an initiative launched in 2020 with the commitment to plant a new tree for every inhabitant of the city, thus aiming for three million newly planted trees by 2030[59].

[54] IEA, WEO, 2020
[55] Art 2 UN Convention on Biological Diversity
[56] King Island-Natural Resource Management
[57] UN Environment's sixth Global Environment Outlook, 2019
[58] Lear more about biodiversity loss in Annex 1
[59] https://forestami.org/en/

Furthermore, indigenous people and local communities often have traditional knowledge needed to play a key role in protecting and restoring biodiversity and can offer excellent bottom-up, self-driven, cost-effective, and innovative solutions that often can be scaled up and inform national and international practice[60].

Carbon sinks and carbon sources

A carbon sink is anything that absorbs more carbon from the atmosphere than it releases. The ocean, soil and forests are the world's largest carbon sinks. A carbon source, on the other hand, is anything that releases more carbon into the atmosphere than it absorbs. Examples of carbon sources include the burning of fossil fuels or volcanic eruptions.

Protecting carbon sinks is essential for tackling climate change and keeping our climate stable. But they are all increasingly under threat.

Forests

The world's forests can act as both a carbon sink and a carbon source (Fig 15). It is important to ensure that we optimise on the absorption ability of forests. This includes preserving and protecting all forests that act as a sink, and equally important to convert the forests that have become a carbon source back to its original sustainable state where possible.

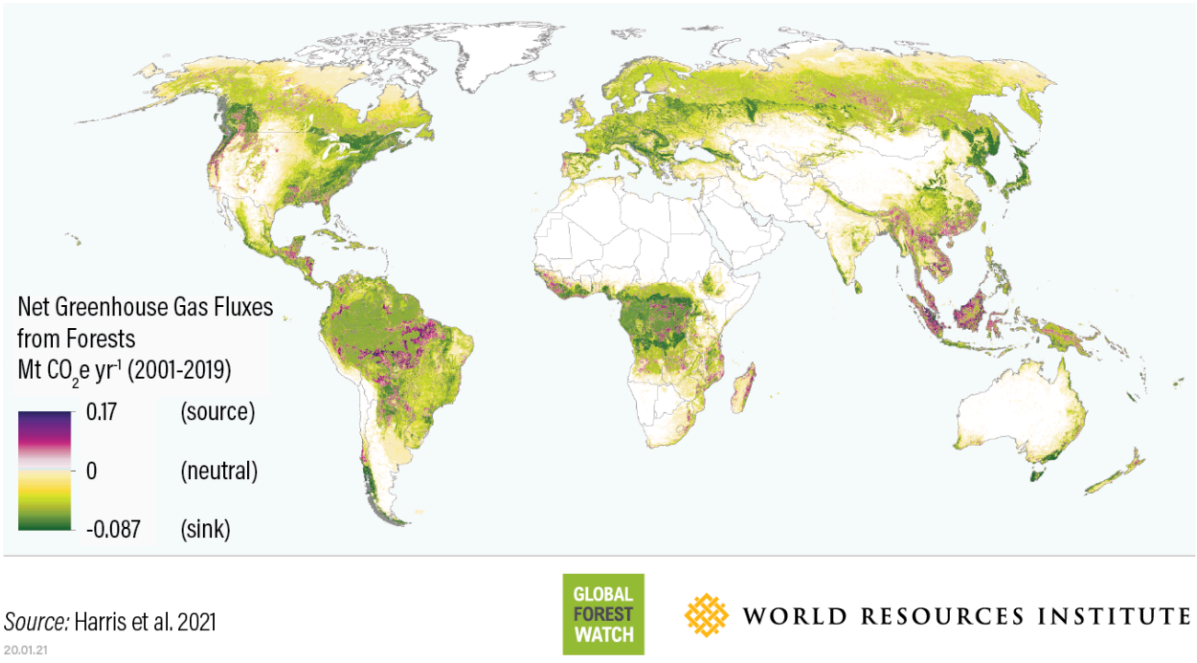


Fig 15: Forests: Carbon sinks or carbon sources? Harris et Al. 2021 (https://www.wri.org/insights/forests-absorb-twice-much-carbon-they-emit-each-year)

Recent scientific data document that the world's forests absorb twice as much CO2 per year as they emit. However, current trends are going in the wrong direction, and this must be urgently addressed.

By far the most important ecosystems for mitigating climate change are the tropical rainforests. Collectively they sequester more carbon from the atmosphere than temperate or boreal forests. However, they are gradually being destroyed for agricultural development. The Amazon, the Congo River basin and Southeast Asia are home to the three largest tropical rainforests.

[60] UN Environment's sixth Global Environment Outlook, 2019

Due to clearing for plantations, uncontrolled fires and drainage of peat soils, the forests across Southeast Asia have collectively become a net source of CO2 emissions over the past 20 years.

The Amazon River basin, which spans nine South American nations, is still a net carbon sink but is on the verge of switching to a net source if current rates of forest loss continue. Deforestation in the Amazon basin has increased recently as a result of fire damage and clearance for cattle pasture.

Only the Congo River basin has enough remaining standing forest to continue to be a significant net carbon sink. Tropical rainforest of the Democratic Republic of the Congo absorbs 600 million metric tonnes more CO2 each year than it emits.

In order to combat climate change, it is essential to preserve the last remaining trees in all three forests.

The world's largest managed forests are located in the United States, Canada, China, Europe, and Russia. These serve to provide lumber, and have designated patches of trees that are periodically cut down or thinned, causing CO2 emissions, while other patches are left alone to regenerate and absorb CO2.

Whether these forests are CO2 sources or sinks ultimately depends on how they are managed, including the length of time between harvest cycles, the amount of forest harvested, the age of the trees, and, most significantly, the total area used to compute fluxes.

Recent research shows that keeping existing forests standing remains our best hope for maintaining the vast amount of carbon forests store and continuing the carbon sequestration that, if halted, will worsen the effects of climate change. Although important to plant new trees and give these young forests the chance to grow into old ones, protecting primary and mature secondary forests today is most important for curbing climate change.

Oceans

The ocean makes up more than 70% of the planet's surface. It is where life initiated, and continues to allow life to flourish, both in the waters and on land. Marine phytoplankton have produced about half of the world's oxygen, meaning every second breath you take came from the ocean.

Climate change is causing the planet to warm up, and the increased heat and carbon emissions are pushing the ocean to its limits as it has absorbed approximately a quarter of the additional CO2 released and 90 percent of the heat.

Phytoplankton are the main reason the ocean is one of the biggest carbon sinks. These microscopic marine algae and bacteria play a huge role in the world's carbon cycle, absorbing about as much carbon as all the plants and trees on land combined. Meanwhile, slow-moving currents drive dissolved carbon into the ocean's cold depths or is buried in the sediments of the seafloor, where it is buried for centuries.

The ocean has protected us from the worst consequences of climate change, but at a cost to itself as it is increasingly acidifying and heating up. Increased levels of CO2 in the water are causing the oceans to become more acidic making it harder for some species to form their shells; and rising ocean temperatures are causing a variety of problems, including loss of sea ice, more frequent, intense storms, and marine heat waves that can kill off millions of animals.

Recent research document that it is essential to identify solutions that can remove CO2 and heat from the ocean. Likewise, industrial and fisheries management policies that are adaptive and forward thinking must be implemented and waste management policies must be properly designed, implemented and monitored so that pollution becomes a thing of the past.

2.4 Building the future we want

In order to keep the temperature below 1,5C°, as recommended by the IPCC scientists, we must curb our GHG emissions and reach net-zero emissions by 2050 at the latest[61]. Currently we emit approximately 50 billion tons a year, the task at hand is not a small one.

To be able to face so many interlinked challenges we must start thinking differently about global social integration. We are increasingly interlinked and interdependent, experiencing new types of migration, new social movements, new types of economics, new types of viruses, and we should be trying to envision new ways in which we could live on the planet more positively collectively.

The 2030 Agenda strives to achieve a world in which all people are given the opportunities to live fulfilling lives within the limits of the biosphere. While Rachel Carson and the Brundtland Report generated widespread environmental interest, they also initiated a shift in global environmental consciousness which stimulated a new and ever-evolving form of thinking about sustainable development. The latter have inspired many global agreements striving to guide us towards a better and fairer life in harmony with the needs of the biosphere.

"The future depends on what you do today."
Mahatma Gandhi

The role of science and the precautionary principle

We have landed in the 'environmental paradox' where human well-being has reached levels that is threatening our planetary life support system. When determining the way forward in such a situation it is advisable to follow the precautionary principle[62]. The precautionary principle acknowledges that while science and technology has often brought great benefits to humanity, it has also contributed to the creation of new threats and risks. It implies that there is a social responsibility, especially from public bodies to protect humanity from exposure to such harm, when scientific investigation has found a plausible risk. These protections should be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result and hence would justify setting in motion all necessary means to stay within the safe operating space of the planetary boundaries.

The Intergovernmental Panel on Climate Change (IPCC) was created in 1988 by the members of the United Nations with the objective to provide governments at all levels with scientific information needed to develop climate policy as well as constructive input into international climate change negotiations. The IPCC currently has 195 members.

Thousands of scientists from all over the world contribute to the work of the IPCC through the publication of various assessment reports. Thousands of climate related scientific papers are published each year, and these are assessed by the IPCC authors to provide a comprehensive

[61] IPCC 2018 Special Report on Global Warming of 1.5°C highlights that limiting global warming to 1.5°C compared to 2°C will have clear benefits to people and natural ecosystems and will require rapid, far-reaching and unprecedented changes in all aspects of society including Global net human-caused emissions of carbon dioxide (CO2) to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. This means that any remaining emissions would need to be balanced by removing CO2 from the air.
[62] Will Steffen et al., Planetary boundaries: Guiding human development on a changing planet, 2015

summary of the latest drivers of climate change. The latter include impacts and future risks, how adaptation and mitigation can reduce those risks, and how to most accurately calculate GHG emissions and removals. The open and transparent review by experts and governments around the world is an essential part of the IPCC process and ensures an objective and complete assessment which reflects a diverse range of views and expertise. The IPCC also indicates where scientific evidence is weak and further research is needed.

As such, the publications of the IPCC provide a key contribution and support to the decision-making regarding climate change of national as well as international organisations, including the UNFCCC agreement which took place in Paris in 2014, also called the Paris Agreement. The Paris Agreement is a legally binding international treaty on climate change, which was adopted by 196 parties on 4. November 2015. The overarching goal of the Paris Agreement is to keep "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels."

The scientific evidence produced by leading scientists is guiding global leaders when implementing the precautionary principle regarding climate change.

Adaptation and mitigation to climate change

When following the precautionary principle in relation to the climate challenge, actions usually fall into one of two strategies: mitigation efforts to lower or remove GHG emissions in the atmosphere, and adaptation efforts to adjust systems and societies to withstand the impacts of climate change. It is fundamental to pursue both strategies in parallel to be as resilient as possible to future climate related events.

Mitigation is the reduction of something harmful or the reduction of its harmful effects. The goal of mitigation is to reduce human interference with the climate system as much as possible in order to "stabilise GHG levels in a timeframe sufficient to allow ecosystems to adapt naturally to climate change and ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner"[63]. To mitigate anthropogenic CO2 and GHGs we need to reduce overall emissions by changing behaviour and where consumption cannot be reduced identify technologies that can make each of these sources free of GHG emission. Once such sustainable, or green alternatives, have been identified they must be made economically competitive so that they become both the environmental and economic best option and as such adopted at scale.

Transport provides a useful example: first we must reduce our emission by taking less planes, using public transport and biking and walking where possible. Where personal transport is still the only solution, we should adopt more sustainable solutions such as electric vehicle (EV) or hybrid vehicles and fuel them from renewable sources. To get the consumer buy-in it is important that the cost of the EVs or hybrid is competitive with the traditional cars, and this should happen at the same time as the electricity system moves from fossil to renewable generation. Over the last few years, the cost of EVs and hybrid car has come down substantially, however where the cost is not yet fully competitive it is important to use policy appropriately to incentivise the buyers. While incentives can be useful to help an industry become competitive, certain industries are simply not sufficiently mature, such as the cement and steel industries for example, and much research and development must be invested in finding the "green alternatives" of these manufacturing industries to reduce their GHG emissions sufficiently[64].

[63] IPCC, AR5, Climate Change 2014: Mitigation of Climate Change, 2014
[64] Bill Gates, How to avoid a climate disaster, 2021

Adaptation on the other hand, in reference to climate change, involves adjusting to actual or expected future climate and its effects. Adaptation seeks to moderate or avoid harm or exploit beneficial opportunities[65]. The goal is to reduce the vulnerability to the harmful effects of climate change such as increasing sea-levels, more intense extreme weather events or food insecurity. It also encompasses making the most of any potential beneficial opportunities associated with climate change, such as seasonal changes allowing for increased crop yields or changes in output. Differences in vulnerability to climate-related extremes such as heat waves, droughts, floods, cyclones, wildfires, and other dangerous weather types differ greatly and are related to non-climatic factors and from multidimensional inequalities often produced by uneven development processes[66]. The vulnerable and poorer segments of society and geographical regions are always more at risk as they are not able to make the adjustments needed. Policies must be put in place to help and support the vulnerable segment of society adapt on an equal footing with the rest of society.

Governments at various levels in all countries, are responsible for adaptation to climate change through strategic development plans including addressing extreme weather, protecting coastlines from rising sea-levels, better land, forest, and water management, developing more resilient crop varieties and protecting energy and public infrastructure. Furthermore, the rich countries have the power and means to adapt while the poorer countries suffer the greatest consequences[67]. Therefore, the more affluent countries have a duty to assist poorer countries in their efforts towards adaptation. The Paris Agreement aims to facilitate developments in this direction. As a matter of fact, Art 9, 10 and 11 on finance, technology, and capacity-building support as well as Art 8 on loss and damages provide for a solid framework and a valid support mechanism in this respect.

Case-studies that inspire – How science led the way to saving the ozone layer[68]

In the mid-1970s, scientists warned that man-made chemicals in everyday products like aerosols, foams, refrigerators, and air-conditioners were harming the ozone layer. At that time, they didn't know the scale of the problem. But in 1985, a hole was confirmed in the ozone layer over Antarctica. The world's natural sun shield, which protects humans, plants, animals, and ecosystems from excessive ultraviolet radiation, had been breached.

Suddenly, a future blighted by skin cancers, cataracts, dying plants and crops and damaged ecosystems loomed. There was no time to lose. Scientists had raised the alarm and the world listened.

In 1985, governments adopted the Vienna Convention for the Protection of the Ozone Layer, which provided the framework for the Montreal Protocol to phase out ozone-depleting substances, including chlorofluorocarbons (CFCs). The Protocol came into effect in 1989 and by 2008, it was the first and only UN environmental agreement to be ratified by every country in the world.

The results have been dramatic. Around 99 per cent of ozone-depleting substances have been phased out and the protective ozone layer above Earth is being replenished. The Antarctic ozone hole is expected to close by the 2060s, while other regions will return to pre-1980s values even earlier. Every year, an estimated two million people are saved from skin cancer and there are broader benefits too, as many of the ozone-depleting gases also drive-up global temperatures.

Although tremendous progress has been made, the ozone holes will take decades yet to heal, and only if there is full and continuous compliance with the Montreal Protocol. Close and continuous

[65] IPCC, AR5, Climate Change 2014: Impacts, Adaptation, and Vulnerability, 2014
[66] IPCC, AR5, Climate Change 2014: Impacts, Adaptation, and Vulnerability, 2014
[67] SDG 13A and 13B, https://www.un.org/sustainabledevelopment/climate-change/.
[68] https://www.unep.org/news-and-stories/story/rebuilding-ozone-layer-how-world-came-together-ultimate-repair-job

monitoring of the atmosphere, even for supposedly banned substances and for the possible effects rising surface temperatures in polar regions may have on stratospheric ozone is needed.

Scientists discover new risks every day, and in 2016, the Montreal Protocol was updated to include the Kigali Amendment to phase down hydrofluorocarbons (HFCs), potent GHGs often used as replacements for the banned ozone-depleting substances in refrigerators and air-conditioners. The Kigali Amendment came into force in 2019 and has today been ratified by 123 countries. It also encourages the development and use of more energy-efficient cooling technologies. Adopting low-global-warming-potential alternative refrigerants could potentially double the climate benefits of the Amendment, according to this recent scientific assessment.

The global dimension of the challenges of climate change are not the first humanity has had to face. The Montreal Protocol, and subsequent additions such as the Kigali amendment, have proven that international agreements based on sound scientific evidence can lead to action that changes the course for humanity on Earth. As such we have a precedent for what needs to be done for climate change and we can be hopeful in our mission to identify and implement solutions to global issues.

New economic thinking for the 21st century

To facilitate the change in mindset and for sustainability to take off we need to acknowledge that the capitalist model upon which globalisation is based is causing and fuelling inequality, food and health insecurity and climate change on local as well as global scale.

In 2011 Kate Raworth took a 'new look' at what the starting point for economic principles could be other than perpetual GDP growth. She found that humanity's long-term goal of "meeting the human rights of every person within the means of our life-giving planet" should be the starting point which economic principles should help us achieve. She came up with the concept of 'doughnut economics', and when the UN delegates were negotiating the 17 SDG's "the image of the Doughnut was on the table as a reminder of the big-picture goals they were aiming at"[69]. Kate Raworth's model strives to break with the past century of economics blindly pursuing ever-increasing GDP, or national output, as its primary measure of progress, and to change the economic mindset to one that is never set but is instead always evolving[70].

The SDGs are very close to what Kate defines as the Doughnut's inner ring – its social foundations – which sets out the basics of life on which no one should be left falling short, and she combines this with Johan Rockström's framework of the planetary boundaries, and as such has mapped the safe and just space for humanity to continue to thrive.

The goal of economics is to eliminate both shortfalls and overshoot at the same time and requires a dynamic balance rather than endless GDP growth. Such dynamic balance is found in designing an economic model for sustainable development. The various limits (shortfalls and overshoots) are of course deeply interconnected and do in many instances reinforce each other both negatively and positively, and cannot be addressed in isolation but as part of a complex socio-ecological system.

[69] Kate Raworth, Doughnut Economics, 2018

[70] Learn more about Kate's seven ways to think like a 21st century economist: https://www.kateraworth.com/

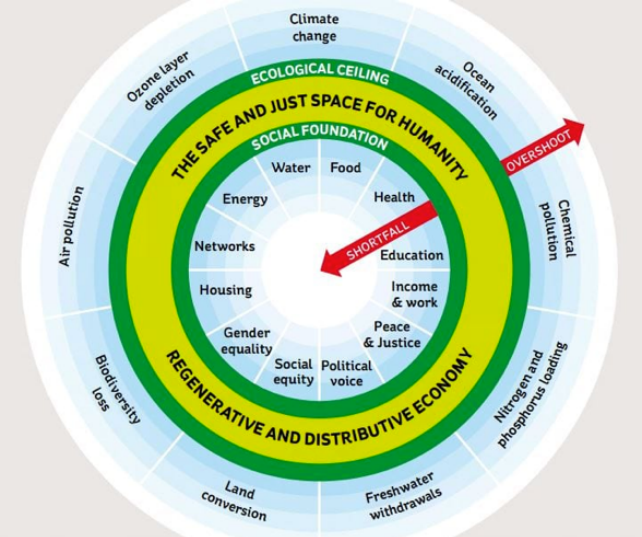


Fig 16 The doughnut: a 21st century compass

As we have observed, humanity has been and is increasingly putting pressures on Earth's life-giving systems and this has resulted in at least four of the nine boundaries having been transgressed. Similarly, despite unprecedented progress in human well-being over the past 70 years, we continue to fall short on many of the social foundations (Fig 17). We can measure and monitor the shortfalls of the social foundations as well as planetary overshoots, and we must assure the transition to a globally sustainable future that addresses both shortcomings and overshoots. This is the task of every government, every company, and every member of a community. Therefore we must re-evaluate the way we shop, eat, travel, earn a living etc. (more in chapter 3 and 4).

To achieve the SDGs while protecting our planet, we must ensure that the future gains of sustainable economic development primarily go towards increasing the capacity and opportunities of the least advantaged people in societies. The resources spent in educating girls, improving the status and opportunities for women, and enabling poor people to achieve full participation in society will strengthen both economic and human development, and reduce alienation and conflicts in society at large. In the words of Joseph Stiglitz "The only sustainable prosperity is shared prosperity"[71]. Reducing inequality both within societies and between nations must be a priority for the benefit for all[72].

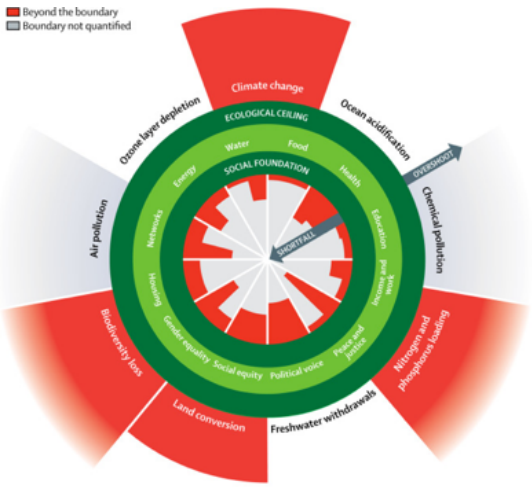


Fig 17 – Transgression of both social and ecological boundaries

[71] Joseph Stiglitz, Our Planet, Our Future, An Urgent Call for Action, 2021
[72] UN Environment's sixth Global Environment Outlook, 2019

Concluding remarks

We must acknowledge that the exponential rise of pressures on Earth has been caused primarily by the rich minority on planet Earth, the 1.5 billion affluent people, that have benefitted from the Industrial Revolution. This trend continues today and is documented in a recent study by Oxfam and the Swedish Environment Institute where they found that in the period from 1990 – 2015, the richest 10% of the population were responsible for 52% of cumulative global emissions in that period while the poorest 50% of the population in that same period were responsible for 7% of cumulative global emissions[73]. While the richest pollute the most, the impact of these emissions is disproportionally impacting the poorest regions in the world, with an estimated 140 million displaced people in sub-Saharan Africa, South Asia, and South America by 2050[74].

Furthermore, it is only in the recent past and in the future that the global middle-class will grow substantially and with that consumerism will go to scale as billions of people have and are rising out of poverty and will be demanding the same affluent lifestyle as the rest of the middle and upper classes. While it is certainly a positive thing that increased economic prosperity will allow many citizens on the Earth to have a right to development, without significant changes in how we all consume, the pressures the Earth is being put under will continue to grow in magnitude.

While the Agenda 2030 is striving to achieve a certain minimum standard of living for all, if 10.4 billion people on Earth are going to live unsustainable lives, we will reach many of Earth's tipping points and we may face a planetary collapse. We are the first generation that may eradicate absolute poverty and hunger. To facilitate healthy and affluent lifestyles of 10.4 billion peoples will require continued economic development, but this development must be sustainable and within the planetary boundaries.

This scientifically founded concern for the future is coupled with an immense share of hope based on humanity's ability to adapt, innovate, and design new solutions to even the biggest problems. While it is a huge challenge, humanity can succeed in a global transition to a world within a safe operating space of planetary boundaries. However, time is becoming increasingly limited[75].

[73] Eric Kemp-Benedict et al., The Carbon Inequality Era: An assessment of the global distribution of consumption emissions among individuals from 1990 to 2015 and beyond, 2020
[74] World Bank, Groundswell: Preparing for Internal Climate Migration, 2018
[75] Our Planet, Our Future, An Urgent Call for Action, 2021

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Energy at the Core of the Problem

CHAPTER 3

Alessi, Pia Lovengreen

MAY 2022 | LET'S ACT ERASMUS PLUS PROJECT

3. Energy at the core of the problem

Introduction

3.1 The energy paradox

- Access to energy is key to human and economic development
- SDG7: Ensure access to affordable, reliable, sustainable, modern energy for all
  - i. Access to electricity
  - ii. Access to clean fuels for cooking and heating
  - iii. Renewable energy
  - iv. Energy efficiency
- Link between energy and development
- Achieving a just energy transition is a global issue

3.2 Energy consumption – where are we now and where do we need to get to

- Energy consumption today
- High and Low energy and CO2 emitters
- Scaling up low-carbon sources

3.3 Global Governance of SDG7 and SDG13

- From Paris Agreement and beyond
- IPCC 2018 Special Report
- Global target - Net Zero by 2050

3.4 Concluding Remarks

Introduction

The great transformation of human conditions, which entailed an enormous impact on the conditions of the planet, began with one revolution, agriculture, and went on with two, scientific and industrial. In the blink of an eye, one species rose to such complete dominance of the biosphere, first accidentally, now capriciously and sometimes maliciously[1].

Agriculture changed the conditions for humanity on Earth, it allowed the population to grow much larger than previously and for many to enjoy higher standards of living. Agriculture also led to empire building, urbanisation, and the development of trade. It was however not until James Watt made the coal fired steam engine more reliable and efficient at the end of the 18th century that the economy started to grow significantly. First, the steam engine was adopted in mines and factories across the UK, and then it paved the way for the rise of the railway system, a major innovation of modernity. After the steam engine came electricity, bringing light, telephones, televisions, refrigerators and much more. This process of prompt and profound innovation culminated with the introduction of modern concrete and mass steel production, which allowed for massive urbanisation and a wide-spread road system. All of these modern inventions allowed for the Global economy to grow like never before and required ever increasing amounts of energy.

As we saw in previous chapters, the pursuit of economic growth has been the single dominant narrative for nations since WW2 as the only model that would bring well-being, prosperity, and stability to nations. This growth has come with a heavy price-tag. Growth based on the burning of fossil fuels and natural resource extraction is clearly established as interfering with the stability of Earth's climate, rendering it progressively less resilient. The solution is not to simply stop economic growth, as billions of people still need to be lifted out of poverty, rather alternative solutions must be identified and implemented.

To keep the temperature below 1,5C°, as recommended by the IPCC scientists, we must curb our GHG emissions and reach net-zero emissions by 2050 at the latest[2]. Currently we emit approximately 50 billion tonnes a year, the task at hand is not a small one.

To understand what needs to be done, in this chapter we will explore how and why energy is fundamental to human development and why, despite having such detrimental effects on the climate on Earth, access to modern energy has been identified as one of 17 goals of the SDG. We will then analyse energy use and CO2 emissions in different regions worldwide to prepare for the next chapter, which explores potential solutions. Finally, we will take a look at the Paris climate agreement and examine if it provides adequate governance tools to tackle the climate challenge on a global scale.

3.1 The energy paradox

Access to energy is key to human and economic development

"Energy is central to nearly every major challenge and opportunity the world faces today. Be it for jobs, security, climate change, food production or increasing incomes, access to energy for all is essential. Transitioning the global economy towards clean and sustainable sources of energy is one

[1] Johan R, Breaking Boundaries, 2021

[2] IPCC 2018 Special Report on Global Warming of 1.5°C highlights that limiting global warming to 1.5°C compared to 2°C will have clear benefits to people and natural ecosystems and will require rapid, far-reaching and unprecedented changes in all aspects of society including Global net human-caused emissions of carbon dioxide (CO2) to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. This means that any remaining emissions would need to be balanced by removing CO2 from the air.

of our greatest challenges in the coming decades. Sustainable energy is an opportunity – it transforms lives, economies and the planet."[3]

Sustainable Development Goal 7 (SDG7) strives to ensure access to modern energy for all. However, we find ourselves in the 'energy paradox', on the one hand energy is key to human development, as it is an enabler of many of the other SDGs, while at the same time also the main cause for the increased anthropogenic GHG emission over the past 70-100 years. As such, SDG7 aims to address both issues simultaneously by proposing that access to energy is fundamental for human development, but that this energy must be modern, i.e., it must come from renewable sources and its use must be as efficient as possible in order not to have negative consequences on the planet's climate. SDG7 is relevant to both developing and developed/emerging countries. It addresses the lack of energy access, which is prevalent in developing nations, and it is also these countries that will face the majority of future energy demand. Moreover, it is also pertinent to developed and emerging countries due to their high levels of fossil fuel consumption and related CO2 emissions.

To incorporate all these elements, the SDG7 includes four distinct goals that need to be tackled and improved simultaneous at varying degrees depending on the situation in the given country or location to meet the universal access to modern energy goal:

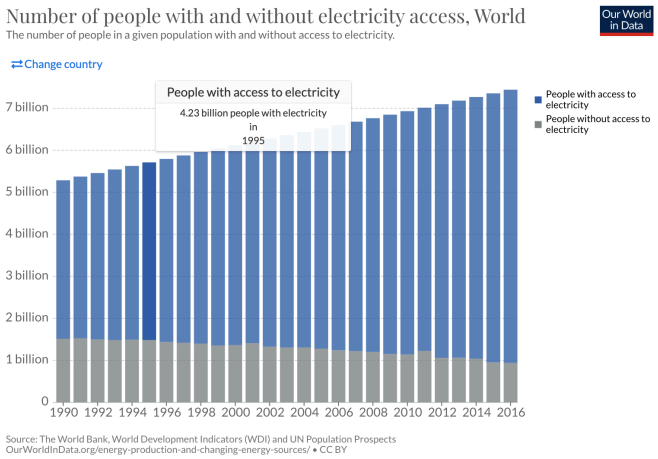
SDG7: Ensure access to affordable, reliable, sustainable and modern energy for all

i. Access to electricity

Definition: The proportion of population with access to electricity.

Access to electricity is measured as the share of people with electricity access at the household level. It comprises electricity sold commercially, both on-grid (the main electricity network) and off-grid (producing decentralised electricity, mostly with innovative technologies).

Global access to electricity has been steadily rising in recent decades. In 2001 1.4 bill people did not have access to electricity, and by 2019 this number had halved to 700.000 million[4]. Between 2005 to 2016, 1.26 billion got access to electricity for the first time, an impressive 126 million per year (Fig 1).



[3] UN, SDG Tracker: https://sdg-tracker.org/energy#:~:text=The%20UN%20explains%3A%20%22Energy%20is,energy%20for%20all%20is%20essential.&text=Sustainable%20energy%20is%20an%20opportunity,%2C%20economies%20and%20the%20planet.%22

[4] World Bank, Tracking SDG7, The energy tracking report, 2021

Fig 1: Number of people with and without access to electricity, 1990-2016

Despite such impressive numbers, one continent is lagging: Africa. Sub-Saharan Africa is today home to 75% of the world population without electricity access. In Africa the number of people without access to electricity, which peaked at 610 million in 2013, has declined progressively to around 580 million in 2019[5] (Fig 2).

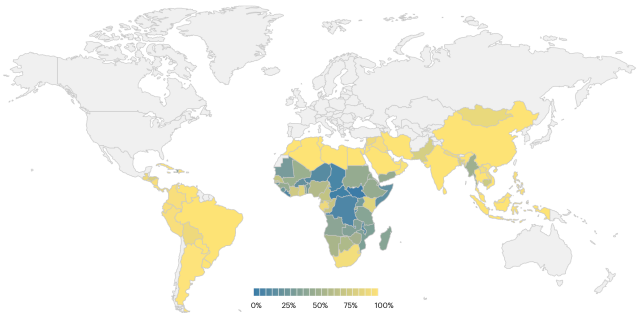


Fig 2: Proportion of the Population without access to electricity, IEA, 2019

Goal: By 2030 ensure universal access to affordable, reliable and modern energy services. This concerns around 700 million people worldwide (approximately 10% of the world population), mainly living in emerging economies where still many households, public buildings (schools, health clinics, local authorities' offices) and businesses do not have access to electricity, and where services like lighting in public spaces are missing. It therefore requires that all homes, public institutions and businesses worldwide will have access to electricity by 2030.

ii. Access to clean fuels for cooking and heating

Definition: The proportion of population with primary reliance on clean fuels and technology for cooking and heating.

Access to clean fuels is measured as the share of the total population with access to clean fuels and technologies for cooking and heating. Access to clean fuels or technologies such as liquefied petroleum gases (LPG) or clean cookstoves reduce exposure to indoor air pollutants, a leading cause of premature death in many low-income households.

The number of people without clean cooking facilities has been declining gradually over the last two decades, only just keeping ahead of population growth (Fig 3). Since 2010, over half a billion people have gained access to clean cooking with a vast majority of these being in India and China as a result of liquefied petroleum gas (LPG) programmes and clean air policies[6].

[5] IEA, Universal Access to Sustainable Energy Will Remain Elusive Without Addressing Inequalities, 2021
[6] IEA, WEO 2017, Special Report on Energy Access, 2017

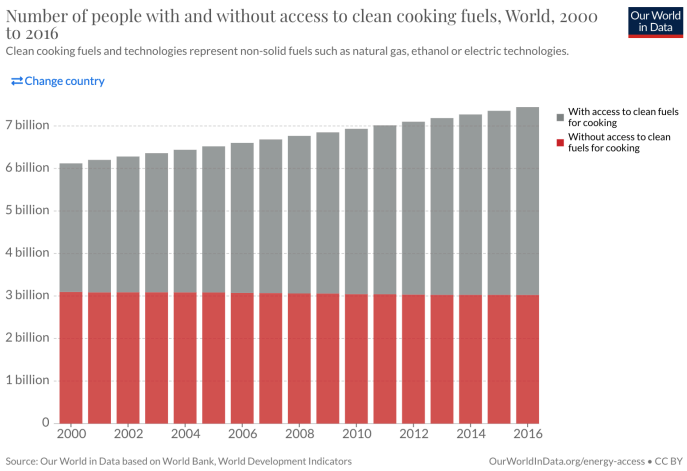


Fig 3: Number of people with and without access to clean cooking fuels, World Bank, 2000-2016

Today, more than 2.6 billion people worldwide still do not have access. 65% of the global population without access are in Developing Asia with 1.6 billion people lacking clean cooking facilities. Seven-times more people lack clean cooking access than electricity in this region. In sub-Saharan Africa the situation is acute and since 2015, only 25 million people have gained access to clean cooking in the region, and as a result the number of people without access increased to around 900 million by 2018 as population growth outpaced the provision of clean cooking[7] (Fig 4).

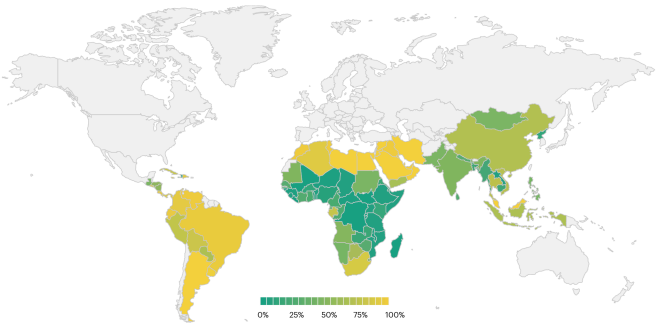


Fig 4: Proportion of the population without access to clean cooking facilities, IEA, 2018

Goal: By 2030 ensure universal access to affordable, reliable and modern energy services.
This concerns around 2.6 billion people worldwide[8] (approximately 36% of the world population) that continue to cook and heat their homes over an open fire. It requires that all homes have access to cleaner fuels, such as LPG, and/or to modern technologies for cooking, such as improved cookstoves by 2030.

iii. Renewable energy

Definition: The share of renewable energy in the total final energy consumption.

This is measured as renewable energy (inclusive of solar, wind, geothermal, hydropower, bioenergy and marine sources), as a share of final energy consumption.

Global consumption of renewable energy has increased significantly over the last two decades, with a distinct upward trend from 2005 (Fig 5). Despite its rapid growth, renewable energy consumption

[7] IEA, WEO 2017, Special Report on Energy Access, 2017
[8] IEA, WEO, 2020

remains far below that of fossil fuels and great efforts must be made by all sectors to accommodate increasing amounts of renewables in the energy mix. The growth of renewable energy since 2005 has been largely due to reduction in technology costs and is expected to continue. Using clean energy technologies along with energy efficiency solutions will be key to reducing GHG emissions.

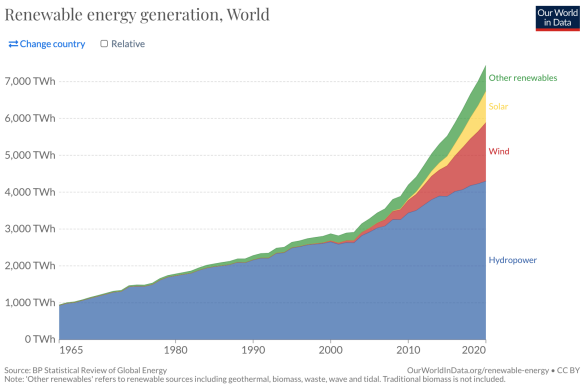


Fig 5: Renewable energy generation, World

Goal: By 2030, substantially increase the share of renewable energy in the global energy mix. This requires that a substantial amount of the energy consumed in developed countries be replaced by renewable energy, and that a substantial amount of the households and business in emerging economies that gain first time access to electricity, do so through renewable energy.

iv. Energy efficiency

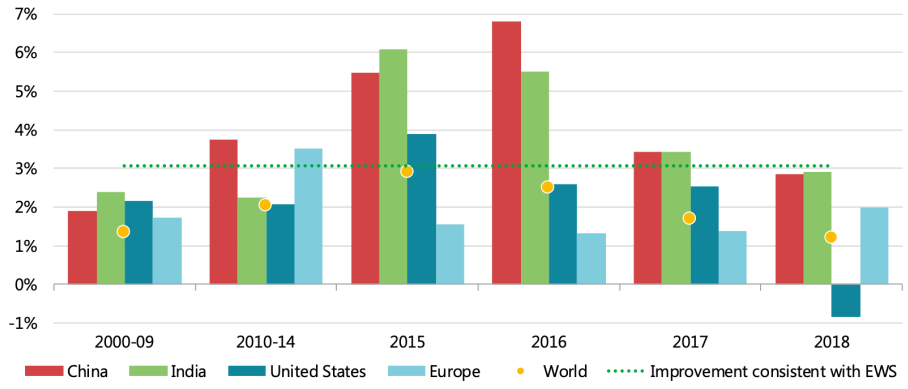
Definition: Refers to minimizing the amount of energy needed to obtain the same or better energy service through better technology and fuel usage.

Energy efficiency includes both a more efficient transformation of primary energy into final energy (reduce losses in generation and transmission of electricity) and an efficient use of final energy (for personal and productive uses). When striving for energy-efficiency in homes and buildings, the goal is to use less energy to heat, cool, and run appliances and electronics. When implementing energy-efficiency in manufacturing facilities the goal is to use less energy to produce the same goods.

Even though energy efficiency has tremendous potential to boost economic growth and avoid GHG emissions, the rate at which technologies and processes are becoming more energy efficient has been slowing globally in recent years due to a combination of certain factors including increased demand for primary energy for industry, cooler winters and warmer summers, demand for bigger cars and increased residential living area as well as increased per person device ownership and use. Regional differences are noticeable (Fig 6).

Energy efficiency will need to increase globally from 1.2% in 2018 or 1.7% in 2017 to at least 3% to achieve a level of energy intensity improvement consistent with meeting global climate change and sustainability goals and can be supported through continued technical efficiency improvements, better and stronger policies, digitalisation, and increased investment[9].

[9] IEA, Energy Efficiency 2019, 2019



Source: IEA (forthcoming), *World Energy Outlook* 2019; IEA (2019a), *World Energy Balances 2019* (database).

Fig 6: Primary energy intensity improvement

Goal: By 2030, double the global rate of improvement in energy efficiency.
This requires that we improve insulation of buildings and replace old, inefficient electric devices and vehicles with modern, energy efficient technologies, which should meet stricter global energy efficiency standards.

Link between energy and development

It is not possible to establish direct causation[10] between energy access and human development because too many external variables compromise the reliability of causality between the two. However, over the past 200 years we have observed a correlation between economic and social development with energy sector transformation. As we can observe in Fig 7, the richer a country gets the lower its reliance on traditional use of biomass (negative correlation) while electricity use and its per-capita energy use rise[11] (positive correlation).

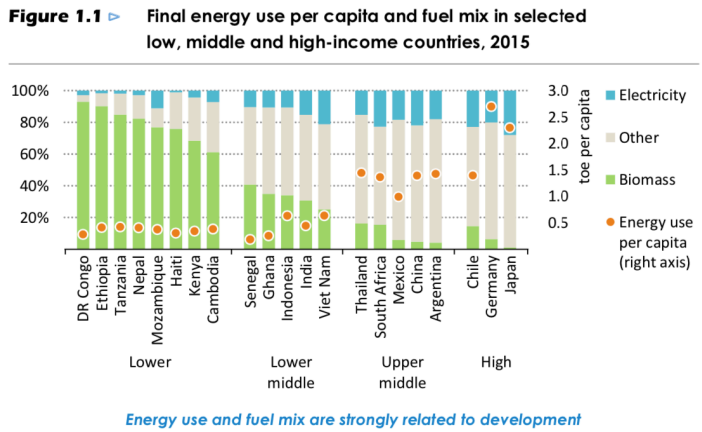


Fig 7: Final energy use per capita and fuel mix in selected low, middle and high-income countries, 2015

Therefore, despite not being able to establish direct causation, access to energy is recognised as one of the main drivers and essential conditions for economic and human development. Insufficient access to energy can cause the marginalisation of entire villages or cities, as well as undermine access to quality health and educational facilities as well as business opportunities for the individuals. Women and children suffer the most from the lack of energy, as they are primarily responsible for the household's energy and water supply, food preparation and cleaning. This causes physical drudgery, with additional physical consequences. Biomass (wood, dung and agricultural

[10] Causation means that one event causes another event to occur
[11] IEA, WEO 2017, Special Report on Energy Access

waste) is in fact most frequently burned on inefficient traditional stoves and open fires. No, or limited, access to energy not only reduces women and children's empowerment and increases inequalities, but also affects the entire household's health, as toxic fumes are produced by inadequate combustions.

The poor and those without modern energy access are often the same and having access to modern energy is not only a necessary condition for overall poverty alleviation but is also in many cases an added obstacle to break the vicious circle of poverty as they are forced to spend a large share of their income on low quality and often expensive energy sources for lighting (kerosene and candles), as well as pay high prices for mobile phone and battery charging. The same is the case regarding basic cooking needs, where they are dependent on inefficient and polluting fuels and technologies which are time consuming to acquire and use.

While cost and affordability of energy access is a key concern for the poorest households, other barriers exist with regard to transitioning to cleaner household fuels including social, cultural and individual characteristics such as perceptions about the security and reliability of supply of alternatives to biomass. Such barriers remain relevant for medium and upper-level income families which explains why a significant number of families within these income categories do not have access to electricity[12] (Fig 8).

The transition to modern energy use can therefore be a challenge not only for low-income families. Use of modern energy services requires those services to be technically available (i.e., either through grid-based connection or decentralised solutions), affordable (i.e., at a price that does not prohibit use and where initial connection is reasonable compared to family income), adequate (i.e., sufficient supply and quality of supply), acceptable (i.e., in line with historical or cultural factors) and reliable (i.e., available and usable for most of the time). Even in countries that have achieved universal access to energy, such as in most high-income countries, the quality and affordability of access to modern energy often remains a challenge.[13]

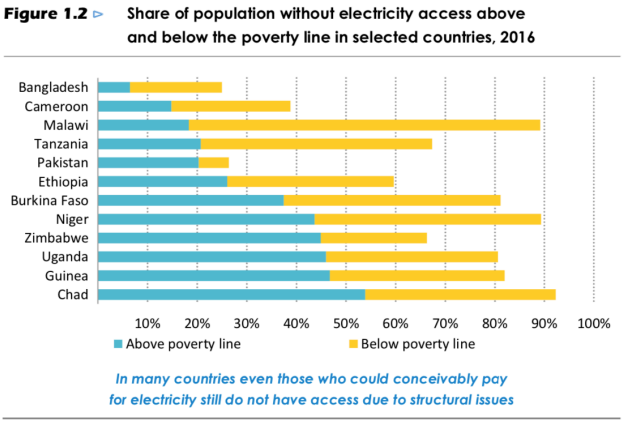


Fig 8: Share of population without electricity access above and below the poverty line, 2016

[12] Michael U. Treiber, Fuel and stove diversification in the light of energy transition and technology adoption theory, Noragric Department of International Environment and Development Studies, 2012

[13] IEA, WEO 2017, Special Report on Energy Access, 2017

Achieving a just energy transition is a global issue

Tackling climate change requires a swift energy transition, moving away from fossil fuels by optimising energy efficiency and renewable energy in developed and emerging economies and reducing biomass reliance and loss of forests by promoting renewable as the first-time access in developing economies.

To ensure a just transition, it is crucial not to leave anyone behind and to treat those whose livelihoods and environments are disproportionally impacted with fairness and consideration. This includes the workforce in the shrinking fossil fuel industry, that should receive adequate training to be fit for job opportunities in innovative industries. It also includes addressing energy poverty, a phenomenon that not only concerns developing countries but is also a reality for many families living in developed countries. SDG7 strives to provide modern energy to all and to achieve this it is of the uttermost importance to safeguard vulnerable families from the adverse and potentially disruptive effects of the energy transition

Another dimension of assuring a just energy transition concerns the effects of climate change. From extreme weather and increasing temperatures to rising sea levels, the effects of climate change often have disproportionate effects on the marginalised or underserved communities and most often it is the poor and vulnerable that will suffer first and will be the worst hit.

Noah Diffenbaugh and Marshall Burke have in a recent research analysis concluded that climate change has already made it significantly harder for poorer countries to catch up economically with richer countries, and that this is a phenomenon that will only increase in the future. The fact that developing countries are, and will continue to be, the hardest hit by the effects of climate change is linked to a variety of issues, but the primary driver is the parabolic relationship between temperature and economic growth, with warming increasing growth in cool countries and decreasing growth in warm countries[14]. Such trans-national issues can only be adequately addressed by global energy governance as some form of compensation is justified for those countries that are least responsible for past and present GHG emissions and yet are paying the steepest price.

Climate change is also expected to affect low-income communities in developed countries harder than high-income communities. Low-income communities are more likely to live in suboptimal housing conditions with bad insulation, have relatively high energy bills and low income which may significantly impact the health and social welfare of the family. As families living in low-income communities have less means to be able to adapt to climate change, such as installing air-conditioners and preparing for extreme weather events, they are more likely to be greater affected by the effects of climate change.

Given the strong connection between energy access and human and economic development on the one hand, and energy and climate change on the other, it is clear that achieving the SDG7 is closely tied to achieving many of the other SDGs. In fact, access to modern energy is key to the overall objective of Agenda 2030 which is to increase equality and prosperity for all while leaving no one behind. Let's take a closer look.

[14] Diffenbaugh N. S., Burke M., 2019. Global warming has increased global economic inequality, Proceedings of the National Academy of Sciences, p.116

Poverty | SDG1: "End poverty in all its forms everywhere"

The International Poverty Line is set by the World Bank and is today fixed at 1.90$ a day[15]. It is important to emphasise that this is extremely low and people living well above the International Poverty Line may still be living in hardship and poverty.

People living in poverty, especially extreme poverty, are often hungry, have no access to education or health services, and no access to light at night. Therefore, poverty is often referred to as a 'trap', as the elements that could help them escape poverty are not accessible like education, nutritious food and clean water, access to health and energy services. As such, poverty cannot be addressed in isolation, and it will take a holistic approach to assist people in rising out of poverty.

Access to energy has an important role to play in addressing poverty. Lack of energy is considered not only as a form of poverty, but also a consequence and a cause of it.

• Lack of energy is a form of poverty because it prevents people from meeting their basic needs, as well as empowering and developing on personal level.
• It is also a consequence of poverty, as low-income households often cannot afford energy services, although indispensables for daily living. As a result, they either do not manage to pay their bills (and their energy supply is interrupted) or opt for non-adequate, unhealthy, and dangerous solutions to heat the house or to cook (just apparently cheaper, but expensive to maintain).
• It is also a cause of poverty because it precludes possibilities of income generation. With no or limited energy, it is difficult to develop at personal level (i.e., studying or reading at night, watching TV, etc…) or to run a business, and therefore the possibilities of rising from the poverty status are very limited.

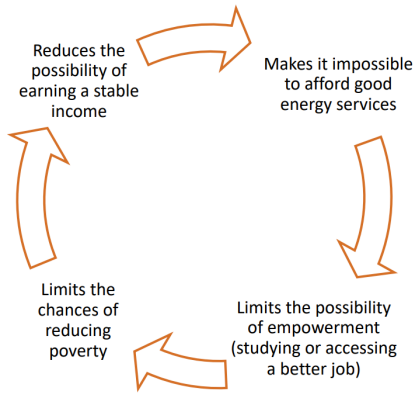


Fig 9: Energy Poverty: A vicious circle

In many parts of the world, women are responsible for supplying energy to the household and therefore, often disproportionally affected by this vicious circle. Not only do they not have access to modern energy services, but they often have to spend several hours every day to collect firewood to cook and heat the homes over an open fire. To break this vicious circle, modern energy services need to be affordable to low-income families, in a way that can be sustained in the long run (and not only for a short period, as in the case of a one-time discount). This principle applies both to developed and developing countries. For this purpose, specific policies and subsidies could be adopted to reduce energy prices for vulnerable consumers.

[15] World Bank, www.worldbank.org

Food | SDG2: "Zero Hunger"

SDG2 seeks to end hunger and all forms of malnutrition and double agricultural productivity. Malnutrition is the result of not having access to sufficient food, or not consuming adequate nutrients, and can therefore be a result of poverty due to access to limited resources, or the result of inadequate calories consumption often leading to obesity, the other side of malnutrition. (More in chapter 4)

Ensuring sustainable access to nutritious food universally will, on the one hand, require sustainable food consumption and production throughout the world. On the other, it will require access to modern energy and cooking facilities that will allow families to prepare their food adequately so they can be sure the quality and quantity of their every-day meals meet the nutritional needs of their family members. Just imagine how hard it is to prepare a meal without the possibility of boiling water, or baking bread?

Improving access to modern energy and cooking technologies contributes to achieving the SDG2: "Zero hunger".

• Access to modern energy forms is important for small-scale farmers to produce enough food for their families. Giving farmers access to modern energy to irrigate their lands and using modern farming technologies, allow them to improve food security for themselves and their families. This reduces poverty and hunger in the short and long-term.
• Access to modern fuel types, such as electricity and LPG, makes the preparation of nutritious meals easier and avoids the problems related to fuelwood scarcity, which may lead to consuming foods that do not need cooking. More nutritious food is usually more elaborate and needs to be cooked to become digestible or safe enough to be eaten (i.e., meat, beans, eggs …), and to be preserved adequately for future consumption. If those options are inaccessible because of the lack of energy, the average consumption of proteins and carbohydrates will be reduced, leading to poor nutritional balance and malnutrition as well as food poisoning.
• In developing countries, collecting firewood for cooking and heating can be very time and energy consuming, as forests are often not close to villages. This physical drudgery requires a higher caloric intake that is not always possible to satisfy, and often aggravates health conditions. When wood or alternative fuels (like kerosene) must be purchased, energy has a strong effect on the family finances. In fact, a big part of their income must be used to purchase fuels for cooking, rather than food itself.
• Biofuels, such as crop residues and dung, are often burnt to fuel cooking in developing countries, when they could be used as fertilizers to increase land productivity.

Health | SDG3 "Ensure healthy lives and promote well-being for all at all ages"

SDG3 aims to ensure healthy lives and promote well-being for all at all ages. Crucial to healthy lives is access to health facilities that can provide necessary services by qualified staff and the avoidance of unnecessary exposure to external factors that are bad for our health, like air pollution and inadequately managed water and sanitation. Having access to modern forms of energy and cooking facilities is important for both of these reasons. Far too many deaths continue to occur because health facilities do not have access to electricity and cannot provide the help needed. The lack of light during child-labour at night, lack of cooling facilities to store medication and immunisation securely are examples of this.

According to the World Health Organisation (WTO), there are around 4 million premature deaths every year worldwide as a direct result of household air pollution caused by domestic smoke

deriving from dirty cook stoves and fuels[16]. Most of these victims are women and children, as they spend more time in the house and are responsible for collecting firewood, cooking, and heating.

Providing access to modern energy will therefore contribute to achieving the SDG3: "Ensure healthy lives and promote well-being for all at all ages".

• Electrification enables doctors and health workers to intervene during emergencies at any time. Hospital refrigerators allow storage of medicines and vaccines and make modern treatments and disease prevention accessible.
• When modern technologies and fuels are not available, traditional biomass (wood, agricultural residues, animal waste) is burned to cook. Similarly, when electricity is not accessible, candles, kerosene, or other highly polluting fuels are used for lighting. This, together with scarcely ventilated homes, leads to serious health consequences, in particular, lung diseases.
• Firewood collection is a drudgery that heavily affects people's health. The average firewood load varies from 25 – 50 kg, with damaging consequences to postures, as well as back and muscle pain.
• Without electricity is impossible to watch TV or make the fridge work. Having a functioning refrigerator in the house reduces the risk of food poisoning and makes food, vaccines, and medicines last longer. Watching TV give people access to more information about health, hygiene, social norms and sexuality, topics that may be taboo in many countries due to a lack of information about them.

Education | SDG4: "Quality Education"

Education enables upward socio-economic mobility and is a key to escaping poverty, especially in childhood but also in adult life when one must adapt to changing circumstances. According to UNESCO, about 258 million children and youth do not have access to education worldwide[17]. This is because most of these families cannot afford to send their children to school regularly (school fees, stationary, books and material) and often they need the extra income the children generate from work. Children are also often responsible for firewood and water collection, meaning they have limited time to study and attend school. Having access to electricity at home and at school, allows students to extend studying hours, read at night, watch TV and have diversified sources of information.

Enhancing access to energy therefore supports the achievement of SDG4: "Quality education".

• Lack of access to energy particularly affects women and young girls, as they are responsible for collecting firewood and water as well as cooking and heating the houses. This time is taken from more educative and empowering activities such as reading, studying, and attending school.
• Without electricity it is difficult to study, to do homework, to read in the evenings, and impossible to compete with students in other parts of the world or sectors of society that can turn on the computer, charge the phone and browse on the internet to get better informed. Worldwide, an average of 69% of primary schools have access to electricity, while in least developed countries this falls to 34% with Sierra Leone with the lowest percentile at 4%[18]. Electrification also makes peripheral schools more attractive to more innovative teachers. Access to electricity, in fact, triggers innovation and increases the quality of teaching, allowing the usage of computers, tablets, mobile devices and internet connection.

While the Covid-19 pandemic and lockdowns affected over 1.5 billion students worldwide, the long-term social and economic consequence have been particularly severe for the most vulnerable and marginalised students and families. The disruptions exacerbated already existing inequalities,

[16] WHO, Household Air Pollution, 2018 http://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health
[17] UNESCO, UIS (UNESCO Institute for Statistics), 2018 www.uis.unesco.org
[18] UNESCO, What makes a good classroom? New UIS (UNESCO Institute for Statistics) data on school conditions, 2019

especially where distance learning was not possible due to lack of access to electricity and relevant technology.

Equality | SDG 5: Achieve gender equality and empower all women and girls & SDG 10: Reduce inequality within and among countries

While most of us agree that men and women are born equal, there continues to be discriminatory laws, as well as social norms, which are obstacles to women having the same rights and opportunities as men. Worldwide, nearly 1 in 4 girls between the ages 15-19 are neither employed or in education or training – compared to 1 in 10 boys[19]. As a result, women continue to be underrepresented at all levels of political leadership and get less pay for the same work. As women and girls perform a disproportionate share of unpaid domestic work (as they are responsible for collecting firewood and water, food preparation, taking care of the very young and old family members and cleaning the house and clothes), they are often the most affected by the lack of modern energy. This has a strong impact on their health (because of the physical drudgery needed to collect firewood, as well as the inhalation of toxic fumes), but also on their empowerment possibilities (limited time to study, read, earn a salary, etc.). This also translates into long-term lower economic income. If women lack the opportunity or capability to earn a stable income, it hinders the potential for approximately half of the national population to generate wealth, consequently impeding overall economic growth.

Improving access to energy will therefore contribute to achieving SDGs 5: "Gender equality" and 10: "Reduced inequalities".

• As some girls have very little or no time at all to study, they suffer the most from illiteracy or inadequate education. A low level of education also means limited chances to earn a stable salary and be independent from the family of origin or from the husband. Formal education is a source of higher individual satisfaction and a healthier life.
• Because of the poverty status, families in developing countries make their children, especially girls, marry before they turn 18. This way, their families can benefit from a payment, favours, or other benefits, granted by the husband (who is usually much older than the bride). However, child marriage can be prevented by improving access to modern energy. Given the positive correlation between access to electricity and higher educational outcomes, the first can be considered as a contributing factor in preventing child marriage. Girls in secondary school are up to 6 times less likely to marry, compared to those with no or little education[20].

Water | SDG 6: Ensure access to water and sanitation for all

Humanity has always tried to settle close to water, as fresh water is a precious resource that is essential to human health and for the provision of food. Population growth is putting a huge strain on the limited resources of fresh water we have worldwide.

In the future, both energy and water demand are expected to grow substantially due to population increase and climate change. The IEA estimates that the interdependency of water and energy is set to intensify in the coming years, with significant implications for both energy and water security. Over the next 25 years (2014-2040) the amount of energy used in the water sector will more than double, mostly because of desalination projects, while with energy-related water consumption is expected to increase by nearly 60%.[21]. While demand will increase globally, this is especially true in developing countries, particularly in Africa, where the population is expected to double by 2050

[19] UNICEF, Gender equality – Equal rights and opportunities for girls and boys help all children reach their full potential,
[20] World Bank, Economic Impacts of Child Marriage: Global synthesis report, 2017
[21] IEA, WEO – Special report: Water-Energy Nexus, 2016

which will increase demand for water and energy as a result of increased food production, industrial and agricultural products, heating and cooling, as well as first time access to energy, water and sanitation by a new wealthier segment of the population.

The energy sector is responsible for a high consumption of water, as it is needed for the generation of energy and for the extraction and processing of fossil fuels. On the other hand, energy is needed to extract, treat, and transport water to where it is most scarce. In most developing countries, energy and water are also vital to growing crops used as biofuels for heating or cooking.

The connection between energy and water is indisputable: improving access to modern energy will also enhance the SDG 6: "Clean water and sanitation".

Innovative and technological solutions will play an important role in reducing energy and water consumption and waste. To do so, combining renewable energy sources with extractions or filtering technologies will be key. For instance, photovoltaic solar panels (PVs), can be installed in peripheral areas with no access to the national grid and could be used to power automatic wells to extract water (instead of using a more polluting and expensive generator).

Economic Growth | SDG 8: Promote inclusive and sustainable economic growth, employment and decent work for all & SDG 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation

Sustainable and inclusive economic growth, along with strengthened infrastructure, play a pivotal role in driving progress and fostering innovation in industrialisation. These factors not only boost trade but also create decent jobs, ultimately elevating living standards. Energy is instrumental for sustainable economic growth and industrialisation. At the individual level, lack of energy leads to limited education and business opportunities, and therefore to a lower salary or unemployment and a poorer quality of life. Nationally, insufficient energy infrastructures can leave entire villages or cities in the dark, causing their marginalisation and economic stagnation.

There is a strong interconnection between access to energy and the achievements of both the SDG 8: "Decent work and economic growth" and SDG 9: "Industries, innovation and infrastructures".

• Access to electricity increases industrial and agricultural productivity, as it makes productive processes faster and more effective, but also facilitates self-empowerment. Running a shop, a restaurant, a barber shop, hair saloon or any other business activity is difficult without electricity!
• Renewable energy represents an important resource for achieving access to modern energy in developing countries and at the same time creating new, sustainable, business opportunities. New jobs, such as the solar panel installer, or businesses (for instance, opening a shop dealing solar panels technologies, batteries, etc.) are created at the local level.
• Access to energy is also important for connecting to internet and mobile networks. Internet and mobile phones provide access to an infinite amount of information (that can inspire new opportunities) and new services (for instance paying utility bills by mobile phone), even in marginalised rural areas.

Sustainable Communities and Consumption| SDG 11: Make cities inclusive, safe, resilient and sustainable & SDG 12: Ensure sustainable consumption and production patterns.

As more and more people look for better jobs and living conditions, migration from the countryside to the cities will be a continuing phenomenon in the coming decades. For this urbanisation process not to create any more social injustice and worsen environmental degradation, it is important that cities be planned and organised in the most sustainable way. This means that the urbanisation process, and the consequential economic growth and increased productive processes will have to

consume resources sustainably. As much energy will be needed to meet these needs, renewable sources and technological innovations will play an important role to keep cities, their populations, and the environment in general health. Improving access to energy is therefore instrumental to building sustainable communities and ensuring sustainable consumption and production.

• Accommodation will need to be built according to higher standards in terms of energy efficiency and construction materials, heating, insulation etc., to have as little dispersion and consumption of energy as possible.
• All productive processes should aim to improve energy efficiency and increase the usage of renewables, in order to have a smaller impact on the environment and society.
• It is important that local governments provide the right incentives for their citizens to buy less polluting cars (electric or hydro cars, for instance), but also to renovate their fleets with hydrogen or solar busses.
• Governments should also be responsible for educating people to efficient waste collection and to the importance of recycling.

Climate Change | SDG13 Take urgent action to combat climate change and its impacts

The most urgent area for action today is climate change. If we do not cut record high GHG emissions now, global warming is projected to reach beyond 1.5°C above the pre-industrial level in the coming decade (more in chapter 2).

As we are already seeing, the compounded effects will be catastrophic and irreversible: increasing ocean acidification, coastal erosion, extreme weather conditions, higher frequency and severity of natural disasters, continuing land degradation, loss of vital species and the collapse of ecosystems. These effects, which will render many parts of the globe uninhabitable, will also affect the poor the most. They will put food production at risk, leading to widespread food shortages and hunger, and potentially displace up to 143 million people in Sub-Saharan Africa, South Asia and Latin America by 2050[22]. The exploration, development and deployment of all forms of renewable energy sources is key to ensure clean, affordable and sustainable energy, especially in marginal areas, while at the same time contributing to fight climate change and reduce GHG emissions. Improving access to energy is therefore crucial to meet the SDG 13: “Climate action”.

• To respect the commitment taken with the Paris Agreement and keep the global temperature increase below 1.5°C, it is important that both developing and developed countries reduce energy consumption and improve energy efficiency in all productive sectors. It is also crucial to increase the usage of renewables, both at national level (generating energy from renewable sources, instead of fossil fuels), but also within households (by producing the energy needed for the family with a solar panel on the rooftop, for instance) (more in chapter 4).
• Studies have shown that achieving the universal access to modern energy by 2030 would increase CO2 emissions by only 0.7%[23]. This means that providing universal access to energy will have limited impact on the global increase of CO2 emissions. Nevertheless, it is important not to underestimate the effort and ensure a clean and sustainable transition to a low-carbon economy, in both developed and developing countries.

[22] World Bank, Groundswell: Preparing for Internal Migration, 2018
[23] IEA, An achievable goal: Giving modern energy to the billions who lack it, 2011

3.2 Energy consumption – where are we now and where do we need to get to

Energy consumption today

According to the International Energy Agency (IEA), the energy sector is responsible for approximately three-quarters of GHG emissions[24], which is why we urgently need to shift away from fossil fuels to an energy mix dominated by low-carbon sources of energy.

Fossil fuels account for more than 80% of energy consumption globally today. We get the largest share of our energy from oil, followed by coal, gas, then hydroelectric power[25] (Fig 10).

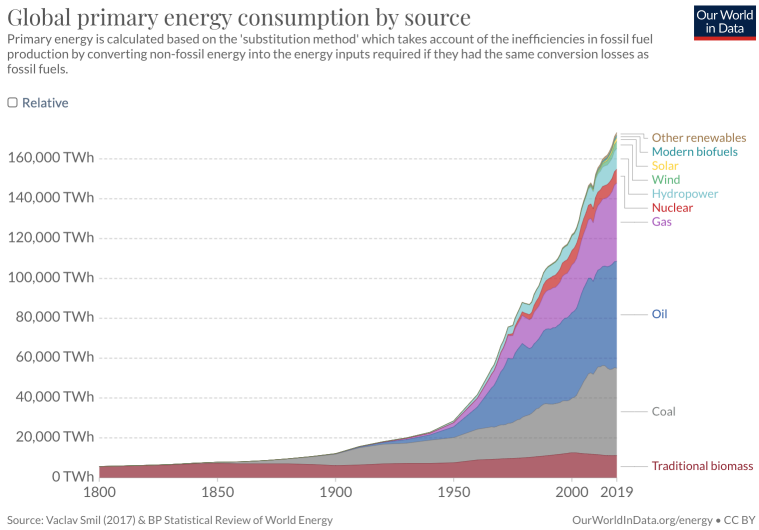


Fig 10: Global primary energy consumption by source from Vaclav Smil's work Energy Transitions: Global and National Perspectives

Fig 10 presents global primary energy consumption by source dating back to the year 1800, and indicates that until the mid-19th century, traditional biomass (wood, crop waste, or charcoal) was the dominant source of energy used across the world. With the industrial revolution came the rise of coal, followed by oil and gas, and by the 1970s hydropower and nuclear were added. It was only in the late 1980s that the 'modern renewables', including solar and wind, were added[26].

What is noteworthy with Vaclav Smil's graph is the speed at which the energy consumption has increased over the past 70 years (1950- 2020). However, the speed at which we need to reach net-zero CO2 emission must be even faster (Fig 12), as we only have 30 years to reach the inverted results (2020-2050) i.e., take global fossil fuel consumption to net-zero.

When observing the primary energy consumption by source since 1965 (Fig 11) and comparing it to where we need to get to by 2050 if we are to implement the GHG reductions needed to assure a stable climate (Fig 12), it becomes clear that we stand at a crossroad. One road continues along the trends of the past, increasing the consumption of fossil fuels and the emission of GHGs that comes with that. The other road reaches peak energy consumption in 2019 where an energy transition starts, progressively replacing the primary energy consumption from fossil fuels (coal, oil, natural gas) with renewables (wind, solar and other modern fuels) by 2050.

[24] IEA, NetZero, 2021
[25] Our World in Data – Energy Mix – https://ourworldindata.org/energy-mix
[26] Please find a table of all types of fuels and their related GHG emission in Annex

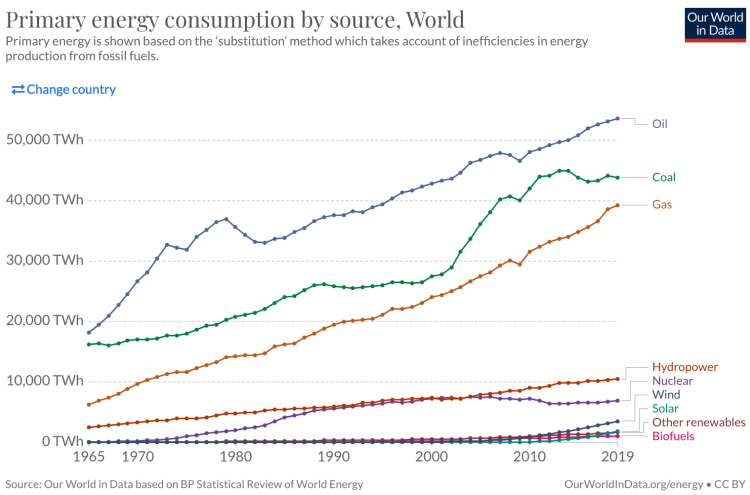


Fig 11: Primary energy consumption by source, 1965-2019

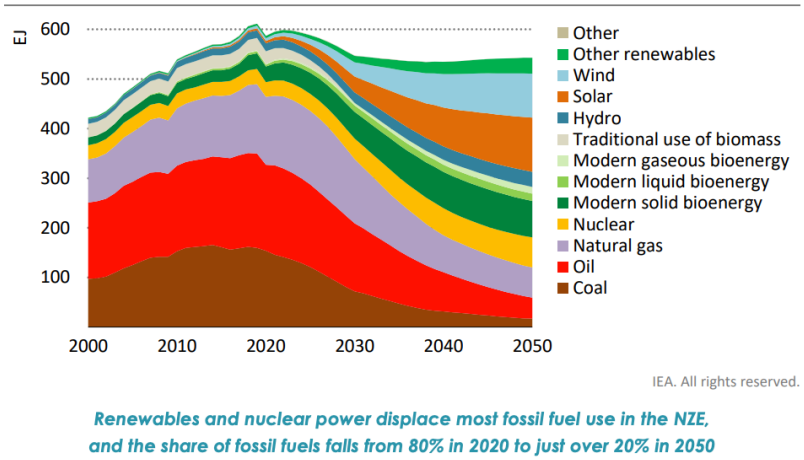


Fig 12: IEA, Net-Zero primary energy consumption by source, 2000 - 2050

Only by pursuing the second road can we hope to keep average temperature increase below 1.5 °C relative to the pre-industrial temperature and somewhat limit the effects of climate change. It requires a global effort, however the starting point for various countries differ greatly.

Unfortunately, the global consumption of fossil fuels did not peak in 2019, despite massive efforts to introduce new renewables as an alternative, hence time and scale is becoming of increasing essence.

High and low energy and CO2 emitters

As we can observe in Fig 13, the energy consumption per capita and the energy mix differs greatly by country. The energy consumption in the US per capita in 2019 was much higher than most other countries, including other developed countries, and was based primarily on fossil fuels. Compare this to Sweden, which also had a high per capita consumption, but mainly based on low-carbon sources (nuclear, hydro and to a lesser degree wind and solar), or with India that had a much lower per capita consumption, however primarily coming from fossil fuels. Clearly the path to net-zero for these countries will vary greatly. The US must strive at reducing overall energy consumption through energy efficiency measures and by replacing the fossil fuels with low-carbon energy. Sweden must consistently pursue its virtuous and fruitful mission to replace the residual fossil fuel with low-carbon energy with the help of energy efficiency and renewables. Finally, as India's per capita energy

consumption is expected to increase in the coming years, it is pivotal to make sure this new demand is met as efficiently as possible by low-carbon energy while gradually replacing fossil fuels consumption with low-carbon energy.

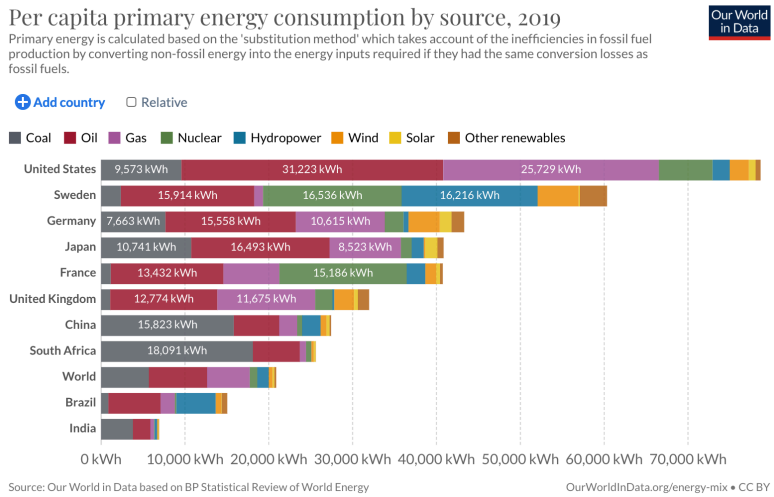


Fig 13: Per capita primary energy consumption by source, 2019[27]

Scaling up low-carbon sources

In all countries, no matter their current situation, scaling up low-carbon sources of energy will be fundamental to reaching net-zero by 2050. Fig 14 indicates that in 2019, 15.7% of global primary energy came from low-carbon sources. Low-carbon sources are the sum of nuclear energy and renewables (hydropower, wind, solar, bioenergy, geothermal and wave and tidal). 11.4% came from renewables and 4.3% came from nuclear. Hydropower and nuclear account for most of our low-carbon energy: combined they account for 10.7%. Wind produces only 2.2%, and solar 1.1%, however both sources are growing quickly. While low-carbon sources have more than doubled since the 1960, progress has been slow since much of the gains made in renewables has been offset by a decline in nuclear energy[28].

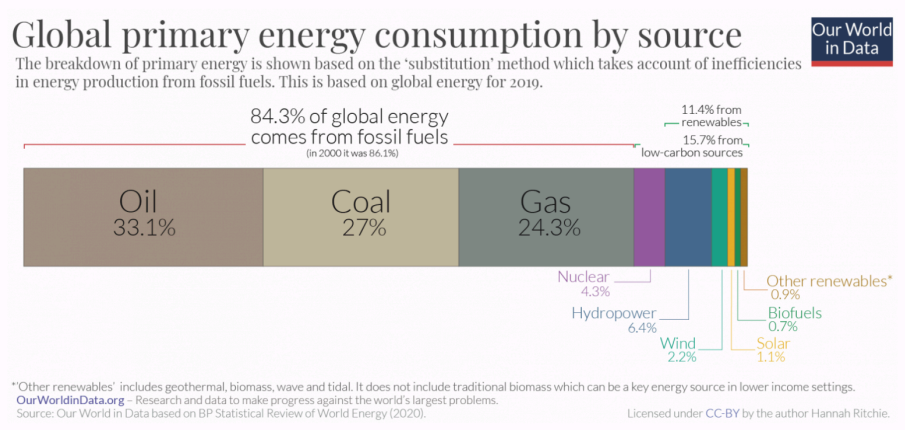


Fig 14: Global primary energy consumption by source

[27] Note these figures don't include energy produced from traditional biomass as there is no reliable data on this.
[28] Our World in Data – Energy Mix – https://ourworldindata.org/energy-mix

Which countries get the highest share of energy from low-carbon sources?

While the global average of low-carbon sources was 15.7 in 2019, there are huge discrepancies between countries (Fig 15).

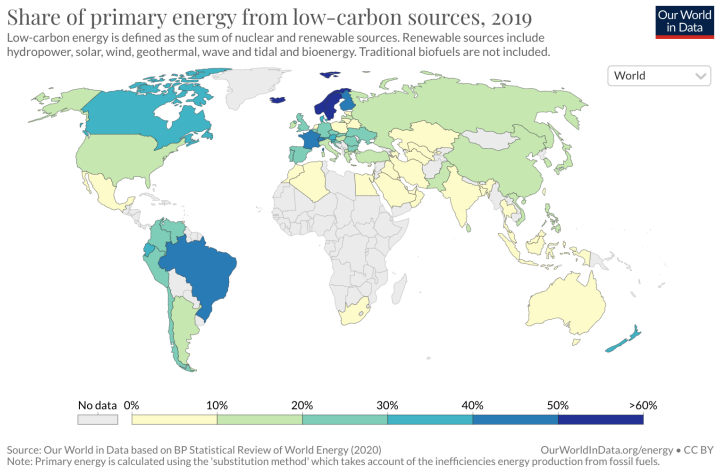


Fig 15: Share of primary energy from low-carbon sources, 2019

In 2019, Iceland got 79% of its energy from low-carbon sources, being one of the highest in the world. Most of this came from hydropower (55%) but also other renewables, mainly geothermal energy (24%). Other countries also get a significant percentage of its energy from low-carbon sources, including Sweden (69%); Norway (66%) France (49%) and Switzerland (49%)[29].

While some countries are faring very well, others continue to rely almost entirely on fossil fuels. This concerns many of the world's oil-producing countries, including Saudi Arabia, Oman, and Kuwait, who all got less than 1% from low-carbon sources in 2019.

Amongst the largest emerging economies, in 2019 South Africa produced only 5% from low-carbon sources, India got 9% from low-carbon sources, and China 15%. Brazil, on the other hand, produced 46% from low-carbon sources in 2019[30].

Progress in shifting towards a low-carbon economy has been slow globally. That may leave us pessimistic about the future. However, some countries with high carbon footprints have demonstrated that significant progress on decarbonising energy systems, including: Morocco (with the Noor Ouarzazate complex – the largest solar farm in the world covering the equivalent of 3500 football fields), India (having established a goal of generating 40% of its power through renewables by 2030, a realistic goal given its progress so far), Costa Rica (one of the global leaders striving for 100% of the electricity production to be renewable by 2021), the European Union (with the EU Green Deal targeting 55% net GHG emissions reduction by 2030)[31] [32]

Poorer countries face an extra challenge: they must grow their economies, giving their increasing populations access to energy, healthcare and education all while avoiding the carbon-intensive pathways today's rich countries have taken. To do this, clean energy needs to be cheap, undercutting fossil fuel alternatives. In this regard, the world's richest countries also have a role to play in the scaling-up low-carbon energy, which should help to drive down costs. We have already seen this effect with the rapid decline in solar prices in recent years.

[29] Our World in Data – Energy Mix – https://ourworldindata.org/energy-mix
[30] Our World in Data – Energy Mix – https://ourworldindata.org/energy-mix
[31] National Geographic, Climate change report card: These countries are reaching targets, 2019
[32] European Commission, 2030 climate and energy framework

3.3 Global Governance

The Brundtland Report was innovative at the time of its publication and laid the groundwork for many of the international agreements that have been developed since. This is especially true for the Earth Summit, which took place in Rio de Janeiro in 1992. It provided a platform for UN Member States to collaborate on issues related to sustainability which were too immense for single Member States to handle on their own. This Forum became the place where the issue of climate change was first addressed. During the following years, the climate change debate emerged as a crucial aspect of environmental protection, and its threat became more and more disturbing. This resulted in the adoption of the international environmental treaty called the Framework Convention on Climate Change (FCCC). In due course, it led to the adoption of the Kyoto Protocol in 1997, (first commitment period from 2008 to 2012 and second commitment period from 2012 to 2020) and successively the Paris Agreement in 2015 (entered into force on 4th November 2016), the two main global agreements addressing climate change.

From Paris Agreement and beyond

While the threats of climate change had been acknowledged for some time, it was only in Paris in 2015 that the scale and urgency converged with the visions and actions needed. This unique momentum allowed 195 countries to agree on a framework that could lead to a serious response to climate change. Whether this new framework will succeed in reversing the trend of catastrophic climate change remains to be seen, but several new factors can give some optimism according to Henry Claude and colleagues[33].

The first factor is the risk perception. Growing awareness of the magnitude of climate risks has changed the understanding of most governments and in the face of pressure exerted by public opinion led many to adopt a more proactive attitude on climate policies[34].

The second factor is economic. The declining costs of low or zero carbon solutions like solar and wind, coupled with advancements in energy efficiency, have generated significant interest in their implementation. These solutions not only offer immediate social benefits, promoting public health and reducing traffic congestion, but also pave the way for a sustainable future.

The growing sense of urgency to address climate challenges, together with the availability of affordable solutions discussed in Paris, led nations to express willingness to present voluntary climate plans or Nationally Determined Contributions (NDC). NDCs provide a bottom-up approach that resulted in the extraordinary result of 189 countries, covering more than 95 percent of global emissions, presented their voluntary climate plans either before the conference or at the meeting[35].

Although the commitments made in Paris fell short of ensuring the goal of limiting average temperature increase to 1.5°C above pre-industrial levels, the framework was designed to facilitate the possibility of resubmitting commitments as technology advanced, and improved financing and policies allowed for setting more ambitious goals.

Every single member state can therefore revise and resubmit more ambitious NDC goals on an ongoing basis. NDCs comprise nationally determined climate change mitigation and adaptation goals, including further contributions such as climate finance, technology, and capacity building, and when submitted they can be monitored on an international level. COP26 in Glasgow in November 2021 provided a opportunity for parties to submit ambitious revisions as will every COP to follow.

[33] Henry, Claude; Tubiana, Laurence. Earth at Risk. Columbia University Press.
[34] Please refer to the chapter IPCC 2018 Special Report outlining the risks p. 18
[35] Henry, Claude; Tubiana, Laurence. Earth at Risk. Columbia University Press.

Another noteworthy aspect of the Paris process was the attempt to engage the public at large including women, children, youth, indigenous people, NGOs, local authorities, workers and trade unions, business and industry, the scientific and technological community, and farmers. All these groups are directly impacted by climate change and by the NDCs but are also themselves able to contribute with their own actions and financial commitments through the so-called "Climate Action Agenda". The idea is that there is not a single institution, or process, that alone can coordinate the response to climate change, but rather that we are collectively responsible, and we can all contribute to the plethora of initiatives that synergistically contribute to achieve this ambitious goal. The result of engaging the public at large has been the active participation of all sectors of society and indeed, recent research shows that citizens are starting to reckon a zero-carbon future as their most desirable option.

IPCC 2018 Special Report

The perception of the risk posed by increased GHG emissions became undisputable in 2018 after the publication of the IPCC Special Report, subsequently confirmed in the 6th IPCC Assessment Report 2021 published in August 2021. The 2018 IPCC Special Report examined the impacts of global warming of 1.5°C above pre-industrial levels, and related global GHG emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty[36].

The conclusions of this Special Report were dramatic, documenting that keeping temperatures below the 1.5c° threshold is humanity's best chance to avoid truly catastrophic unravelling, a task that is still possible, but would be extremely difficult, as it translates into cutting global emissions approximately in half by 2030, and getting to net-zero by 2050.

The IPCC 2018 Special Report was not the first of its kind to make such blunt and terrifying calls for change. Since the IPCC was created specifically by the UN to provide policy makers with the most reliable information possible, it does not only strive for the highest level of scientific accuracy supported by a large pool of leading scientists, but everything published must also be signed off by the 195 governments themselves. As a result of such rigorous process (both scientific and political), previous IPCC projections have been extremely conservative, often dangerously underestimating risks as the projections. The publication of the 2018 Special Report was therefore a clear acknowledgement and statement from the Global community that our common house is "on fire".

This is the reason why the IPCC 2018 Special Report got such attention worldwide and justified the mission of many important social movements including Greta Thunberg's School Strike for the Climate, Extinction Rebellion in the UK, the Sunrise Movement in the US, 350.org and many more climate campaigns. The voice and impact of these movements are growing by the day and are calling on Governments and political leaders as well as CEOs and the public at large to come together to present a new economic model addressing the shortcomings of the capitalist model which is failing many people and the environment on multiple fronts.

The transformation that is called for goes beyond the short-term political cycles and would result in economies built to protect and to regenerate the planet's life support systems (the many ecosystems and biodiversity), and to sustain all the people (with no discrimination) who depend on them. Proposals on how such revised economic models could look are surfacing in many places including the EU Green Deal and the US Green New Deal and are laying out the first plans on how such a new economic model could look while halving emissions by 2030 and getting to net-zero by 2050 (more in chapter 4).

[36] IPCC Special Report, 2018

Since the Rio Earth summit in 1992 there has been many calls for change so why should we believe, it will finally happen? Several fundamental aspects have changed substantially and are worth noting. First, the tragic consequences of a climate collapse are no longer some far-distant possibilities for most people as they are already visible in most of our every-day lives and every year increasingly so. Secondly, for the first time we actually have the technology needed to start making many of the needed changes, and they are finally cost-effective. Furthermore, an ever-increasing number of political leaders have expressed personal commitments to change the course of affairs by harmonising social and economic dynamics with environmental needs in order to pursue a safer and sustainable future for ourselves and the future generations. Finally, companies are acknowledging the demand for low-emission products and services and are working hard to deliver them, while the population at large is getting increasingly informed and actively engaged in changing old habits with new more sustainable ones.

Time is of essence if we need to half the GHG emissions by 2030. However, history shows us that under severe pressure, ambitious goals supported by solid and well-thought policies can indeed lead to a swift and profound transformation of society in a very short period. The evidence and risks are clear, and the failure to address these issues is a matter of choice, not the inevitable destiny of humankind.

Global target - Net Zero by 2050

Reducing global GHG emissions to net-zero by 2050 is consistent with efforts to limit the long-term increase in average global temperatures to 1.5˚C stated in the Paris Agreement and calls for a complete transformation of how we produce, transport, and consume energy, with an unprecedented scale and speed.

While encouraging signs have been coming from many governments throughout the world, such pledges must now be underpinned by adequate policy and prompt action. There is still a lot of work to be done, and decisions over the next decade will play a critical role in determining the pathway to 2050[37](Fig 16).

The path to net-zero is challenging and thus requires immediate and massive deployment of all available clean and efficient energy technologies, such as low-carbon electricity generation and energy efficiency technologies. It also requires additional investments in solutions that are still not 100 percent cost-effective such as advanced batteries, hydrogen electrolysers, and direct air capture and storage[38]. Emission reductions in industry, aviation and shipping as well as the building sector must progress substantially over the next 5-10 years and be ready for deployment by 2030 (more in Chapter 4).

While the world economy is expected to grow substantially by 2030 (40% larger than today) it is expected to use 7% less energy, thanks to energy efficiency measures. Making net-zero emissions a reality hinges on a singular, unwavering focus from all governments – working together with one another, and with businesses, investors, and citizens. The IEA estimates that around 55% of the cumulative emissions reductions that will happen between today and 2050 are directly linked to consumer choices concerning modes of transport, heating and cooling of homes, as well as the food and goods consumed (more in Lesson 4). Many aspects of the energy transition may be challenging to implement, which is why it is important that Governments ensure that decisions are transparent, just, cost-effective and are people-centred and inclusive[39].

[37] IEA, WEO 2020
[38] IEA, NETZERO, 2021
[39] IEA, NETZERO, 2021

According to the IEA four regional patterns are likely to emerge during the period up to 2030:

- In advanced economies, including the European Union and the United States, demand for energy peaked in 2019 and recovery will accelerate the deployment of renewables and the decline of coal.
- In the Asia Pacific region, including China and India, rising economic growth will drive up demand for all fuels. Renewables will lead in terms of absolute growth, followed by natural gas, then oil. Asia Pacific is the only region that will witness a growth in coal demand, primarily in India and Southeast Asia.
- In oil and gas exporting economies, especially the Middle East and Eurasia, lower oil and gas revenues will end up reducing overall economic activity. Gas and oil will mostly satisfy the growth of domestic energy demand, but renewables are expected to gain some ground amid efforts to diversify electricity supply. The outlook in these economies depends both on the speed at which global energy systems transition away from imported oil and gas, and on the success of domestic efforts to diversify their economies away from fossil fuels.
- In emerging markets and developing economies, including in Africa and Central and South America, increasing levels of energy use per capita will drive rapid demand growth. Renewables will account for most power system growth, and oil for most transport demand growth.

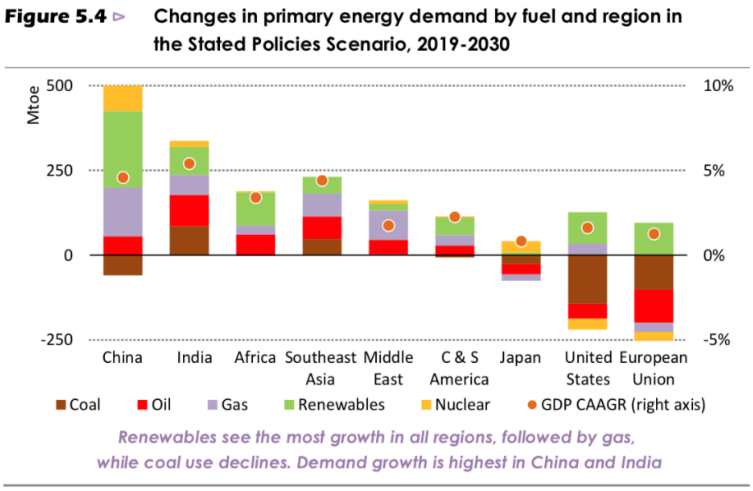


Fig 16: Changes in primary energy demand by fuel and region in the SPS, 2019-2030, IEA, 2020

3.4 Concluding Remarks

We know that humanity is changing the Earth's climate. This fact has been acknowledged in several parallel global processes, starting with the Earth Summit in 1992 and culminating in 2015 with the Paris Agreement, confirmed in the IPCC Special Report in 2018 and subsequently in 6th IPCC Assessment Report 2021. The signs have been there for several decades, but for the first time we now have Global consensus that anthropogenic GHG emission is causing climate change and that there is a real urgency in addressing this issue. Now that we have a Global framework, we can take collective action.

The task at hand for humanity is to keep average temperature increase below 1.5 °C relative to the pre-industrial temperature. To do this we must find affordable and equitable ways to bring every

sector of the global economy to net-zero carbon emissions no later than 2050. At the same time, we must adapt to effects of climate change we can't prevent, taking special care for those with the fewest resources, who have contributed least to the problem but, at the same time, are likely to be disproportionally affected.

Over the next 30 years, with the global population growing and the demand for higher living standards increasing the profound societal transformation that we are embarking on to maintain a habitable Earth must engage all spheres of society, from policy makers to business leaders, individual citizens, and especially young people. The changes will affect multiple aspects of people's lives, from transport, heating and cooking to urban planning and jobs. The IEA estimates that around 55% of CO2 emissions are linked to consumer choices and will require significant behavioural changes.

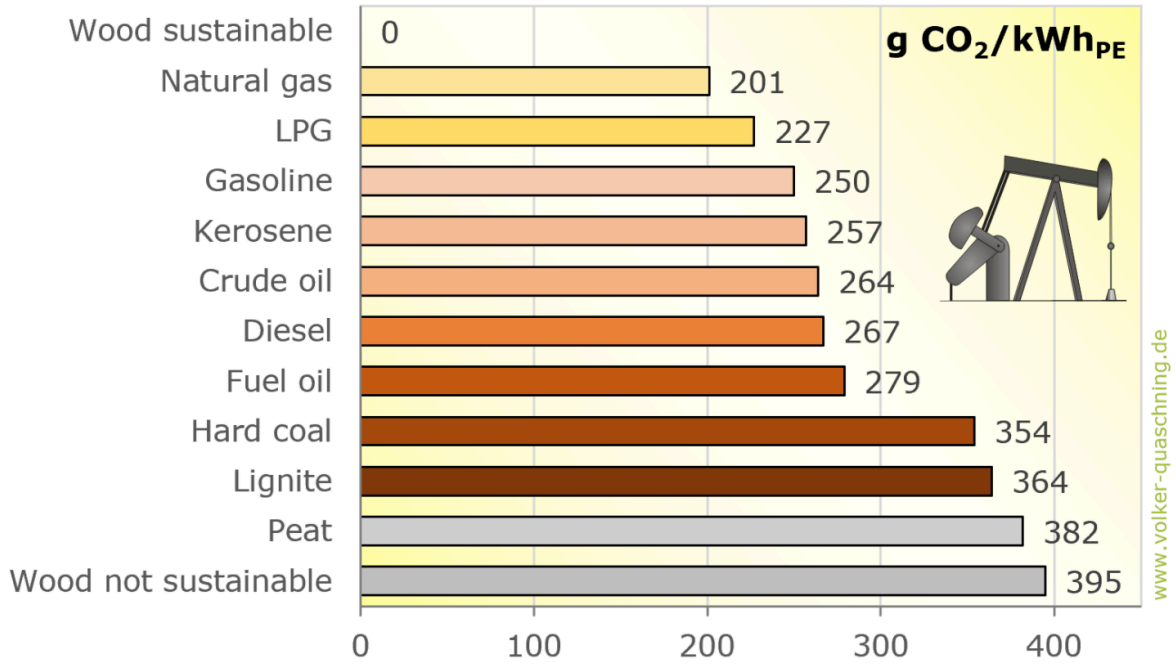
To successfully decarbonize our economy in three decades we need to take bold steps and take them fast. Some of the technical solutions that will take us to zero-emissions by 2050 already exist and must be deployed extensively. Other technologies are still in the research phase, particularly in the industry and transportation sectors, and must therefore be brought to market and scaled as soon as possible to be able to make a decisive impact towards success. The IEA suggest that some of the biggest innovation opportunities concern advanced batteries, hydrogen electrolysers, and direct air capture and storage[40]. Increase in both public and private investment in research and development in science and technology is an essential part of the path that will lead us to a zero-emission economy and restored global biodiversity.

While decarbonizing the economy by 2050 will be a challenge in its own, it is fundamental that this is achieved with equitable and fair procedures and goals. The world's energy systems must be decarbonized at the same time as living standards improve and demand for energy increase for all people in the developing world. Furthermore, vulnerable communities everywhere, that are likely to be disproportionally impacted by climate change must be given adequate resources to protect themselves. It is key to acknowledge that we will not solve the climate problem without simultaneously solving the intertwined problems of equity and economic development.

[40] IEA, IEA, NETZERO, 2021

Annex 1

Specific Carbon Dioxide Emissions of Various Fuels



It is important to note that the CO2 emission per kWh varies depending on the source from which energy is derived. This explains why it is important to prioritise the phasing out of high-emitters (peat, lignite, coal) first, and why relatively low-emitters such as natural gasses are the preferred "bridge" fuel till renewables can provide sufficient energy for all fossil-fuels to be phased out.

Sustainable wood refers to wood that has been harvested responsibly from well managed forests that are continuously replenished and in which there is no damage caused to the surrounding environment, or to native flora and fauna. Wood from unsustainable sources, on the other hand, is chopped down leaving bare areas that usually never really recover.

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A World of Opportunities – how to reach net-zero?

CHAPTER 4

Alessi, Pia Lovengreen

OCTOBER 2022 | LET'S ACT ERASMUS PLUS PROJECT

4. A World of Opportunities: how to reach net-zero?

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Introduction

The world emits approximately 50 billion tonnes of greenhouse gasses (GHG) a year[1], with approximately three-quarters of emissions coming from energy use, and just under one-quarter from agriculture and land use to feed an increasing population (including processing, packaging, transport and retail), and the remaining 8% from industry and waste other than energy use (Fig1).

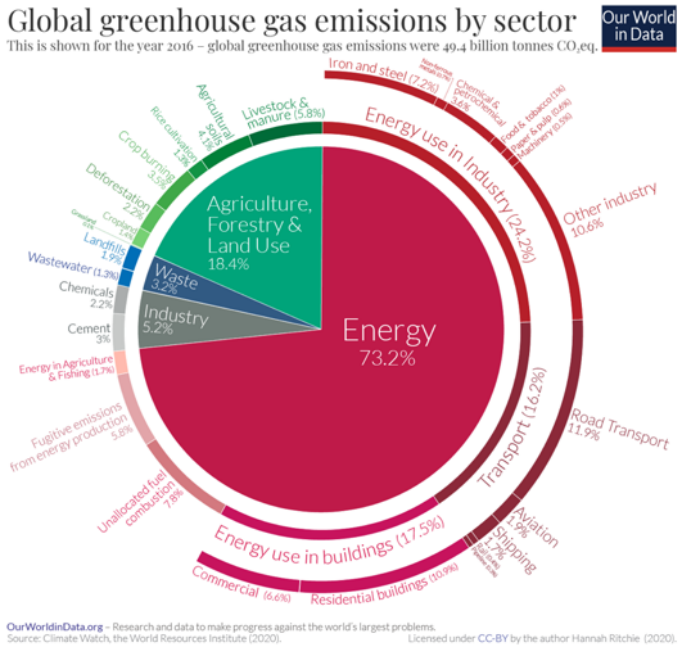


Fig 1: Emissions by sector[2]

Considering the vast range of sectors and processes contributing to global emissions, there is no silver bullet solution to reducing GHG emissions. Focusing on electricity, or transport, or food, or deforestation alone is insufficient[3]. Even within the energy sector, the largest contributor to GHG emissions, there is no single solution that can be adopted everywhere. If we manage to decarbonise electricity supply, we still need to find viable solutions concerning heating, road transport, shipping and aviation.

The scale of the mission to get to net-zero emissions is probably the largest we have ever taken on. Getting to net-zero means reducing GHG emissions to as close to zero as possible and balancing any remaining emissions by removing GHG from the air through the creation of new carbon sinks. We have taken on grand challenges in the past such as the Moon landing, banning ozone-depleting chemicals and designing a COVID-19 vaccine in record time which gives us hope that we can outperform yet again. Achieving net-zero emissions will require the fastest economic transition in history and will depend on the policies adopted, the speed of their implementation and the level of resources committed[4] within two key areas in particular, that is energy (including electricity production, heat, transport, and industrial activities) and food production (including agriculture and land use change).

[1] Measured in carbon dioxide equivalents CO2equivalent
[2] Ritchie H., Roser M., 2020. Emissions by Sector. Our World in Data
[3] Ritchie H., Roser M., 2020. Emissions by Sector. Our World in Data
[4] IRENA, 2020. Global Renewable Outlook – Energy Transformation 2050

The key actions needed within these two distinct areas will be the main focus of this chapter. It will include 1. how to improve efficiency i.e., using less energy to produce a given output, using equal or less land surface while increasing overall food production, optimising fertilisers and other inputs for increased food production, and reducing food waste; and 2. how to transition to low-carbon alternatives i.e., adopting new low GHG options to meet new energy demand, replacing old fossil fuel sources with renewable form of energy, and concerning food production or consumption, it means substituting carbon-intensive products with options with a lower carbon footprint.

4.1 Energy Transition – vision for a fossil free future

The path to net-zero

Reaching net-zero emissions in energy consumption requires innovation across multiple sectors. Rockström and Gaffney, along with many fellow scientists, argue that the graphs depicting the different pathways towards net-zero by 2050 show clearly that in order to stabilise the planet's temperature under +1.5°C (compared to pre-industrial times), the lion's share of climate-action needs to be accomplished promptly. To achieve this, Rockström and Gaffney introduced a new rule of thumb which has been called the "Carbon Law" which consist of halving emission every decade from now till 2050 (Fig 2). The latter can and should be the guiding principle for initiating change across all levels of society, from the individual to the global.

The 2018 IPCC report[5] aligns closely with the carbon law, asserting that achieving a net-zero total CO2 emission by 2050 necessitates a reduction of global net anthropogenic CO2 emissions to fall by approximately 45% of 2010 levels by 2030 (within a range of 40–60%), culminating in a net-zero status by 2050[6].

The objective stands distinctly before everyone's eyes. Yet, the question remains: How will we attain it?

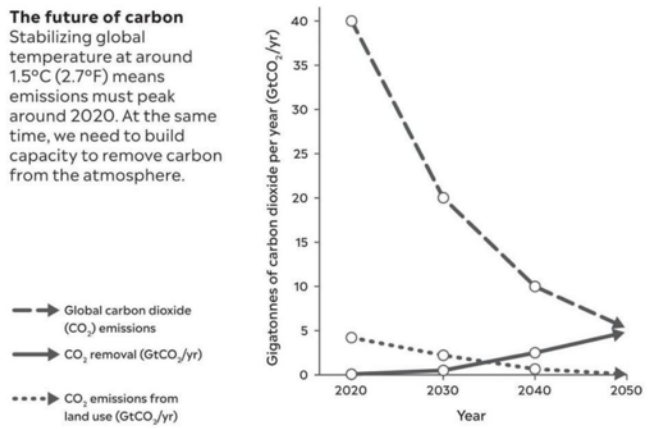


Fig 2. The future of carbon – stabilizing global temperatures at around 1.5°C[7]

[5] IPCC SR1.5 2018 report
[6] IPCC SR1.5 2018 report
[7] Figure from: Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House p. 125

To achieve this goal, it is evident that we have entered the initial stages of the endgame for fossil fuels. To effectively execute the necessary energy transition within the required timeframe, active participation in emission reduction is imperative across all sectors of the economy. Furthermore, where feasible, these sectors should also engage in GHG removal efforts.

The task at hand is of such magnitude that a clear vision or strategy must provide the guide needed to take us to net-zero by 2050. A robust strategy is essential, outlining the precise contributions from each sector, detailing the necessary policy adaptations, identifying readily deployable technologies, and distinguishing those that require additional research. Moreover, it should specify the timeline for scalability, leaving no room for ambiguity.

Many qualified institutions have proposed net-zero roadmaps that are all advocating for GHG reduction pathways that align with the objectives and prescriptions outlined by the carbon law, that is, halving GHG emissions every decade until 2050. We have opted to showcase the Net Zero roadmap (NZE) put forth by the International Energy Agency's (IEA), illustrating the progression towards 2030, 2040, and ultimately 2050. While multiple pathways exist to attain global net-zero emissions by 2050, numerous uncertainties have the potential to impact all of these roadmaps. Meaning that the IEA's NZE is one of many possible paths, not "the one and only path" to net-zero emissions, and update will be needed along the way as circumstances change. (Fig 3).

The IEA methodology used to present the NZE scenarios:

1. The Stated Policies Scenario (STEPS), which reflects all of today's announced policy intentions and targets, insofar as they are backed up by detailed measures for their realisation.

2. The Sustainable Development Scenario (SDS) supposes a certain surge in clean energy policies and investment which will put the energy system on track to achieve sustainable energy objectives in full, including the Paris Agreement, energy access and air quality goals. The SDS would guide certain committed countries toward achieving net-zero emissions by 2050, which would then inspire the world as a whole to reach the same goal, albeit by 2070.

3. The Net Zero Emissions by 2050 case (NZE2050), which extends the SDS scenario by modelling what would be needed in the next ten years to put global CO2 emissions on track for net zero by 2050. NZE2050 examines what it would take to get the entire world to net-zero by mid-century.

As you can observe in Fig 3, each scenario requires the GHG emission cuts to be increased further than the previous, and only the NZE2050 will allow the entire world to achieve net-zero by 2050.[8]

[8] IEA, WEO 2020

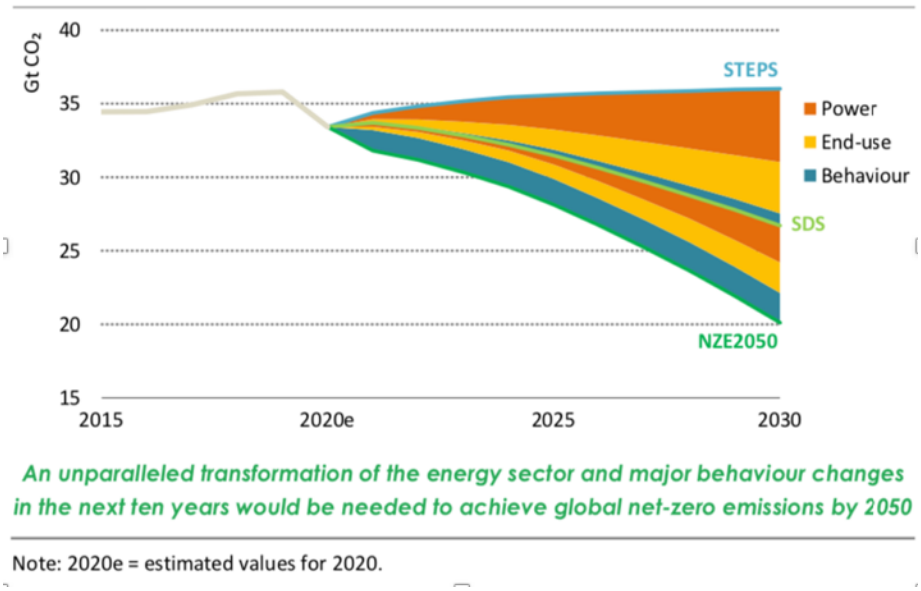


Fig 3: Energy and industrial process CO2 emissions and reduction levels in the scenarios

According to the IEA NZE roadmap, CO2 emissions from global energy-related and industrial process will fall to around 21 Gt CO2 in 2030 and to net-zero in 2050 (Fig 4). While some countries will reach net-zero before others, it is expected that overall CO2 emissions in advanced economies will fall to net-zero by around 2045 while emerging market and developing economies will fall to net-zero by 2050.

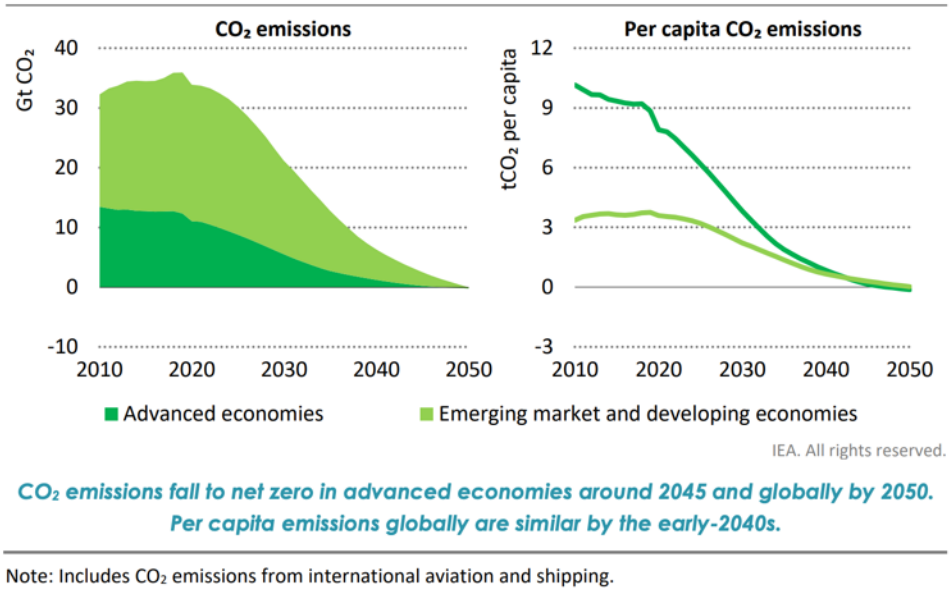
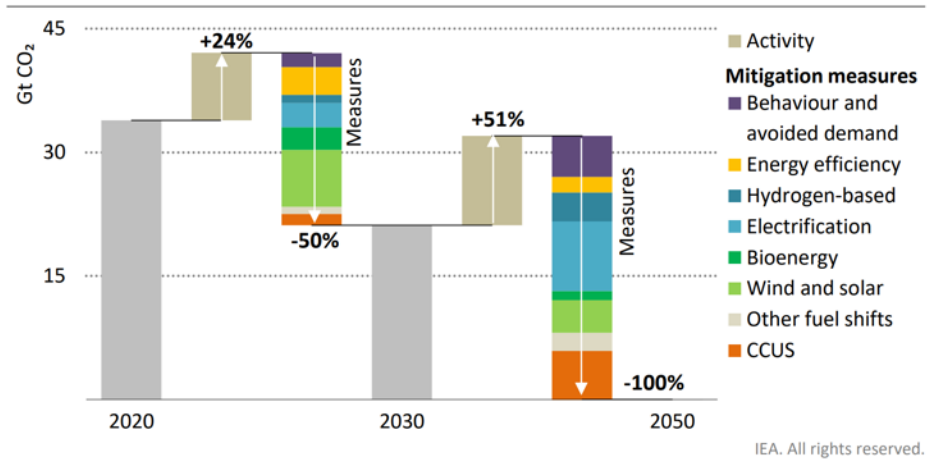


Fig 4: IEA CO2 emissions reductions from global energy-related and industrial process based on NZE roadmap[9]

Trends for the future

The transition to net-zero CO2 emissions requires a radical transformation of the energy sector. Innovative technologies, modern fuels and behavioural changes will all contribute significantly towards the cumulative CO2 savings needed. The key pillars of decarbonisation of the global energy system are energy efficiency, behavioural changes, electrification, renewables, hydrogen and hydrogen-based fuels, bioenergy and CCUS (Fig 5).



Solar, wind and energy efficiency deliver around half of emissions reductions to 2030 in the NZE, while electrification, CCUS and hydrogen ramp up thereafter

Fig 5: Emissions reductions by mitigation measure in the NZE, 2020-2050

To understand the potential of the technologies and fuels that will drive the transition across various sectors, it is crucial to have a clear understanding of these key concepts:

Energy efficiency

Energy efficiency means using less energy to perform the same task. Energy efficiency offers several benefits, including decreased energy demand, resulting in lower energy bills and reduced GHG emissions. While renewable energy technologies also help accomplish these objectives, improving energy efficiency is usually the cheapest way to reduce the use of fossil fuels. Examples include choosing LED light bulbs and energy efficient appliances or larger efforts such as upgrading insulation of private homes or choosing energy efficient vehicles.

According to the IEA NTZ roadmap, reducing energy demand growth through improvements in energy efficiency will make a significant contribution in reaching GHG emission targets for 2030 and 2050, while also resulting in substantial cost reductions. Numerous efficiency measures within industry, buildings, appliances, and transportation can be swiftly implemented and rapidly scaled up.

Renewables

Renewable energy is derived from resources that are replenished naturally on a human timescale. Such resources include biomass, geothermal heat, sunlight, water, and wind. All these sources have their strengths and weaknesses, and the choice depends on local availability. One of the main obstacles to the use of renewable sources is that many of them only produce electricity intermittently i.e., when the sun is shining, or the wind is blowing. However, they can be paired with energy storage solutions to provide reliable electricity 24 hours a day throughout the year.

Renewable energy technologies are the key to reducing emissions from electricity supply. While hydropower has been a leading low-emission source for many decades, it is mainly the expansion of wind and solar that is expected to lead the way to net-zero. According to the IEA NZE roadmap, the share of renewables in total electricity generation globally is expected to increase from 29% in 2020 to over 60% in 2030 and to nearly 90% in 2050 (Fig 6). Renewables are not only expected to play an important role in electricity generation but are also expected to play an important role in reducing emissions in buildings, industry and transport. Renewables can be used either indirectly, via the consumption of electricity or district heating that was produced by renewables, or directly, mainly to produce heat.

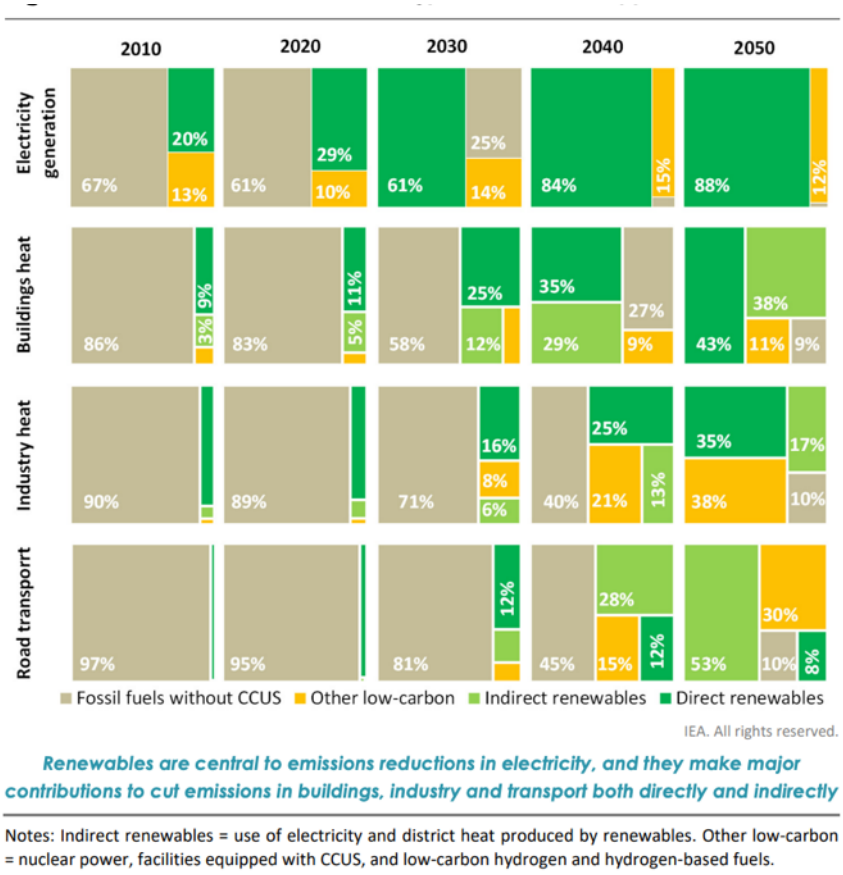


Fig 6: Fuel shares in total energy use in selected applications

Electrification

Electrification refers to the process of replacing technologies that use fossil fuels (coal, oil, and natural gas) with technologies that use electricity as the source of energy. Electrification has the potential to reduce GHG emissions depending on the resources used for electricity generation. For example, driving an electric vehicle (EV) powered by electricity generated from renewable sources can be more environmentally friendly than using a vehicle with a combustion engine that runs on diesel or petrol.

Based on the IEA NZE roadmap, electrification stands out as a critical catalyst for emissions reduction across various sectors in the next 30 years. It is projected to contribute to approximately 20% of the total emissions reduction target by 2050. Despite significant electricity “savings” resulting from energy efficiency, global electricity demand is expected to more than double between 2020 and

2050 due to electrification[10], with substantial increase in demand from industry, hydrogen production and passenger cars. (Fig 7)

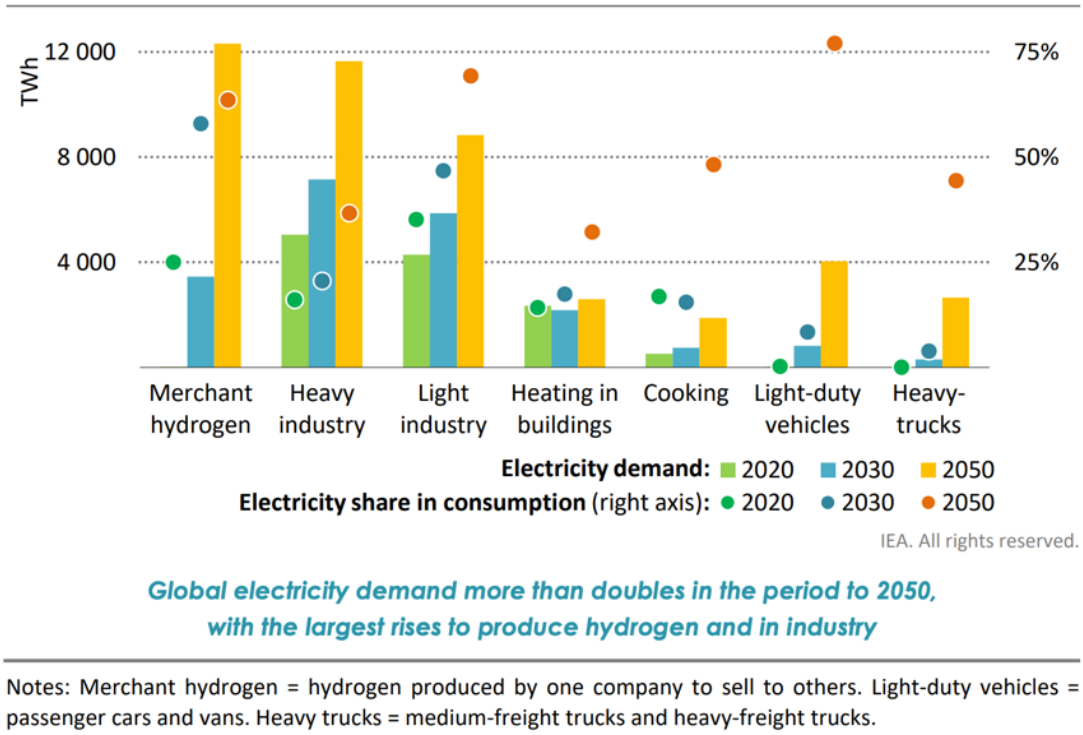


Fig 7: Global electricity demand and share of electricity in energy consumption in selected sectors[11]

Storage

Energy storage involves capturing energy produced at one point in time for subsequent utilisation and its fundamental purpose lies in balancing energy demand with energy production. Energy, depending on its form, can be stored in several ways. Water reservoirs formed by constructing dams serve as a form of energy storage, allowing the generation of electricity at a later time. Electricity cannot itself be stored on any scale, but it can be converted to other forms of energy which can be stored and later reconverted to electricity on demand. Storage systems for electricity include batteries, ultra-capacitors and pumped hydro-storage. Gas such as natural gas, biogas, biomethane or hydrogen can be stored on a large scale in underground storage (usually depleted gas reservoirs, aquifers, and salt caverns) or as liquefied natural gas (LNG). As it is easier to store large amount of gas, increased research and experimentation is done to convert power to gas and as such store the energy as a fuel. Liquid energy like crude and refined oil and finished oil products are usually stored in tanks above the ground.

As we have seen, renewable energy sources are critical to the decarbonisation of our electricity systems, but most (except biogas) are by their nature intermittent. Incorporating energy storage systems between renewable generation and consumption enables the balance of demand and supply. As a result, it becomes an indispensable component for facilitating the maximum integration of renewable energy into the energy mix. Research and innovation are still needed to reach sufficient storage capacity to meet expected demand for energy storage in 2050.

[10] with electricity produced from renewable and not from fossil fuels
[11] IEA,2021, Net Zero by 2050 – A Roadmap for the Global Energy Sector

Hydrogen and hydrogen-based fuels

Hydrogen can be produced from a variety of sources, either from natural gas and coal or through the electrolysis of water using renewable power like solar and wind. The GHG emissions from hydrogen depend on the source of its production. This distinction gives rise to terms like 'grey', 'blue' and 'green' hydrogen. 'Grey' hydrogen is derived from fossil fuels and often associated with higher emissions. 'Blue' hydrogen also comes from fossil fuels, but it incorporates a process to capture and store the CO2 emissions, making it a more CO2-friendly option. On the other hand, 'green' hydrogen is obtained through water electrolysis in specialised electrochemical cells powered by electricity generated from renewable sources and is CO2 neutral.

Hydrogen is easy to store and transport, making it an excellent backup fuel for intermittent renewables in the medium and long term. However, its integration into the established natural gas infrastructure will necessitate some infrastructure upgrading and retrofitting. While less than 0.1% of global dedicated hydrogen production today comes from water electrolysis, with declining costs for renewable electricity, in particular from solar PV and wind, there is growing interest in electrolytic hydrogen. Green hydrogen can, if properly developed over the coming years, play an important role in the decarbonisation of certain sectors, especially the chemical industries and other energy-intensive industries such as steel and cement, aviation and maritime and land transport.

Bioenergy

Bioenergy is a type of renewable energy derived from living organic materials called biomass. This resource can be utilised to produce transportation fuels, heat, electricity, and various products. Biomass is derived from plant and algae-based materials including crop waste, forest residues, purpose grown grasses, microalgae, and food waste. Biomass can be converted into liquid transportation fuels (called biofuels, the two most common being ethanol and biodiesel) that are equivalent to fossil-based fuels, such as gasoline, jet, and diesel fuel. Biomass can also be converted into heat and electricity using biopower technologies. There are three ways to harvest the energy stored in biomass to produce biopower: burning, bacterial decay, and conversion to a gas or liquid fuel. Finally, biomass can also serve as a renewable alternative to fossil fuels in the manufacturing of bioproducts such as plastics, lubricants, industrial chemicals, and many other products currently derived from petroleum or natural gas.

One of the key advantages of bioenergy is that it can use existing infrastructure, i.e., biomethane can be used in existing natural gas pipelines and end-user equipment, while many liquid biofuels can use existing oil distribution networks and be used in vehicles with only minor or limited alterations. For bioenergy to be carbon neutral it is important to complement it with carbon capture and storage.

In the IEA NZE roadmap bioenergy with carbon capture and storage (BECCS) plays a critical role in offsetting emissions from sectors where the full elimination of emissions is otherwise very difficult to achieve.

Carbon Capture and Storage, Carbon Capture and Utilization

Carbon capture and storage (CCS), also known as carbon capture and sequestration, involves capturing CO2 before it is released into the atmosphere and then permanently storing it (carbon sequestration), often within underground geological formations. The aim of CCS is to prevent the release of CO2 with the intent to mitigate the effects of climate change.

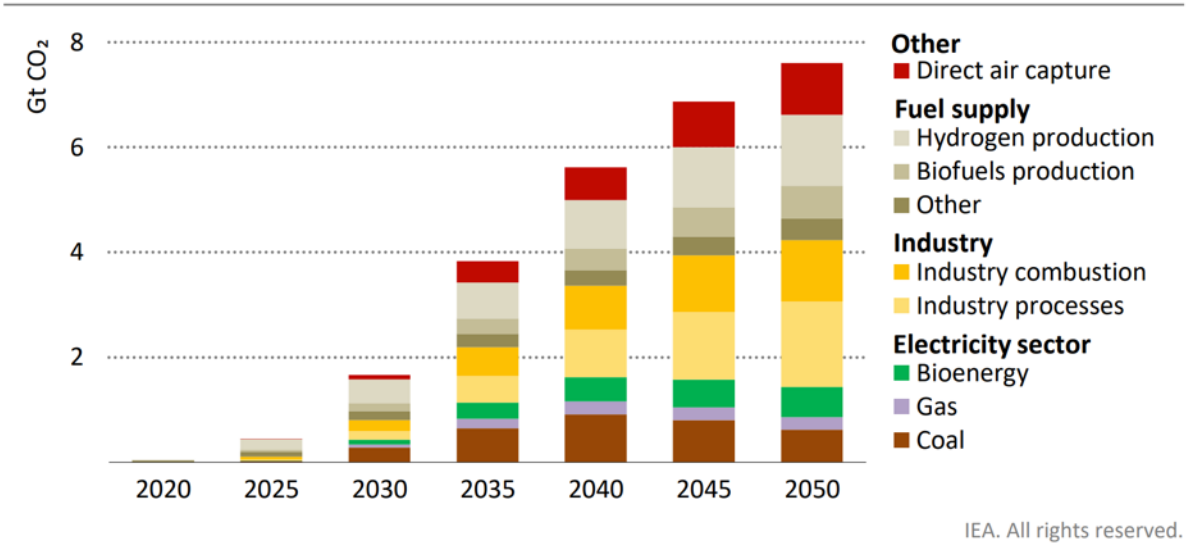
Carbon capture and utilization (CCU) is the process of capturing CO2 to be recycled for further usage. CCU differs from CCS in that it does not aim nor result in permanent geological storage of CO2.

Instead, CCU aims to convert the captured CO2 into more valuable substances or products, such as plastics, concrete or biofuel, while retaining the carbon neutrality of the production processes.

CCU and CCS are sometimes discussed collectively as carbon capture, utilization, and sequestration (CCUS). Because CCS is a relatively expensive process yielding a product with an intrinsic low value (i.e., CO2), hence, carbon capture makes more sense economically when being combined with a utilization process where the cheap CO2 can be used to produce high-value products to offset the high costs of capture operations.

Certain specific locations with a very large potential for producing renewables-based electricity and bioenergy may become a key source of carbon dioxide removal (CDR). This includes making use of renewable electricity sources to produce large quantities of biofuels with CCUS, and to carry out direct air capture with carbon capture and storage (DACCS). An example of such places includes Iceland where we find the Orca Climeworks CDR plant.

According to the IEA NZE roadmap, CCUS can facilitate the transition to net-zero CO2 emissions in a number of ways including: tackling emissions from existing assets, providing a way to address emissions from some of the most challenging sectors, providing a cost-effective pathway to scale up low-carbon hydrogen production rapidly, and allowing for CO2 removal from the atmosphere through BECCS and DACCS (Fig 8).



By 2050, 7.6 Gt of CO_2 is captured per year from a diverse range of sources. A total of 2.4 Gt CO_2 is captured from bioenergy use and DAC, of which 1.9 Gt CO_2 is permanently stored.

Fig 8: Global CO2 capture by source in NZE

Behavioural change

The scale of the energy sector transformation can only be achieved with the active and willing participation of citizens. It is ultimately people who drive demand for energy-related goods and services, and societal norms and personal choices will play a central role in steering the energy system onto a sustainable path.

In the IEA NZE roadmap 55% of emissions reductions require both the deployment of low-carbon technologies and the active engagement of consumers, e.g., installing a solar water heater or buying an EV. Another 8% of emissions reductions however stem directly and exclusively from behavioural changes and materials efficiency gains that reduce energy demand, e.g., the decision to fly less or

changing to a low-carbon diet. Consumer attitudes can also impact investment decisions by businesses concerned about public image.

Energy Sector Pathways to Net-Zero

The roadmap provided by the IEA NZE states that up to 2030, about half of emissions savings will result from energy efficiency, wind, and solar sources. These sources will also continue to drive emissions reductions beyond 2030. Looking toward 2050, the trend shifts to increased electrification, utilization of hydrogen with carbon capture, and the deployment of CCUS technology. It is important to note that most of these technologies are not yet sufficiently mature, but with continued research and innovation are projected to contribute to over half of the emissions savings between 2030 and 2050.[12]. The IEA NZE taps into all opportunities to decarbonise the energy sector, across all fuels and all technologies (Fig 9).

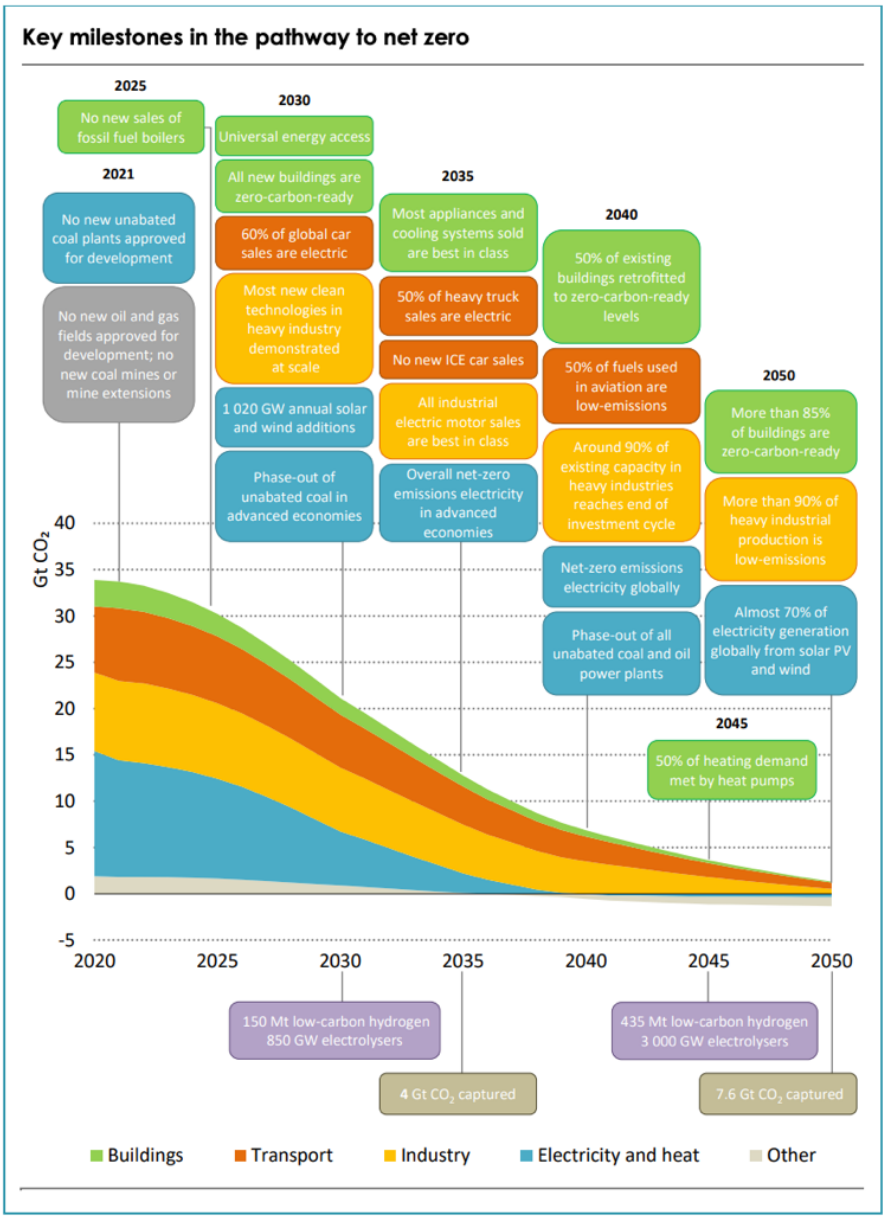


Fig 9: IEA Net-Zero roadmap[13]

[12] IEA, 2021, Net Zero by 2050 – A Roadmap for the Global Energy Sector

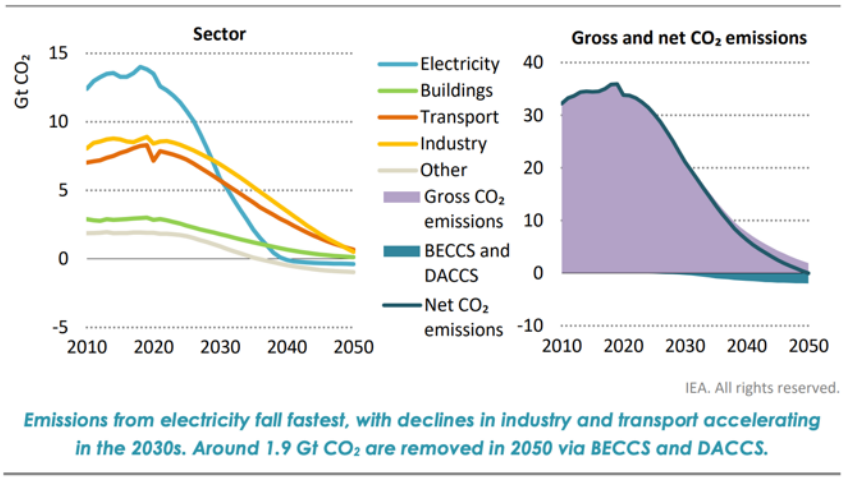
[13] Further explore the IEA interactive visual Net-zero roadmap online: https://www.iea.org/reports/net-zero-by-2050

Let's dig a little deeper into the various sectors:

The fastest and largest reductions in global emissions will initially be observed in the electricity sector (Figure 10). Electricity generation was the largest source of emissions in 2020, but emissions will drop by nearly 60% in the period to 2030, mainly due to major reductions from coal-fired power plants, with the electricity sector eventually becoming a small negative source of emissions around 2040.

In parallel, emissions from the buildings sector will fall by 40% between 2020 and 2030 thanks to a shift away from the use of fossil fuel boilers (natural gas boilers) and the retrofitting[14] of existing building stock to improve its energy performances.

And finally, emissions from industry and transport are both expected to fall by around 20% over this period, while their pace of emissions reductions is expected to accelerate during the 2030s as the roll-out of low-emissions fuels and other emissions reduction options is scaled up. Nonetheless, there are a number of areas in transport and industry in which it will be difficult to eliminate emissions entirely, such as aviation and heavy industry, and both sectors are therefore expected to have a small level of residual emissions in 2050. These residual emissions are offset with applications of BECCS and DACCS.

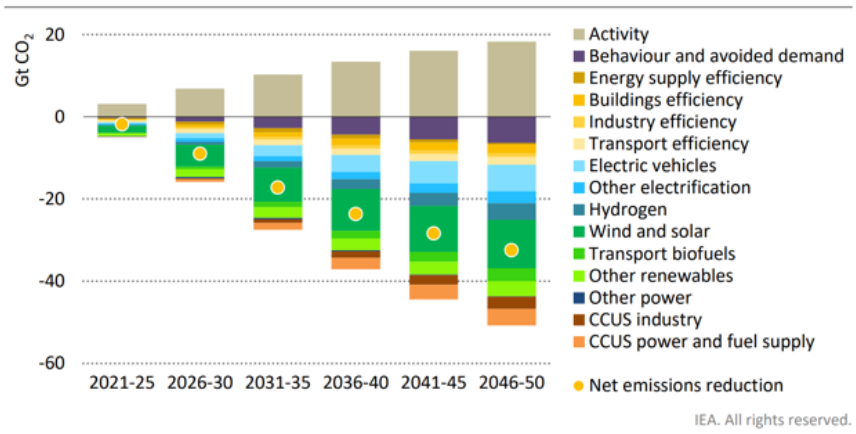


Notes: Other = agriculture, fuel production, transformation and related process emissions, and direct air capture. BECCS = bioenergy with carbon capture and storage; DACCS = direct air capture with carbon capture and storage. BECCS and DACCS includes CO_2 emissions captured and permanently stored.

Fig 10: IEA, Global net-CO2 emissions by sector, and gross and net CO2 emissions in the NZE[15]

The rapid deployment of more energy-efficient technologies, electrification of end-uses and swift growth of renewables are all expected to play a central part in emissions reductions throughout the period 2020 - 2050 (Fig 11). By 2050, it is expected that nearly 90% of all electricity generation is from renewables. There is also a major role for emerging fuels and technologies, notably hydrogen and hydrogen-based fuels, bioenergy and CCUS, especially in sectors where emissions are often most challenging to reduce (Fig 10).

[14] Retrofitting building involves upgrading its energy-consuming systems. Retrofitting may include improving or replacing lighting fixtures, ventilation and heating systems as well as windows and doors and adding insulation where it makes economic sense.
[15] IEA, 2021, Net Zero by 2050 – A Roadmap for the Global Energy Sector

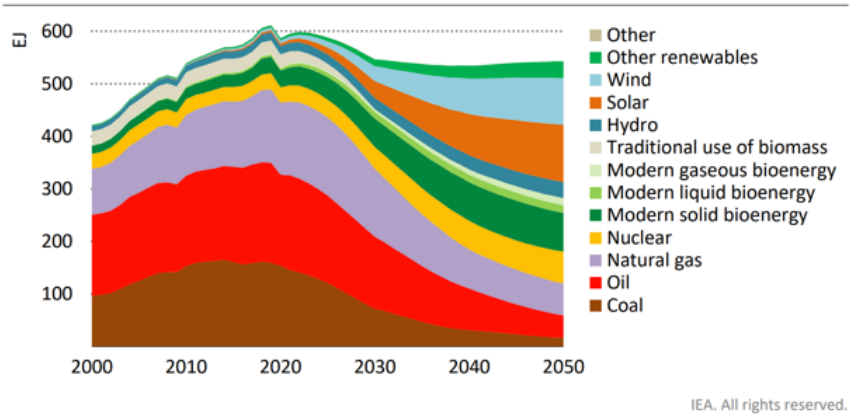


Renewables and electrification make the largest contribution to emissions reductions, but a wide range of measures and technologies are needed to achieve net-zero emissions

Notes: Activity = changes in energy service demand from economic and population growth. Behaviour = change in energy service demand from user decisions, e.g. changing heating temperatures. Avoided demand = change in energy service demand from technology developments, e.g. digitalisation.

Fig 11: Average annual CO2 reductions from 2020 in the NZE[16]

According to the IEA NZE total energy supply will fall 7% from 2020 to 2030 and remain relatively stable after that up till 2050. Increased energy intensity (the amount of energy used to generate a unit of GDP), achieved through electrification, energy efficiency and behavioural changes, is improved over this period and off-sets increased energy demand caused by population and economic growth (Fig 12).

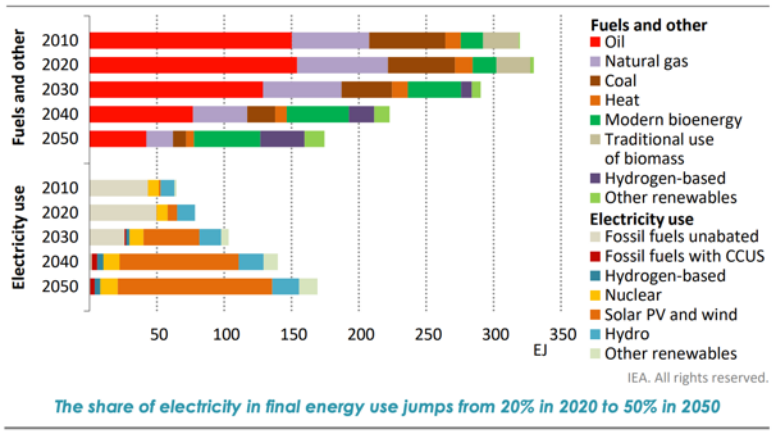


Renewables and nuclear power displace most fossil fuel use in the NZE, and the share of fossil fuels falls from 80% in 2020 to just over 20% in 2050

Fig 12: Total energy supply of unabated fossil fuels and low-emissions energy sources[17]

The energy mix in 2050 is expected to be very different and much more diverse than today, with a massive reduction in fossil fuels and a massive increase in renewables (Fig 12 and 13). Some amount of fossil fuels is still expected to be used in 2050 in producing non-energy goods (chemical feedstocks, lubricants, paraffin waxes and asphalt) in plants with CCUS, and in sectors where emissions are especially hard to abate such as heavy industry and long-distance transport. However, all remaining emissions in 2050 are expected to be offset by negative emissions elsewhere.

[16] IEA, 2021, Net Zero by 2050 – A Roadmap for the Global Energy Sector
[17] IEA, 2021, Net Zero by 2050 – A Roadmap for the Global Energy Sector



Note: Hydrogen-based includes hydrogen, ammonia and synthetic fuels.

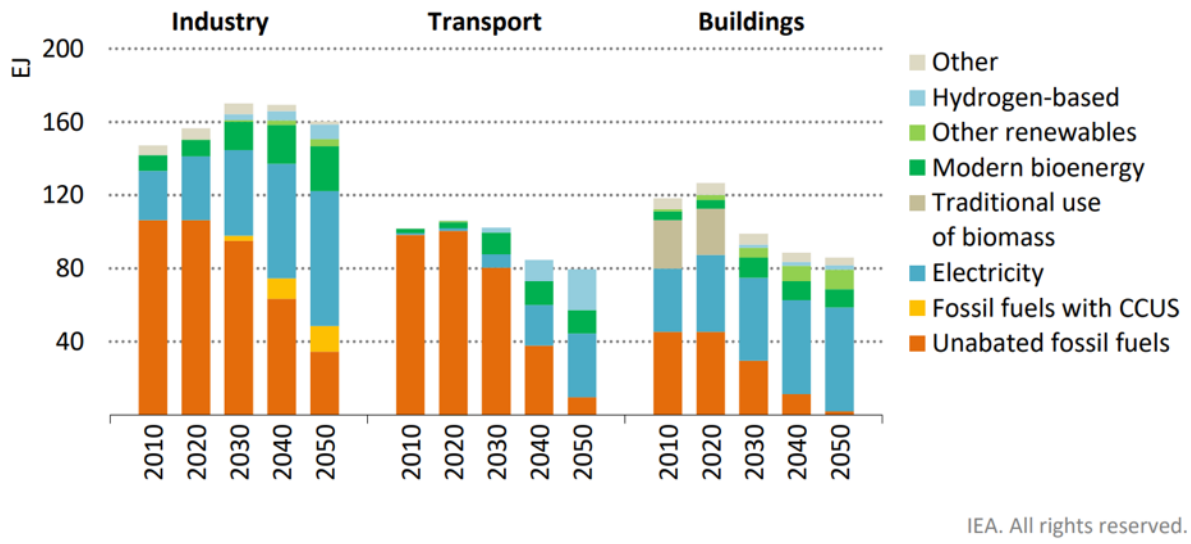
Fig 13. Global total final consumption by fuel in the NZE[18]

The energy intensive heavy industries including steel, cement, plastics, aluminium and chemicals are growing substantially in the coming years due to the growth of both population and the middle-class. Most of the global emissions reductions from industry in the NZE during the period to 2030 are delivered through energy and materials efficiency improvements, electrification of heat, and fuel switching to solar thermal, geothermal and bioenergy. In the following years, CCUS and hydrogen play an increasingly important role in reducing CO2 emissions, especially in heavy industries such as steel, cement and chemicals. Electricity consumption in industry more than doubles between 2020 and 2050, providing 45% of total industrial energy needs in 2050.

In transport, there is a rapid transition away from oil worldwide, which provided more than 90% of fuel use in 2020. In road transport, electricity comes to dominate the sector, providing more than 60% of energy use in 2050, while hydrogen and hydrogen-based fuels play a smaller role, mainly in fuelling long-haul heavy-duty trucks. In shipping, energy efficiency improvements significantly reduce energy needs (especially up to 2030), while advanced biofuels and hydrogen-based fuels increasingly displace oil. In aviation, the use of synthetic liquids and advanced biofuels grows rapidly, and their share of total energy demand rises from almost zero today to almost 80% in 2050. Overall, electricity is expected to be the dominant fuel in the transport sector globally by the early 2040s, and to account for around 45% of energy consumption in the sector in 2050 (compared with 1.5% in 2020). Hydrogen and hydrogen-based fuels account for nearly 30% of consumption (almost zero in 2020) and bioenergy for a further 15% (around 4% in 2020).

In the context of buildings, the shift towards electrification of end-uses, including heating, results in a projected increase in demand for electricity by approximately 35% from 2020 to 2050. Consequently, electricity emerges as the primary fuel source by 2050, accounting for two-thirds of the total energy consumption within the buildings sector. Overall energy consumption in the buildings sector contracts by around 15% between 2030 and 2050 given continued efficiency improvements and electrification. By 2050, energy use in buildings is 35% lower than in 2020. Energy efficiency measures – including improving building insulation and ensuring that all new appliances brought to market are the most efficient models available play a key role in limiting the rise in electricity demand. Without these measures, electricity demand in buildings would be around 70% higher in 2050.

[18] IEA, 2021, Net Zero by 2050 – A Roadmap for the Global Energy Sector



Note: Hydrogen-based includes hydrogen, ammonia and synthetic fuels.

Fig 14: Global final energy consumption by sector and fuel[19]

Furthermore, household's energy consumption is expected to fall by 25% between 2020 and 2030, largely as a result of a major push to improve efficiency and to phase out the traditional use of solid biomass for cooking which is replaced by liquefied petroleum gas (LPG), biogas, electric cookers and improved bioenergy stoves. Universal access to electricity is achieved by 2030, and this adds less than 1% to global electricity demand in 2030.

4.2 Food Transition – vision for a planetary health diet

Emissions and footprint of food production

While the vast majority of GHG emissions come from the energy sector, the battle for climate change is not only being fought over the global energy system. Decarbonisation is also urgently needed in the production of food. Both transitions are needed to succeed; that is undeniable. But right now, the energy transformation – despite all our concerns, the frustratingly slow progress, and the lack of urgency – is far ahead of food. The food transition is lagging in terms of policy, economy, awareness and technology …. The topic of sustainable food is today …. where the energy agenda was 30 years ago[20].

The primary driver behind our breach of the most critical planetary boundaries, such as those related to land biodiversity, climate, and nutrients, is food production. This trend poses a significant threat to the stability and resilience of our planet. Without serious attention, we face multiple crises. Lifting 1 billion people out of poverty and hunger and feeding another 2 to 3 billion new citizens by 2050 will require some 50% more food[21]. Considering we are already in trouble today, the scenario in 2050 looks far from promising.

[19] IEA, 2021, Net Zero by 2050 – A Roadmap for the Global Energy Sector
[20] Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House
[21] Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House

The production of food is responsible for approximately one quarter of CO2 emissions and 56% of the remaining GHGs (methane, nitrous oxide and ground level ozone), hence its overall contribution to climate change is significant[22]. A new approach is urgently needed to halt the degradation of land and to transform agriculture from a source of CO2 emissions to a "carbon sink" taking up carbon from the atmosphere and storing it below the ground and in vegetation.

Use of Earth's precious surface

For most of humanity's history on Earth, we have existed as hunter-gatherers, and the majority of the land remained wild, characterised by landscapes dominated by forests, meadows, and shrubbery. Landscapes have undergone significant changes over the past few centuries, with wild habitats giving way to agricultural land through conversion that alters the land from its original state. Dramatic increases in population, especially since the industrial revolution, has increased the need for food and fodder production at the expense of forests and natural grasslands.

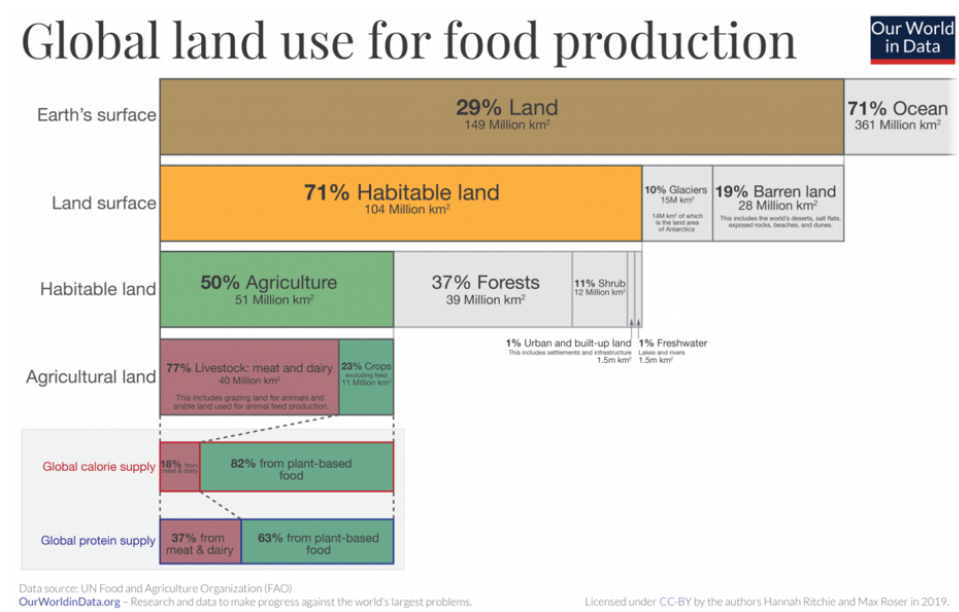


Fig 15: Global land use for food production, UN Food and Agriculture Organisations (FAO)

According to the Food and Agricultural Organisation (FAO) (Fig 15) 29% of Earth's surface is land, of which 10% is glaciers and 19% is barren land including deserts, dry salt flats, beaches, sand dunes, and exposed rocks, leaving 71% as habitable land. Of the habitable land, it is estimated that today, 50% is used for agriculture, 37% is forests, 11% shrubs and grasslands, 1% as freshwater coverage and only 1%[23], a much smaller share than many suspect, is built-up urban area which includes cities, towns, villages, roads and other human infrastructure[24].

Of the 50% of land used for agriculture there is a highly unequal distribution of land use between livestock and crops for human consumption. If we combine pastures used for grazing with land used to grow crops for animal feed, livestock accounts for 77% of global farming land. While livestock takes up most of the world's agricultural land it only produces 18% of the world's calories and 37% of total protein[25].

[22] Rockström, J. Bignet, V., Landqvist M., Stordalen G., The World-Changing Cookbook, Max Stroem
[23] Note that estimates of the global urban land reported in the literature vary widely from less than 1–3 % primarily because different definitions of urban land were used, but is in any case a relatively small number.
[24] Hannah Ritchie and Max Roser, 2020. Environmental impacts of food production, Our World in data
[25] Hannah Ritchie and Max Roser, 2020. Environmental impacts of food production, Our World in data

As a result of the scope and scale of food production, it is the single largest reason that we have transgressed planetary boundaries. The food industry is the single largest sector in terms of climate impact, land use, biodiversity loss, damage to aquatic habitats, freshwater use, over-fertilisation and use of antibiotics and pesticides. Agriculture is the single largest threat to the stability of the planet and our life support systems, from fresh water, pollinators, and soil health to rainfall generation, and quality of air and water. Food production is putting our future at risk[26].

To achieve a sustainable environment, we need to put an immediate stop to land conversion and radically change how we produce food. If we are to feed 11 billion people in the future, we need to reduce our consumption of the most environmentally harmful foodstuffs, increase the agricultural output of the cultivated land and reduce food wastage.

Impact of various food groups and sectors

To be able to determine what actions are most effective it is important to understand what food groups have the biggest footprints, i.e., which foods use the highest percentage of land in their production processes, as well as understand what food groups have the biggest GHG emissions.

Looking at the footprint in terms of nutritional units is useful, as this indicates a measure of how low or high-impact different foods are in supplying protein or energy/calories. Fig 16 indicates the land footprint of foods, measured in square meters (m2) per 1000 kilocalories. As you can see, it is easy to observe some significant differences in the footprint especially between the top two (beef and lamb and mutton) and the rest of the food groups.

One example that is easy to relate to: one burger with fries requires more than seven times as much land area to produce than a plate of pasta with tomato sauce![27]

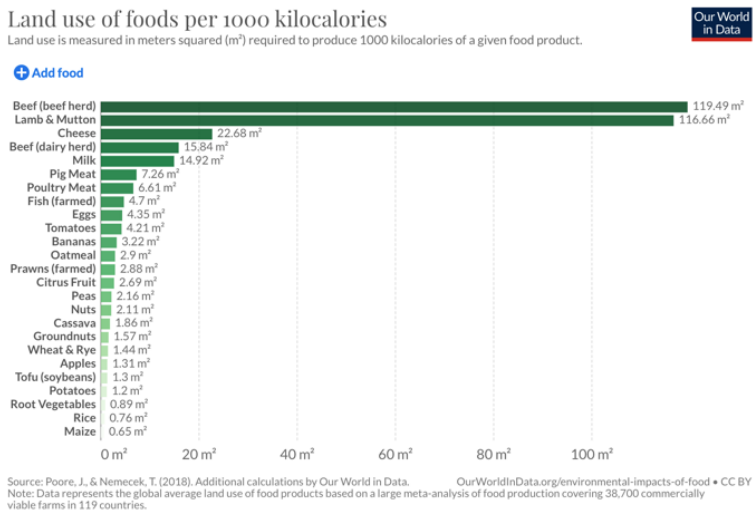


Fig 16: Land use of food per 1000 kilocalories[28]

Categories of GHG emissions from Food Production

While approximately three-quarters of global GHG emissions comes from the energy sector, one-quarter comes from the global food system, which encompasses four key categories worth considering when trying to quantify GHG emissions related to food production (Fig 17).

[26] Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House
[27] Rockström, J. Bignet, V., Landqvist M., Stordalen G., 2018. The World-Changing Cookbook, Max Stroem
[28] Poore J., Memecek T., 2018. Land use of food per 1000 kilocalories. Our World in Data

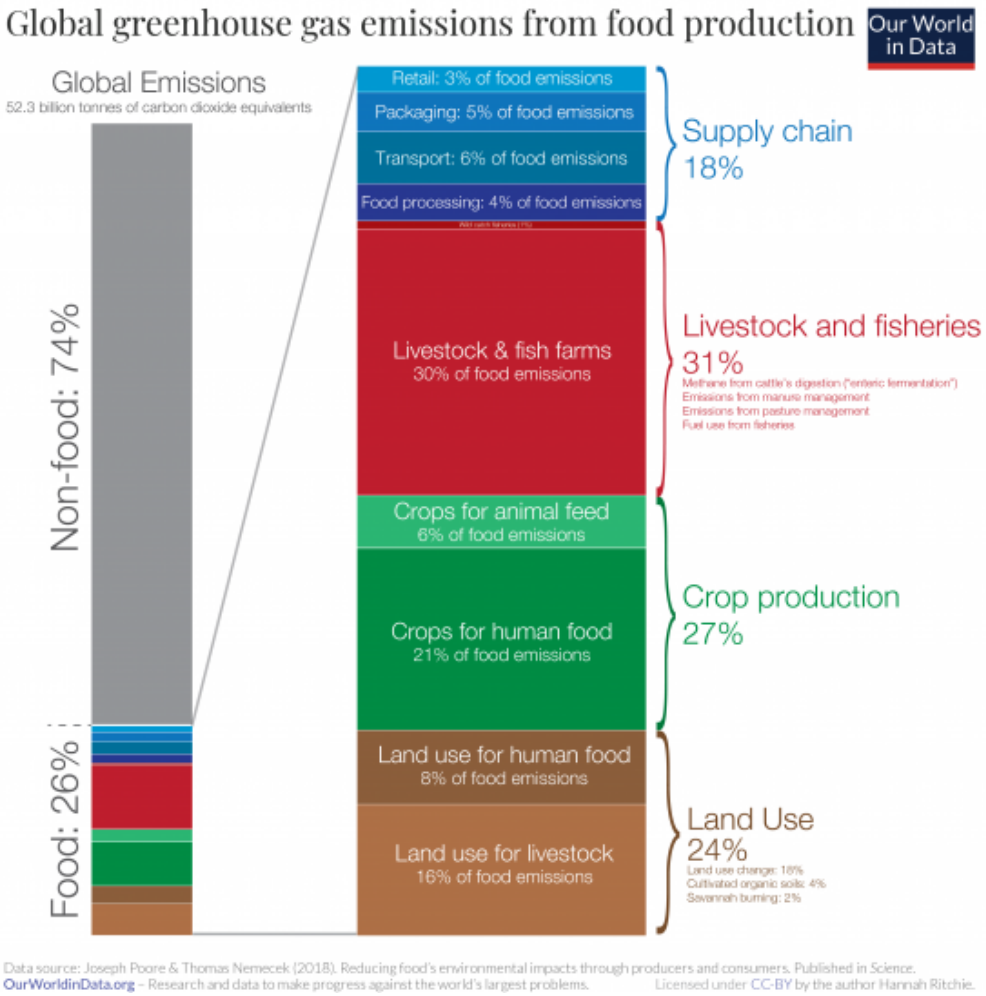


Fig 17. Global GHG emissions from food production[29]

Land use accounts for 24% of food emissions
Twice as many emissions result from land use for livestock (16%) as for land use for human food (8%). Land use is the result of conversion of forests, grasslands and other carbon 'sinks' into agricultural land or pasture resulting in CO2 emissions. 'Land use' here is the sum of land use change, savannah burning and organic soil cultivation (ploughing and overturning of soils).

Crop production accounts for 27% of food emissions.
21% of food's emissions comes from crop production for direct human consumption, and 6% comes from the production of animal feed. These are the direct emissions resulting from agricultural production, which include elements such as the release of nitrous oxide from the application of fertilizers and manure, methane emissions from rice production, and carbon dioxide from agricultural machinery.

Livestock & fisheries account for 31% of food emissions.
Livestock, including animals raised for meat, dairy, eggs and seafood production, contribute to emissions in several ways. Ruminant livestock, mainly cattle, produce methane through their digestive processes (a process known as 'enteric fermentation'). Manure management, pasture management, and fuel consumption from fishing vessels also fall into this category. This 31% of emissions relates to on-farm 'production' emissions only: it does not include land use change or supply chain emissions.

[29] based on data from the meta-analysis by Joseph Poore and Thomas Nemecek (2018), published in Science

Supply chains account for 18% of food emissions.
Food processing (converting produce from the farm into final products), transport, packaging and retail all require energy and resource inputs. Many assume that eating local is key to a low-carbon diet, however, transport emissions are often a relatively small percentage of food's total emissions, at only 6% globally. While supply chain emissions might seem significant, accounting for 18%, they are essential if we want to abate emissions related to food waste. Food waste emissions are large: globally approximately one-quarter of food ends up as wastage either from supply chain losses or consumers. For this reason, a modern and more sustainable supply chain connoted by durable packaging, efficient refrigeration and improved food processing is pivotal to prevent food waste[30] (Fig 18).

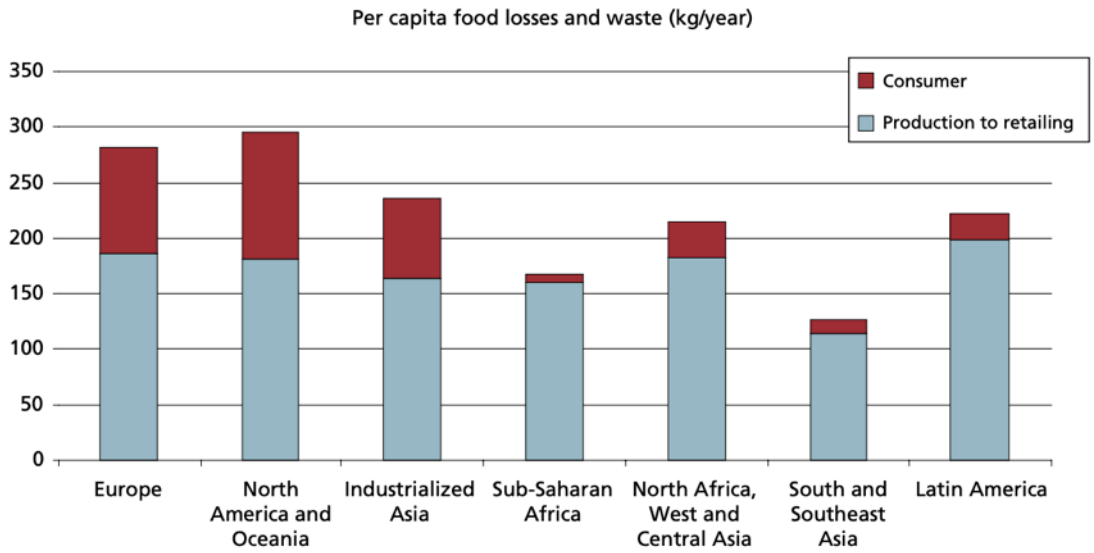


Fig 18: Per capita food losses and waste, at consumption and pre-consumptions stages, in different regions[31]

Unlike many aspects of energy production where viable opportunities for upscaling low-carbon energy and improving energy efficiency are available, the ways in which we can decarbonize agriculture are less clear. We need inputs such as fertilizers to meet growing food demands, and we can't stop cattle from producing methane. Just like with the energy sector transformation, there is no silver bullet solution to GHG emission from food production, rather, we will need a range of complementary solutions including changes to diets, food waste reduction, improvements in agricultural efficiency and technologies that make low-carbon food alternatives scalable and affordable.

Solutions – way forward for food productions

There is substantial scientific evidence that links diets with human health and environmental sustainability. Yet the absence of globally agreed scientific targets for healthy diets and sustainable food production has hindered large-scale and coordinated efforts to transform the global food system. The EAT-Lancet Commission has convened a group of leading scientists to try to fill this gap, tasked to synthesize our knowledge on healthy diets from sustainable food systems and to identify the safe boundaries for the health of both people and planet. The Commission has developed the first global scientific targets for healthy diets, called the planetary health diet, and sustainable food

[30] Gustavsson J., Cederberg C., Sonesson U., van Otterdijk R., Meybeck A., 2011. Global Food Losses and Food Waste - extent, causes and prevention, FAO
[31] Gustavsson J., Cederberg C., Sonesson U., van Otterdijk R., Meybeck A., 2011. Global Food Losses and Food Waste - extent, causes and prevention, FAO

production as a first attempt to set universal scientific targets for the food system that apply to all people and the planet[32].

The Commission acknowledges that food systems have environmental impacts along the entire supply chain from production to processing and retail. Furthermore, these impacts reach beyond human and environmental health, also affecting society, culture, economy, and animal health and welfare. Given the breadth and depth of each of these topics, the Commission decided to focus on two "end-points" of the global food system: final consumption (healthy diets) and production (sustainable food production). This choice is made because these two factors disproportionately impact human health and environmental sustainability.

Targets: Healthy Diet and Sustainable Food Production

It is crucial for the global food system to function within limits for human health and food production, as well as within the safe boundaries of Earth's system processes. Going beyond the thresholds of any Earth system process (for instance, high rates of biodiversity loss) or neglecting any essential food group (like insufficient vegetable intake) raises the potential for jeopardizing both Earth's stability and human health. The Commission has therefore identified two fundamental targets to deliver health for both people and planet, achieved through five strategies:

TARGET 1 – Healthy Diet

Food is putting our health at stake and shortening our lives. It is the single largest killer, responsible for more deaths than smoking, AIDS, tuberculosis, and terrorism combined. Three independent research studies in 2019 estimated that 11 million people in the world die prematurely because of unhealthy food. The fastest growing killers are obesity and diabetes[33]. Obesity is no longer exclusively a problem in wealthy countries, today more than 70% of the 2 billion overweight and obese individuals are in low and lower-middle income countries[34]. Furthermore, as economic affluence has increased in many emerging economies, many have adopted the "western style diet", rich in animal source foods, refined grains, saturated fats and sugar, and low in healthy plant-based foods. This is a diet which is not only much higher in GHG emissions than traditional diets, but it is also linked to increased risk for certain types of "modern" preventable diseases (e.g., diabetes, cancer and heart disease) and as such not only an increased risk to the climate but also the overall health of people[35].

The EAT-Lancet Commission has defined scientifically quantitative targets for a healthy and sustainable diet within the operating spaces for all people, geographies and cultures around the world. This "planetary health diet" optimises health, defined broadly as being a state of complete physical, mental and social well-being and not merely as the absence of disease. The "planetary health plate", based on this scientific evidence, should consist by volume of approximately half a plate of vegetables and fruits; the other half, displayed by contribution to calories, should consist of primarily whole grains, plant protein sources, unsaturated plant oils, and (optionally) modest amounts of animal sources of protein (Fig 19).

[32] Willett W., 2019. Food Planet Health - Healthy Diets from Sustainable Food Systems. EAT-Lancet Commission Summary Report
[33] Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House
[34] Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House
[35] W. Willett et al., Food in the Anthropocene: the EAT Lancet Commission on healthy diets from sustainable food systems. Lancet 2019; 393: 447–92.

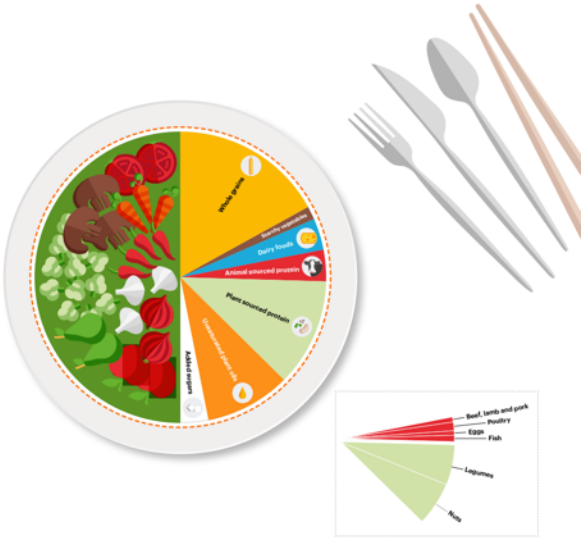


Fig 19: Planetary Health Diet proposed by the EAT-Lancet Commission[36]

The Planetary Health Diet does not suggest that we should all be eating the same diet, rather it gives us the scientific knowledge about what is good and healthy for us and leaves plenty of space for each culture to interpret how to accommodate specific food traditions. Eating according to the guidelines for the Planetary Health Diet not only increases your health but also contributes to safeguard the stability of the planet.

Transformation to the Planetary Health Diet by 2050 will require substantial dietary shifts. This includes a more than doubling in the consumption of healthy foods such as fruits, vegetables, legumes and nuts, and a greater than 50% reduction in global consumption of less healthy foods such as added sugars and red meat (i.e., primarily by reducing excessive consumption in wealthier countries). However, some populations worldwide depend on agropastoral livelihoods and animal protein from livestock, which is why the role of animal source foods in people's diets must be carefully considered within local and regional realities.

The health benefits of adopting the Planetary Health Diet are substantial as it is estimated to prevent approximately 11 million premature deaths per year, accounting for between 19% to 24% of total deaths among adults. It will also assure we produce sufficient high-quality food to feed the growing population, including the 820 million people that still lack sufficient food, and many more that consume either low-quality diets or too much food.

TARGET 2 – Sustainable Food Production

We need a global transition towards farming practices that capture rather than release carbon, that circulate nutrients rather than pollute, and that save water rather than waste it. We need sustainable agriculture, a trend that is already been picked up by 28% of farmers worldwide[37].

Interacting earth systems and processes regulate the state of the planet. The EAT-Lancet Commission has identified the six main systems and processes that are directly affected by food production and for which scientific evidence allows the provision of quantifiable targets. For each of these, the Commission proposes boundaries that global food production should stay within to decrease the risk of irreversible and potentially catastrophic shifts in the Earth system (Fig 20).

[36] Willett W., 2019. Food Planet Health - Healthy Diets from Sustainable Food Systems. EAT-Lancet Commission Summary Report
[37] Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House

	Control variable	Boundary (uncertainty range)
Climate change	Greenhouse-gas (CH_4 and N_2O) emissions	5 Gt of carbon dioxide equivalent per year (4·7–5·4)
Nitrogen cycling	Nitrogen application	90 Tg of nitrogen per year (65–90;* 90–130†)
Phosphorus cycling	Phosphorus application	8 Tg of phosphorus per year (6–12;* 8–16†)
Freshwater use	Consumptive water use	2500 km³ per year (1000–4000)
Biodiversity loss	Extinction rate	Ten extinctions per million species-years (1–80)
Land-system change	Cropland use	13 million km² (11–15)

*Lower boundary range if improved production practices and redistribution are not adopted. †Upper boundary range if improved production practices and redistribution are adopted and 50% of applied phosphorus is recycled.

Fig 20: Scientific targets for six key Earth system processes and the control variables used to quantify the boundaries[38]

The transition to sustainable agriculture needs a guiding principle as was identified in the "Carbon Law" for the energy transition. Rockström and Gaffney propose that such guiding principle should be the "zero target for nature principle", which suggests that since we have already transformed 50% of Earth's land-based ecosystems to agriculture, cities, roads etc., in order to feed the growing population we should only be using the land that we have already converted and make sure that our current cropland stores more carbon rather than it releases. There are already a series of practices paving the way for this new 'green revolution,' primarily based on regeneration and recirculation. This movement must incorporate integrated solutions that combine aspects such as water productivity, soil health, nutrient recycling, crop rotations, and watershed design, along with advancements in biotechnology.[39]

The zero target for nature encompasses several crucial actions. Firstly, it involves an urgent halt to the destruction of the world's remaining forests. This action alone accounts for roughly half of the emissions reductions required from this sector by 2030. Additionally, the target involves promoting reforestation, which stands as the most significant approach to absorbing carbon from the atmosphere. Moreover, the strategy includes the restoration of degraded peatlands, which serve as vital natural carbon sinks. Lastly, it incorporates improved wildfire management, a critical measure considering wildfires currently contribute to 5 to 10% of the annual global CO2 emissions.

Five strategies forward

The analysis shows that staying within the safe operating space for food systems requires a combination of substantial shifts toward mostly plant-based dietary patterns, dramatic reductions in food losses and waste, and major improvements in food production practices. While some individual actions are enough to stay within specific boundaries, no single intervention is enough to stay below all boundaries simultaneously.

According to the EAT-Lancet Commission, the data are both sufficient and strong enough to command immediate action. Delaying action will only increase the likelihood of serious, even disastrous, consequences. It is clear too that a Great Food Transformation will not occur without

[38] Willett W, Rockström J, 2019. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems, The Lancet

[39] Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House

widespread multi-sector, multi-level action, which must be guided by scientific targets[40]. The following five strategies are essential to get the food transformation going:

STRATEGY 1: Seek international and national commitment to shift toward healthy diets

Around half of the countries around the world have drawn up national dietary guidelines, most of which are based solely on the health effects of food and only a handful of which take both health and the environment into account, including: Brazil, the Netherlands, Qatar, Canada and Sweden[41].

The scientific targets set out by the EAT-Lancet Commission provide guidance for the shift needed to take both health and the environment into account. It recommends increased consumption of plant-based foods, including fruits, vegetables, nuts, seeds and whole grains, and substantially limiting animal source foods. This concerted commitment can be achieved by including environmental considerations into national dietary guidelines, by making healthy foods more available, accessible and affordable in place of unhealthier alternatives, by improving information and food marketing, by investing in public health information and sustainability education, and by using health care services to deliver dietary advice and interventions.

It is important to note that unlike the relationship between diet and health, where we can use a single indicator (increased life expectancy) as the yardstick, the relationship between diet and environment is more complex as we cannot use a single yardstick but must use various yardsticks and necessarily apply priority criteria i.e., what is more important: increased life-expectancy or reduced CO2 emissions? While this goes beyond the scope of this paper, it is sufficient to say that scientists have highlighted that there are clear synergies between healthy and sustainable diets. Plant-based food like fruits, vegetables, nuts and seeds, which are good for our health, are also generally less resource-intensive. Similarly, animal-based products such as red and processed meats tend to be worse for our health and that of our planet[42]. There are of course exceptions such as sugar beets and cane which are not as such bad for the environment but not good for our health, or the consumption of fish, which is in principle good for our health, but problematic for the environment due to the risk of over-exploitation and depletion.

STRATEGY 2: Reorient agricultural priorities from producing high quantities of food to producing healthy food

Over the years, the detrimental effects of unsustainable food production on natural resources and ecosystems have weakened the resilience of farming systems, evident in serious soil depletion. When resilience is reduced, farming systems become more vulnerable to threats such as pest outbreaks and extreme weather events. Monoculture farming is one example where high short-term yields and profitability is prioritised at the expense of soil depletion and reduced biodiversity.

Agriculture and fisheries must not only produce enough calories to feed a growing global population but must also produce a diversity of foods that nurture human health and support environmental sustainability. Alongside dietary shifts, agricultural and marine policies must be reoriented toward a variety of nutritious foods that enhance biodiversity rather than aiming for increased volume of a few crops exclusively.

[40] Willett W, Rockström J, 2019. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems, The Lancet
[41] Rockström, J. Bignet, V., Landqvist M., Stordalen G., 2018. The World-Changing Cookbook, Max Stroem
[42] Rockström, J. Bignet, V., Landqvist M., Stordalen G., 2018. The World-Changing Cookbook, Max Stroem

Agro-ecology practices are gaining popularity due to their integration of food production with the natural ecology of the land, ensuring the maintenance of the land's ecosystem services and cycles. Examples include reusing manure as fertiliser or to produce biofuels, crop rotation using different and complimentary plants to increase biodiversity and increasing the use of cutting-edge technologies in production such as vertical farming where farmland is in short supply.

STRATEGY 3: Sustainably intensify food production to increase high-quality outputs

Even people who follow a healthy diet may be exposed to health risks because of unsustainable food production practices (use of fertilisers, antibiotics, pesticides) that both affect the environment and our health.

The existing global food system calls for a novel agricultural revolution that can seamlessly integrate increased productivity with the tenets of sustainability and systemic innovation. The latter would entail achieving a minimum of 75% reduction in yield gaps on current cropland, making substantial advancements in the efficiency of fertilizer and water usage, reusing phosphorus, rethinking the worldwide distribution of nitrogen and phosphorus utilization, adopting climate mitigation strategies such as altering crop and feed management, and fostering increased biodiversity within agricultural systems. In addition, to achieve negative emissions globally as per the Paris Agreement, the global food system must become a net carbon sink from 2040 onwards.

STRATEGY 4: Strong and coordinated governance of land and oceans

While in the past the global commons have been limited to the four zones beyond national jurisdiction: Antarctica, the High Seas, outer space and the atmosphere, Rockström and Gaffney argue that in the Anthropocene, the global commons should include all parts of the Earth system that protect Earth's stability – i.e., all areas within the planetary boundaries[43] so that the global community can collectively do what needs to be done to protect the people and planet and meet the objectives outlined by the 2030 Agenda and the Paris Agreements.

Protecting the people and the planet implies designing and implementing global targets and solutions that strive to keep us within all of the planetary boundaries, among which we recall zero-expansion of new agricultural land into natural ecosystems and species-rich forests, restoration and reforestation of degraded land, enhancement of biodiversity and ocean conservation.

STRATEGY 5: At least halve food losses and waste

While large differences exist between countries, on average approximately 30 % of all food produced in the world is lost or thrown away. In developing countries this is mostly due to transport and storage problems as food spoils quickly without proper refrigeration. In developed countries, this phenomenon is largely linked to consumer choices. Here, we tend to spend comparatively less on food, leading to a sense of disposable abundance. Oversized portions are commonplace, often exceeding our capacity to consume them, and effectively managing leftovers remains a challenge. Furthermore, "ugly" fruit and vegetables are discarded as they do not meet certain characteristics or displease the consumer. Many of these issues can be solved with increased consumer awareness and common-sense initiatives.

Bearing in mind that the population is expected to increase to 11 billion people, and that there are still over 800 million people that go hungry every day, it is absolutely madness that 30% goes to waste. If we do not tackle food waste and cut down on the most resource-intensive foods, we will

[43] Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House

need to produce 50 - 70% more food by 2050[44]. Food waste is therefore not only a completely unnecessary environmental burden but also a matter of food security and equity.

Substantially reducing food losses at the production side and food waste at the consumption side is essential for the global food system to stay within a safe operating space. Both technological solutions applied along the food supply chain and implementation of public policies are required in order to achieve an overall 50% reduction in global food loss and waste as per the targets by the SDGs. Actions include improving post-harvest infrastructure, food transport, processing and packing, increasing collaboration along the supply chain, training and equipping producers, and last but not least educating consumers.

As we have seen, introducing sustainable food systems will be a defining issue of the 21st century. Unlocking its potential will catalyse the achievement of both the SDGs and the goals set by the Paris Agreement. An unprecedented opportunity exists to develop food systems as a common thread between many international, national, and business policy frameworks aiming for improved human health and environmental sustainability for all people and the planet.

4.3 CASE STUDY: The European Green Deal

In order to understand what steps need to be taken to reach net-zero in practice, it is useful to look at a large regional example. The European Union's recently adopted "EU Green Deal" provides a good example of how to plan for net-zero GHG emissions by 2050.

The overarching objective of the EU Green Deal is for the EU to become the first climate neutral continent by 2050, resulting in a cleaner environment, more affordable energy, smarter transport, new jobs and an overall better quality of life for all. To deliver on this objective the EU Green Deal proposes specific strategies that can help curb emissions across all sectors, with a strong focus on reducing GHG emissions from all contributing sectors.

Second, the EU Green Deal strives to decouple growth from resource exploitation. While reductions in emissions have been achieved in the last decade, Europe remains one of the major contributors of resource consumption in the world. Described as a "generation-defining task," achieving this objective will not only require a boost in technological advancements but also rethinking lifestyles, communities, and societies.

Third and finally, the EU Green Deal acknowledges the need to foster an inclusive green transition and to leave no one behind. This commitment is reinforced through the Just Transition Mechanism, which aims to alleviate the socio-economic impacts, especially for the most vulnerable, of the transition needed.

The EU Green Deal outlines the long-term net-zero objectives for the European Union. Achieving these goals necessitates a comprehensive and interconnected policy response. This process involves revising existing legislation to align with the EU Green Deal objectives and drafting new legislation to address any identified gaps. Such policies will in many cases be interlinked and must be mutually reinforcing and striving for the same long-term objectives. This will be an ongoing process, evolving alongside technology, standards, and available financing. Therefore, adjustments and amendments will be required until the ultimate goals are achieved.

[44] Rockström, J. Bignet, V., Landqvist M., Stordalen G., 2018. The World-Changing Cookbook, Max Stroem

The GHG emissions from the energy sector of the European Union will be 93% lower than 1990 levels in 2050, with remaining emissions eliminated using Direct Air Capture (DAC). In the power sector, virtually all unabated coal generation is phased out by 2030 and natural gas substantially reduced by 2050. Renewables account for 75% of new power generation capacity additions to 2050, with offshore wind and solar PV leading the way. By 2050, offshore wind is the single largest source of electricity, providing over a quarter of electricity supply, followed by onshore wind, nuclear power, and solar PV.

Food systems are responsible for around 21-37 % of global greenhouse gas emissions[45] in the EU and use up significant natural resources. The "Farm to Fork Strategy" aims to address these environmental issues as well as fairness, sustainability of the food system and the health of Europeans. The strategy will focus on reducing waste, and transforming the manufacturing, processing, retailing, packaging and transportation of food[46].

On average we have observed a 60% decline in the size of populations of mammals, birds, fish, reptiles, and amphibians in just over 40 years[47]. The "EU Biodiversity strategy for 2030" identifies the key drivers in biodiversity loss as changes in land and sea use, overexploitation, climate change, pollution, and invasive alien species. It furthermore highlights how biodiversity loss and climate change are intrinsically linked, and that nature-based solutions will play an important role in mitigating, and adapting to, climate change.

Concluding remarks

The message is clear: to stand a chance of deviating away from the climate disaster, and to maintain the ecological capacity on earth to feed humanity, we need to follow both the carbon law for energy and the zero law for nature[48].

As we have observed in the IEA NZE roadmap, if we are to reach net-zero objectives by 2050 then renewable technologies like wind and solar PV coupled with a massive push for electrification and increased storage capacity could put us on the right path to halve emissions by 2030. The period from 2030 to 2050 will need to scale-up technologies and modern fuels that are still in the development stage such as CCUS, green hydrogen and bioenergy, for which significant efforts are currently being made.

When it comes to food systems, it is clear that the 10.000 yearlong era of agricultural expansion must come to an end. We have already transformed half of Earth's surface; we must therefore keep the other half intact at all costs. To achieve this goal, it is imperative that we transform every hectare of land from carbon source to carbon sink. Furthermore, these lands should support a wider array of crops, as well as provide a habitat for diverse wildlife and insects. Additionally, each hectare of land should possess inherent resilience to effectively cope with inevitable shocks like droughts, floods, cold spells, and heatwaves.

If we are to create the right conditions for a net-zero world, then we must assure that governments and industries are fully on-board and together strive for the net-zero future we all want. Research indicates that financial and regulatory measures are the most effective in achieving results, and why it is important for governments to push for positive change via a combination of hard measures,

[45] IPCC Special Report on Climate Change, Desertification, Land Degredation, Sustainable Land Management, Food Security, Greenhouse Gas Fluxes in Terrestrial Ecosystems, eds P. R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts.
[46] European Commission, Farm to Fork Strategy, https://ec.europa.eu/food/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf
[47] WWW, Living Planet report 2018
[48] Rockström, J., Gaffney, 2021. Breaking Boundaries – The Science of our Planet, Penguin Random House

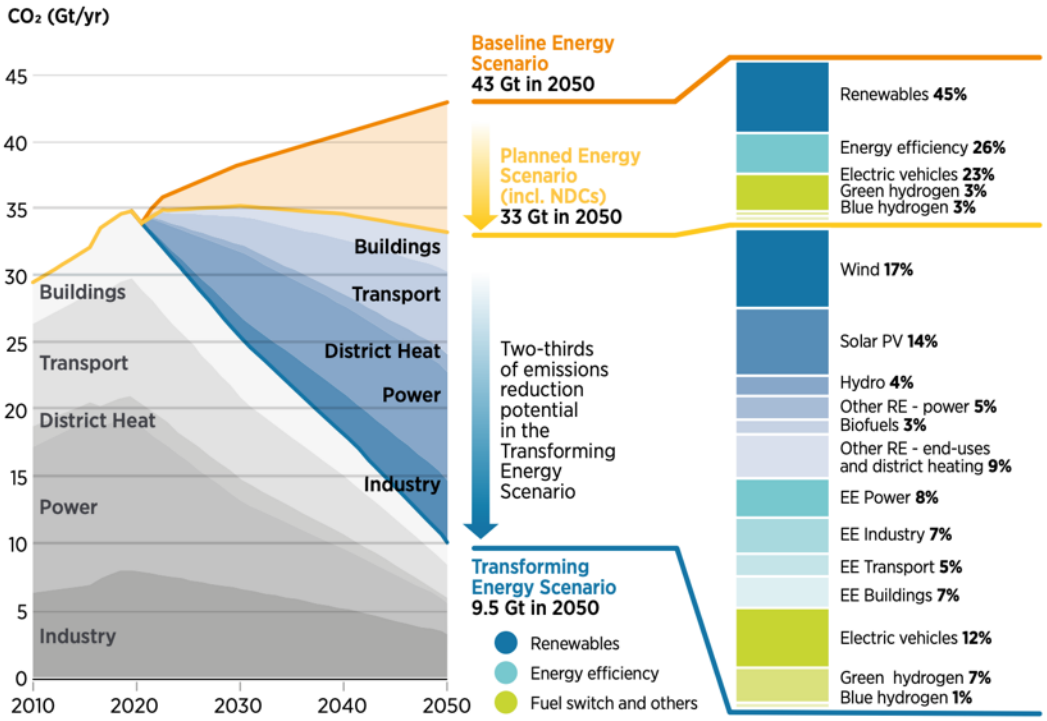
such as taxation, incentivisation and certification, and soft measures, such as public awareness campaigns and labelling schemes.

While taste, comfort and price are fundamental to consumer choices, researchers have documented that health and environmental benefits also have significant impact on consumers preferences. Key to many of the transformations needed are behavioural changes of the consumers. To achieve the scale of the energy and food sector transformation needed the consumer has a strategic position as the driver of demand. Overall societal norms and personal choices will therefore play a central role in reaching the long-term goals of net-zero.

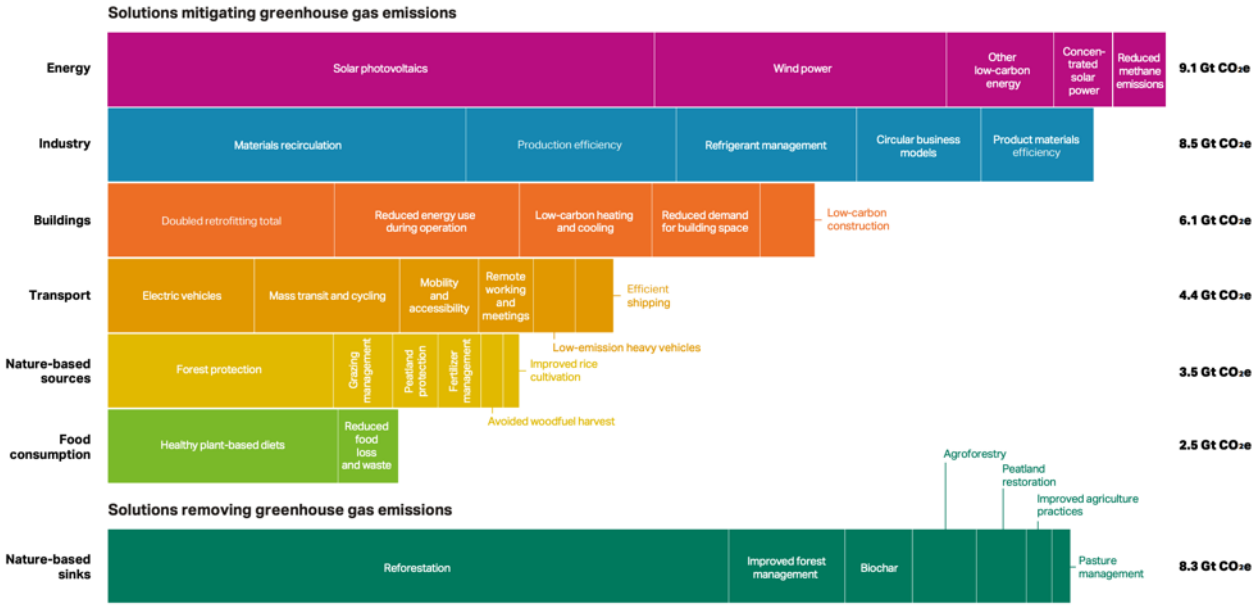
Finally, global cooperation is key to the planetary stewardship needed to react a net-zero world. Cooperation stands as one of the most potent forces within democratic societies. Throughout history, remarkable accomplishments have arisen from the synergy of cooperation. Examples include addressing the ozone layer depletion, combatting acid rain, globally prohibiting atmospheric nuclear testing, and developing a COVID-19 vaccine in record time. Now, we must collectively re-evaluate our connection with Earth and take the necessary actions to restore its stability.

Annex

Annex 1 – IRENA Roadmap to Net-Zero[49]



Annex 2 - Gaffney's Exponential reductions Roadmap by 2030[50]



[49] Figure from IRENA, Global Renewables Outlook: Energy Transformation 2050
[50] Figure from: Falk J., Gaffney O., 2020. Exponential Roadmap - Scaling 36 solutions to halve emissions by 2030 p.18

Annex 3 - EAT-Lancet commission Scientific targets for a planetary health diet, with possible ranges, for an intake of 2500 kcal/day.[51]

	Macronutrient intake grams per day (possible range)	Caloric intake kcal per day
Whole grains		
Rice, wheat, corn and other	232	811
Tubers or starchy vegetables		
Potatoes and cassava	50 (0–100)	39
Vegetables		
All vegetables	300 (200–600)	78
Fruits		
All fruits	200 (100–300)	126
Dairy foods		
Whole milk or equivalents	250 (0–500)	153
Protein sources		
Beef, lamb and pork	14 (0–28)	30
Chicken and other poultry	29 (0–58)	62
Eggs	13 (0–25)	19
Fish	28 (0–100)	40
Legumes	75 (0–100)	284
Nuts	50 (0–75)	291
Added fats		
Unsaturated oils	40 (20–80)	354
Saturated oils	11.8 (0-11.8)	96
Added sugars		
All sugars	31 (0–31)	120

[51] Willett W, Rockström J, 2019. Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems, The Lancet

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With the support of the Erasmus+ Programme of the European Union

What can citizens do

CHAPTER 5

SALMINEN, SONJA M. B.
MARCH 2021 | LET'S ACT! ERASMUS PLUS PROJECT

What can citizens do

Lesson 4 – Let's Act

What can Citizens do?

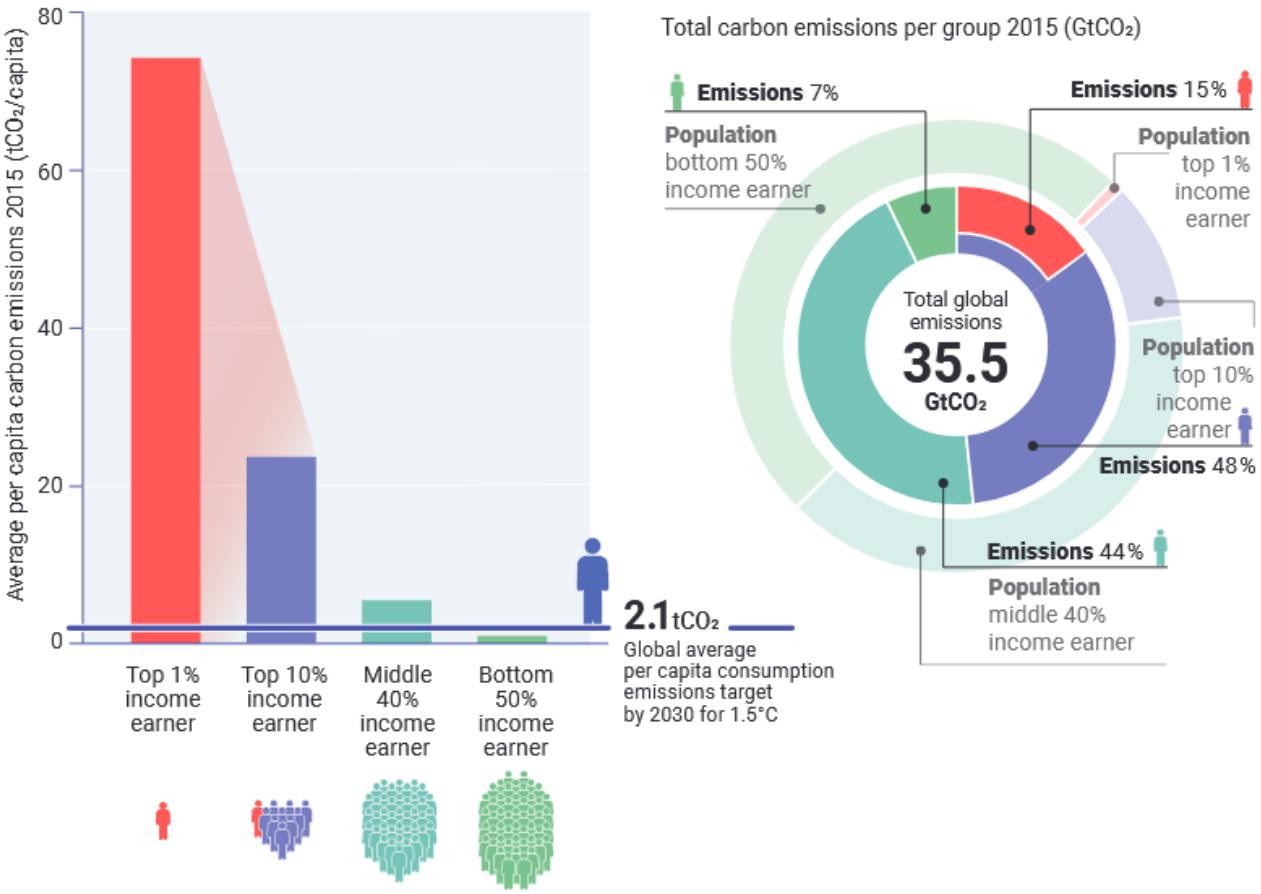
We know that climate changes are made by humans. The good news is that it means that we humans can stop it again.

The present challenges of climate change; unsustainability are intertwined with problems of violence and equality between economies, people, genders, and countries. In order to create the transformation needed to make the planet habitable for future generations changes must happen in all layers of life. All people need to engage in a variety of actions, which will create the transformation of our systems and lives. Both policymakers, business leaders, role models, and individual citizens must act innovatively, immediately, and engaged to create necessary changes. Young people especially have always had a strong potential for changing the world.

We all need to act now

Consumption in households is responsible for at least two-thirds of global greenhouse gas emissions[1], so a systemic change and a transformation of individual behavior are necessary for a sustainable future. Changing one's mindset, understanding oneself as part of the planet – not above it – and actions need insight, awareness, and ethics. This lesson is about how we can educate about change and actions and the type of actions that need to happen on many levels to reach the Agenda 2030. The transformation about change within us, to create relations to nature and each other, understanding oneself as part of the planet – not above it – and create ready action.

[1] Figure and estimates are from UNEP Emission Gap Report, 2020, https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/34432/EGR20ch6.pdf?sequence=3, chapter 6 Bridging the gap – the role of equitable low-carbon lifestyles.



1. Per capita and absolute CO2 consumption emissions by four global income groups in 2015

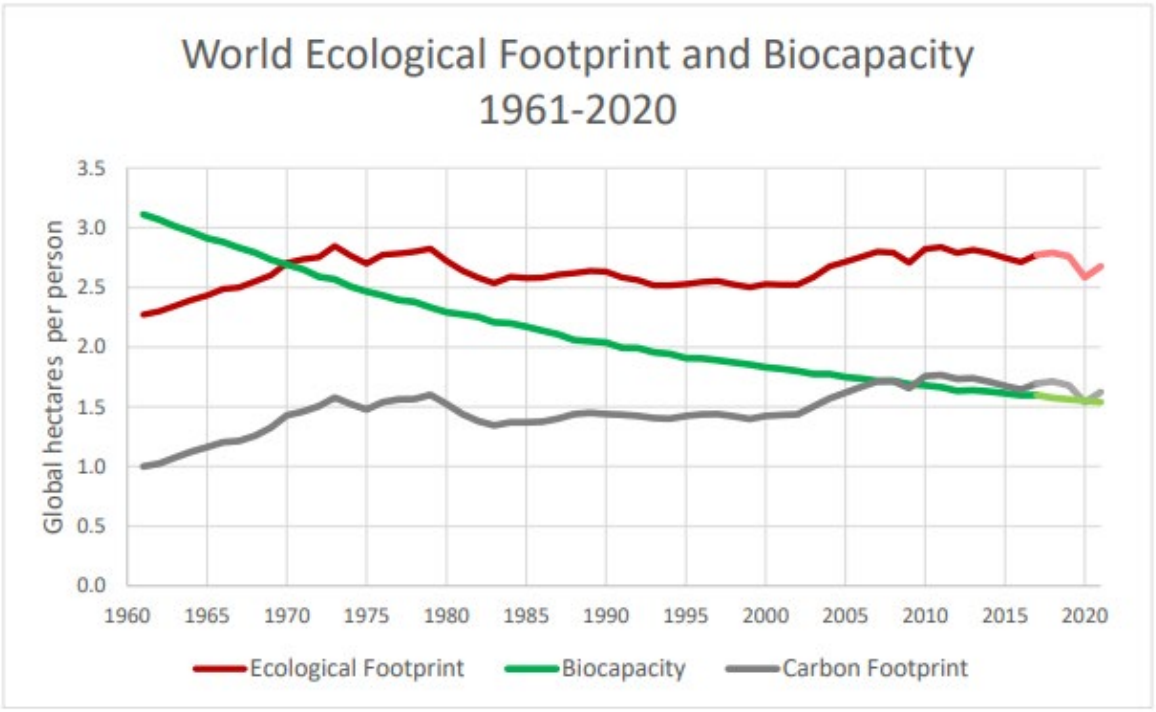
There is a strong correlation between income ad emissions, and there is a very unequal global distribution of emissions connected to consumption. It has been found that the emissions from the highest income groups can be as high as double that of the bottom 50 % of income groups!

Figure 1 shows estimates of the per capita CO2 emissions from different income groups. Further, it shows that individuals in the global top 10 percent of income earners need to reduce their emissions connected to consumption by at least 10 %. The top 1 % however should reduce by at least 30 %[2].

Acquiring a lot of information and learning in depth about the consequences of one's consumption patterns and what it does to the planet is not enough. We have known about the acidification of our oceans, the lacking biodiversity, land system change, and the other environmental dangers to our planet for more than 40 years. This huge amount of information has not started serious and timely action. Over and over again we hear that despite the Agenda 2030, warnings from researchers, UNFCCC[3], indigenous groups, and many

[2] Ibid p. 63.
[3] UNFCC, Climate Change 2022: Impacts, Adaption and Vulnerability Climate Change 2022: Impacts, Adaptation and Vulnerability | Climate Change 2022: Impacts, Adaptation and Vulnerability (ipcc.ch).

others that new records have been set in emissions from agricultural production, transportation, and planet overshoot day[4]. We know now that information is not enough.



2. World Ecological Footprint and Biocapacity 1961-2020 in global hectares per person. The red line is to total ecological footprint per person. The grey line is the carbon footprint per person. The green line shows the biocapacity per person.

If we humans are to fit within planetary boundaries learning how to develop capacities to relate differently to each other and the planet will be essential[5]. We need to understand that humans are not above all but part of life on the planet. We must never separate humanity from other non-human life. "It will be essential for learners to develop capacities to face a new complex, changing and challenging reality with a deep sense of social and ecological accountability[6]". A possible route can be to change from the transmission of static competencies and content to facilitate learners' capacities for ongoing self-reflexivity, accountability, and discernment. The old-fashioned way of transmitting knowledge from teacher to student is obsolete in this regard and should be interchanged with encouraging reflexivity, critical sense, and connection and relation to nature of the students.

Understand your ecological footprint

Compliance with the 1.5°C goal of the Paris Agreement will require reducing consumption emissions to a per capita lifestyle carbon footprint of around 2 to 2.5 tons of CO^2 by 2030, and an even smaller 0.7 tons by

[4] Earth Overshoot Day Earth Overshoot Day 2021 Home - #MoveTheDate.
[5]Tereza Čajková: Why is transformative education a vital response to the multiple challenges of the future? Bridge 47, 2021. https://www.bridge47.org/resources/07/2021/foresight-and-sdg-47-publication.
[6] IBID p.4.

2050[7]. Most climate mitigation pathways that seek to keep temperature rise to within 1.5°C envisage a major role in lifestyle change.

To understand how much change is needed, individuals can measure their footprints. The concept of the carbon footprint was conceived in 1990 by Mathis Wackernagel and William Rees and is now widely used by scientists, businesses, governments, and individuals[8].

It works by calculating the demand for and the supply of nature. This way we can take a closer look at our planet's biological power to regenerate life. The calculation measures the assets that an individual requires to produce the products for consumption and the natural resources needed to absorb its waste, especially carbon emissions. Further, the calculator tracks the use of productive surface areas: cropland, grazing land, fishing grounds, forest area, and any other carbon demand on land. On the supply side, the biocapacity of a nation represents the productivity of its ecological assets: cropland, grazing land, forest land, fishing grounds, and built-up land.

The ecological footprint measures how fast we consume resources (energy, settlement, timber/paper, food/fiber, seafood) and generate waste compared to how fast nature can absorb our waste and generate new resources.

Countries, cities, companies, and individuals can measure their carbon footprints. Earth Overshoot Day[9] marks the date when our demand for ecological resources and services in a given year exceeds what the planet can regenerate in that year. In 2021, it fell on July 29. On that date, we had spent what the planet could regenerate for a year. By measuring the national carbon footprint, it is possible to see different consumption patterns.

The calculation of individual footprints is a complicated affair and takes some time and effort. There are several calculators[10] around and they are an important way towards awareness and the realization of one's complicity in the complex climate change.

The calculator will first establish your country which will account for a certain amount of your footprint. Then the calculator will invite you to answer questions about your consumption of animal-based products, local or transported food, housing type, and housing material, the size of your household, electricity consumption, energy efficiency appliances, renewable energy consumption, and the amount of waste, transportation, vehicles, carpooling, and flight travel. In some of the questions, the individual can add details to improve accuracy.

The calculator from Global Footprint Network calculates your personal Earth Overshoot day and how many Earths were needed if everybody on the planet lived like you. This calculator also invites you to share your

7 Intergovernmental Panel on Climate Change [IPCC] 2018.
8 Mathis Wackernagel and William Rees: Ecological Footprint: Managing Our Biocapacity Budget, 2019.
9 https://www.overshootday.org/.
10 https://www.carbonfootprint.com/calculator.aspx, https://www.nature.org/en-us/get-involved/how-to-help/carbon-footprint-calculator/, https://www.footprintcalculator.org/.

feelings after the calculation and explore the data further. At the end of the calculation, The Global Footprint Network shares its solutions regarding cities, energy, food, population, and planet.

Understand your Slavery footprint

The present global problems are interconnected. The lack of planetary sustainability is connected to many different types of violence, gender inequality, climate change, mental health crisis, economic instability, lack of democracy as well as violation of human rights. To understand parts of this, we can check *how many slaves work for us*[11].

Famous international brands are often produced with the help of bonded/forced labor or hidden slavery. The brands are not always aware of how the production conditions are or where the materials come from in all the different steps in the supply chains. Slaves or forced laborers can often be found in fields, mines, and the processing of raw materials.

International Labour Organisation estimates that around 40.3 million people were victims of modern slavery in 2016. Out of these 24.9 million worked in forced labor, which means that they are working under coercion as domestic workers, in construction, factories, farms, fishing, and in the sex industry[12]. In many cases, their products and services end up in seemingly legitimate commercial channels. Women and girls are disproportionately affected because they account for 71 % of the total. Women and girls represent 99 % of forced labor in the commercial sex industry and 58 % of the other sectors. Around 18 % of people subjected to forced labor exploitation are children.

On the slavery footprint webpage, you can test how many slaves work for you according to your lifestyle and consumption patterns. The survey allows users to input data about their consumer spending habits, which then outputs a graphical "footprint" of the user's participation in modern-day slavery. This way you can increase your awareness and be engaged to take action towards addressing the use of forced labor.

Demand Public and Private Action and Responsibility

In 2021, the eyes of the world were glued to COP26[13] in Glasgow extending hope that the 1.5C target was kept alive and to finalize the outstanding elements of the Paris Agreement. Unfortunately, the COP unintendedly excluded both people with disabilities and attendees from Global South while including business, government, and UN officials at the expense of researchers and CSOs. The global pandemic was another reason for the summit to be less accessible and inclusive than previous COPs.

[11] https://slaveryfootprint.org/.
[12] Global Estimates of Modern Slavery. Forced labour and forced marriage, Geneva 2017. https://www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/documents/publication/wcms_575479.pdf.
[13] https://ukcop26.org/.

On a positive note, the summit saw countries like India pledge to go carbon neutral by 2070 and richer nations committed to double funding to help low-income countries deal with damaging climate effects. Further, it was agreed that world leaders will report their progress on emissions cuts every year.

Regrettably, these results and promises are not to meet the 1.5C target[14]. Researchers from Wageningen University, the Netherlands has calculated that even if all pledges from COP26 are implemented temperatures are still projected to rise 2.4C by 2100[15]. There are serious disagreements on definitions and the details of implementation regarding both energy types and net-zero commitments. All these questions and more need to be informed by research in the future.

Role of policymakers

Overall, it is the role of policymakers and national governments to make informed decisions and to pass laws, rules, and regulations as well of securing funding that can contribute to the lowering of CO2 emissions. There is a huge difference between the economic situations of the countries in the world and their capacity for taking democratic and lasting decisions.

To make informed decisions policymakers are dependent on precise information about the consequences of climate change, perceptions, adaption options, and perspectives of the various benefits – all created by research. The government must integrate the information into broader policies: actions to mitigate CO2 emissions, measures to adapt to a changing climate, activities to increase public awareness, investments in monitoring and surveillance systems as well as research the policy-relevant uncertainties. The policy-makers must keep in mind that the issue of climate change cannot be seen in isolation from other global challenges such as poverty, inequality, and violence. Finally, it is pivotal that civil society, the citizens, and the voters keep on pushing the politicians for change.

There are several scientific uncertainties but decisions need to be made, nevertheless. Policy-focused assessments analyze the best information to answer questions from risk management. Hence, potential implications for the outcomes shall be addressed and explained to the decision-makers by policy workers. Decision-making with much uncertainty is not easy, but it has to be done. Two approaches can be used: The precautionary principle and the benefit-cost analysis.

Risk managers can apply the precautionary principle when there is a potentially serious risk and significant scientific uncertainty at the same time. The principle allows some risks to be unacceptable. The other approach the benefit-cost criterion weighs the benefits and costs of an action. This criterion emphasizes the efficient use of scarce resources but does not deal well with consequences in the far future. There is also the discussion on how to measure benefits and costs at all and among different societies.

Slowing down or halting the buildup of greenhouse gasses is an important response option. The inertia in the climate system creates a long temporal lag between the reduction measures and the slowing down of

[14] COP26 climate pledges: What scientists think so far. 05 November 2021 accessed 19.02.2022. https://www.nature.com/articles/d41586-021-03034-z.
[15] Glasgow's 2030 credibility gap: net zero's lip service to climate action. Published 2021/11/09 accessed 19.01.2022. https://climateactiontracker.org/publications/glasgows-2030-credibility-gap-net-zeros-lip-service-to-climate-action/.

the consequences. Another option is **adaption**. This means enhancing the resilience of systems that are vulnerable to climate variability. A third important response is **information and communication**. There are health impacts, strategies, monitoring, and surveillance. Everything is needed for public support of government decisions.

To inform policymakers of the potential impacts of policy options, policy-focused assessment can be used by civil servants as a process. The best scientific information can be translated into meaningful terms for policies through analyzing and evaluating from multiple disciplines (sociological, economical) so that an understanding of the vulnerability across demographic groups.

Throughout this process, stakeholders should be engaged in consultations and kept informed through adequate risk information tailored to the needs of geographic areas and demographic groups.

Role of corporations

Corporate Social Responsibility

While the UN has guidelines for companies that they must not harm, the local communities in which they operate there are no rules stating that the companies should improve them. This is included in the SDGs, though.

Most companies have long practiced some form of corporate social and environmental responsibility with the broad goal of contributing to the well-being of the communities and society they affect and on which they depend. CSR is certainly a trend and in the past years, sustainability has become a market condition, which means that most companies need to consider the sustainability of their raw materials, production, human resources as well as distribution and services.

The main goal of CSR is to align the social and environmental activities of the company with its business purpose and values. Companies can become socially responsible by integrating social, environmental, ethical, consumer, and human rights concerns into their business strategy and operations as well as following the law.

The way that companies understand CSR will of course vary. Sometimes they are guided by an understanding that they should measure their social and environmental impact along with their profits – profit, people, and planet. CSR can be broken into four categories:

Environmental responsibility. Companies should behave as environmentally friendly as possible. Common CSR actions can be recycling, waste management, water management, renewable energy, reusable materials, 'greener' supply chains, reducing paper use, increasing reliance on recycled or partially recycled materials, offsetting negative environmental impact by planting trees, funding research, and donating to related causes.

Ethical Responsibility. Ensuring that the company is operating fairly and ethically including fair treatment of all stakeholders, leadership, investors, employees, suppliers, and customers. Common CSR actions can be: higher minimum wages to achieve a “livable wage” and materials, components, and ingredients are

sourced to free trade standards i.e. not resulting from slavery or child labor, and ethical branding and marketing – no manipulation or false advertising.

Philanthropic Responsibility. The company has an aim to actively improve the world and community. Common CSR actions can be a donation of earnings to a cause, providing volunteers, creating own charitable trust, capacity building of local employees, basic adult education, and supporting local economic growth.

Economic Responsibility. The company backs its financial decisions in its commitment to doing good in the areas listed above. The end goal is not to simply maximize profits, but positively impact the environment, people, and society.

United Nations Global Compact is the voluntary global framework for companies and stakeholders to create a better world. It is a call to companies to align their strategies and activities with human rights, the rights for labor, environment, and anti-corruption and to act for the advancement of society and the planet[16]. More than 12,000 companies all over the world are participating in this network.

Green business models

It is necessary to create business models which have less impact on the environment and at the same time are economically viable. Hence, the objectives of green business models are to improve energy and resource efficiency, competitiveness, and profit. There are many advantages of these types of business: reduced material costs and reduced garbage reduced CO2 emissions, less consumption of new materials, stronger green profile and improved visibility, improved competitiveness, and the bottom line.

1. **Industrial symbiosis** is a type of cooperation where the surplus or residual product from one company is reused as a resource in another company. This will create economic value for both when the costs will be reduced and the environment will also win. Examples of this:
    1. Garbage used as new material for a product. This reduces garbage costs - trash from the shrimp industry can be used as animal feed. Coffee grounds can be used to add to the compost because it is rich in nitrogen and can give the bacteria the needed energy to convert organic material.
    2. Surplus energy used as income instead of costs - surplus energy from a plan used for cooling servers.
    3. Crafting beer from waste bread from restaurants and shops.
- **Product life extension** through repair workshops or cafes.
    1. Repairing smartphones, laptops, clothes and smaller machines.
    2. Plant-based technology spray that can extend the life of fruit and vegetables.
- **Circular economy** is about keeping the materials and the product in the economy as long as possible with the highest possible value in the products. This is done through minimizing waste, recycling of materials or prolonging the life of the products. This way valuable material is saved, and the climate footprint is reduced. Examples of this:

[16] https://www.unglobalcompact.org/.

1. Sustainable and recyclable packaging types for takeaway food

- **Sharing models** facilitates the sharing of products that are under-utilised. This way the demand for new products and the need for new raw materials are reduced.
    1. Sharing drills and tools for maintenance.
    2. Sharing clothes
- **Product as a service** where services are marketed rather than the products. This will improve incentives for green product design and more efficient product use.
    1. Renting out clothes
- **Recovery and recycling** where waste is used as raw materials for new products.
    1. Collecting organic coffee grounds from cafés and restaurants and selling it as fertilizer.

On top of this, there is brand-new technologies with innovative sustainable ideas. Spinnova is a company with physicists who have invented a new method of how to use organic material from trees to produce fibres for the textile industry. Almost any biological material can be transformed into microfibres (nano celluloses). From this cream-like material any type of fibre can be produced without chemicals and with a small amount of water.

Socio-Economic Enterprises

Social enterprises are businesses with a twist. Sometimes they are operated by a non-profit organization and other times by a for-profit company. All social enterprises have two goals: to achieve social, cultural, community economic and/or environmental outcomes - and to earn a profit.

When profit meets social responsibility, wonderful ideas emerge. Here are some examples.

- Communal laundry with alternatively abled staff which serves as a place for rehearsal for life skills, courage and dreams. The staff helps residents in the area and runs and fetches and delivers service.
- ICT firm for neurodivergent people which offers consultancies, recruitment, youth education and club
- Catering company with Middle Eastern Food and asylum seekers and refugees as staff
- Collecting trash on construction sites by homeless and socially exposed people
- Previous homeless and asylum seekers take care of bees in urban settings.
- Blind people create different types of handicrafts and sell it.

On the surface, many social enterprises look like traditional businesses. When looking more deeply it is possible to discover that mission is at the center of the business and that income generation is playing an important supporting role.

Another goal of social enterprise is the training and employment of people who are typically excluded from the mainstream labour market. This means that individuals achieve both capacity and self-reliance, while their communities are impacted and the reliance on the social safety nets lessens. In some social enterprises only, this element is there and not the profit objective.

The surplus earned will usually be redirected back into the business in pursuit of social and environmental goals.

Good Life Goals

Many people around the world know about the SDGs but often they are not fully aware of how they should act and what they shall do to contribute to reaching the goals. The Good Life Goals[17] represent an effort to help the global audience to recognize the vital role of individual action in achieving the SDGs. They consist of 17 smileys and rephrased goals into actions, 85 suggestions for us all to contribute towards the 2030 agenda and manuals. The Good Life Goals have been designed to be used by policy-makers, businesses, civil society, creatives and educators who want to communicate about the SDGs.

The goals are created with a similar structure. They all have a simple headline with an associated emoji, and this is followed by five actions. The first action is a "learning" ask. This is the most accessible action. The next three actions are challenging behaviour and lifestyle changes/costs/habits. One of each action seeks to be positive, and the penultimate action is most relevant to middle-class over-consumers = the hardest ask. The final action is a demand for change to leaders both in the political and business sphere as well as in the community at large.

[17] https://sdghub.com/goodlifegoals/. The Goals have been created in collaboration between UN 10YFP & Futerra, supported by Governments of Japan and Sweden, IGES, SEI, UNESCO, UNEP and WBCSD.

1. Help end poverty
2. Eat better
3. Stay well
4. Learn and teach
5. Treat everyone equally
6. Save water
7. Use clean energy
8. Do good work
9. Make smart choices
10. Be fair
11. Love where you live
12. Live better
13. Act on climate
14. Clean our seas
15. Love nature
16. Make peace
17. Come together

Good Life Goals for Business

The Good Life Goals include manuals for communication and for world-changing business as well. The Good Life Goals offer a new way of thinking about sustainability by using the goals as an engagement tool for staff and customers in any business. Behaviours which are connected to the products, services and corporate culture of any business can be transformed into positive actions for sustainability. Basically, the Good Life Goals can be used to create engaged customers to drive positive impact, to engage employees in line with the sustainability ambitions of the business and to innovate products and services which support sustainable lifestyles.

In order for any business to get started with the Good Life Goals, they should identify how the SDGs already play a role in the company and which priority areas could get help through the goals. After going through the 85 suggestions for actions, the actions most relevant for the particular business should be identified. This work could be done through a workshop with key employees. Next ideas for amplifying or activating the actions through your customers, employers or partners should be generated. Lastly, an action plan or project plan should be drafted where the next steps, resources required, and key stakeholders are listed with the most impactful ideas.

Examples of business action ideas:

1. Tony's Chocolonely pay a premium on top of the Fairtrade to farmers to provide farmers with a better income.
2. Vodafone and Sanku-PHC fight malnutrition by enabling small flour mills in rural Africa to add key nutrients to their flour.
3. Lloyds Bank encourages more people to be open about their mental health in cooperation with Mental Health UK.
4. Gap Inc help female garment workers in 16 countries to advance into management positions.
5. Barbie has created *Shero dolls* in order to honour inspiring female role models.
6. Levi's encouraged people to stop washing their jeans after a water crisis in Manila, Philippines.

7. IKEA is committed to 100 % renewable energy through membership of RE100.
8. CanGo is transforming the motorcycle taxi industry in Rwanda.
9. Rimmel created a safe online space for young people with the Cybersmile Foundation.
10. Hilfiger launched a clothing line for people with physical disabilities.
11. Airnb and Migraflix launched a selection of cultural experiences curated by refugees and immigrants.
12. The North Face released a collection of refurbished clothing called *Renewed.*
13. Interface created a commitment for how business can create better climate called *The Climate Take Back.*
14. Adidas created a collection of sportswear and sneakers made from ocean plastic in partnership with Parley for the Oceans.
15. REI highlighted the beautiful possibilities of reconnecting with nature in *Path Ahea.*
16. Lush supports the Peace Community of San José de Apartadó, Colombia, by purchasing organic cacao beans.
17. Kao promoted the SDGs by sponsoring a SDG train wrap for one year in Osaka.

Act yourself

How can we change? What is the best behaviour?

The household impact on the environment mainly comes from food, transport, housing and consumer goods. The biggest impact stems from eating meat, living in badly insulated houses and flights. Buying greener and eco-friendly should be paired up with less consumption in general for instance buying more durable products or geting them repaired. What is sustainable lifestyle in one area of the world might not be in another. It depends on the full life cycle of the consumer goods, how it is produced and with which type of fuel. Sometimes people can be very well aware of the need to act sustainably but choose not to due to a variety of reasons from lack of access, fewer options or that the default option is not sustainable. There are factors that we as individuals can control and some that we cannot.

Civil Society Organisation

Civil Society Organisations or **CSOs** are non-state actors. Usually, they do not have the objective to generate profit or to get governing power. CSOs unite people with shared goals and interests. These organisations play a critical role in fostering advocacy in policy development. Very often, the CSOs will also identify development priorities and propose practical solutions. Another important role for the CSOs is to criticize governments' policies[18].

[18] Delivering the Post-2015 Development Agenda. Opportunities at the national and local levels. UNDP 2014. https://sustainabledevelopment.un.org/content/documents/1909UNDP-MDG-Delivering-Post-2015-Report-2014.pdf.

The extent to which governments listen to constructive criticism varies by country. There is a huge risk for civil society reports to be ignored and that crucial governance failings remain unaddressed.

The role of CSOs cannot be exaggerated as they often serve as drivers for sustainable development. The SDGs are now a natural foundation in CSOs to the extent that they almost do not communicate it. Many of the major CSOs were part of the four tracks launched to create an inclusive process when forming the development of the SDGs. The CSOs were part of the tracks consisting of a high panel of prominent people, consultations with governments, companies and civil society and thematic consultations. Some of the organisations that work for sustainability are:

Greenpeace is a global movement, which uses peaceful protest and creative communication to expose global environmental problems and promote solutions that are essential to a green and peaceful future.

Clean Clothes work to improve the conditions in the global textile industry

The Restart project helps people learn how to repair their broken electronics and rethink how they consume them in the first place.

Plant for the planet is a movement, which aims to plant 150 trees for each human being on the planet. Stop talking – plant a tree!

World Saving Hustle is a networking organization that works towards creating a better world by fighting for nature, animal and human rights. They believe that the problems we are facing today are interconnected.

Global Footprint Network is an international research non-profit that among many other things has calculated Earth Overshoot Day. Their vision is to help end ecological overshoot by making ecological limits central to decision-making.

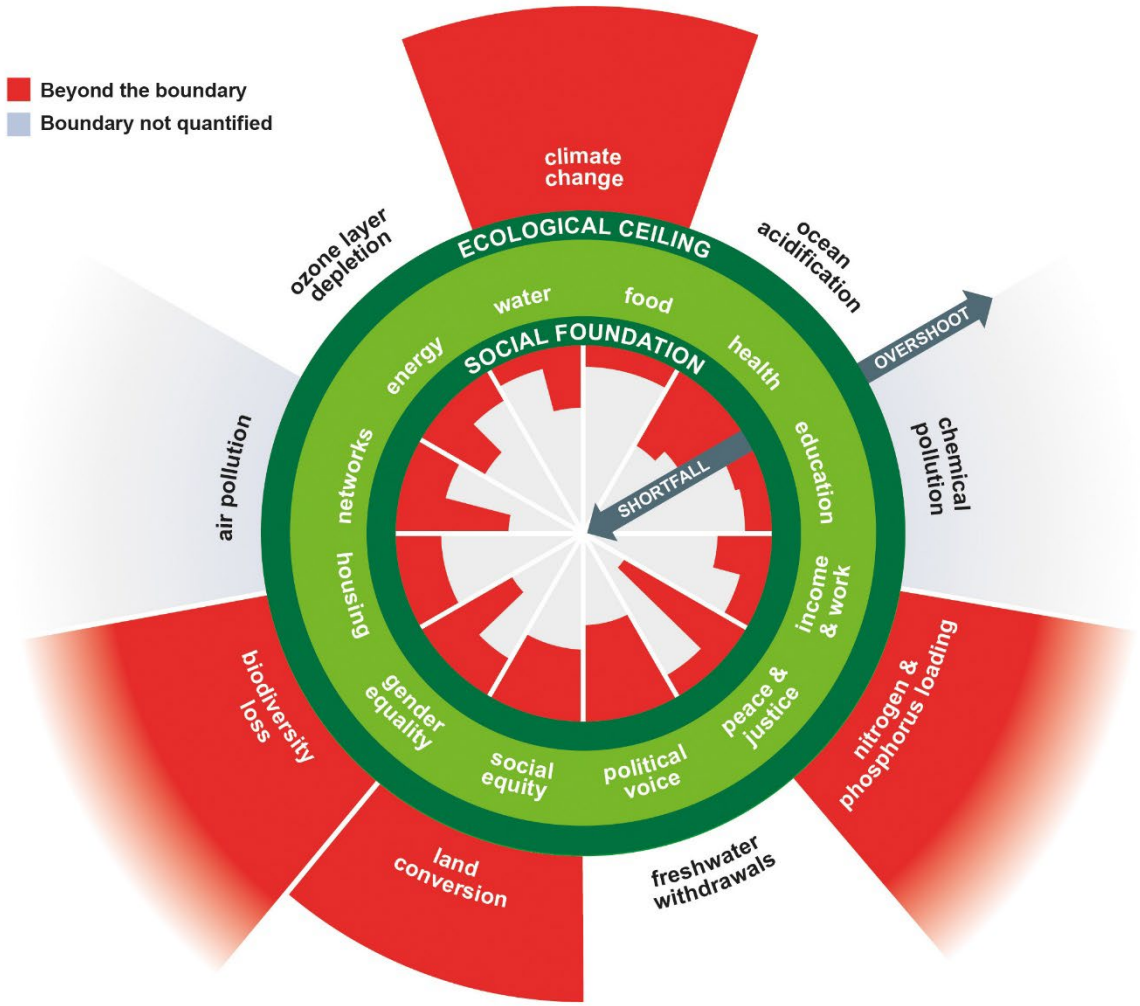
Trainings.350.org is supporting organisations and individuals in getting together and cooperating both offline and online.

Fashion Revolution is a global movement, which works for sustainability and ethics in the fashion industry. The movement consists of designers, academics, writers, business leaders, policymakers, brands, retailers, marketers, producers, makers, workers and fashion lovers. The aim is that the fashion industry produces clothes in a more safe, fair and environmentally friendly way for example through cooperation from cotton production to consumers.

Doughnut Economics Actions

The development goals about the sustainability of the oceans and about climate change are fundamental for achieving other goals of less inequality and gender equality.

The concept of the doughnut economy stems from the book with the same title authored by Kate Raworth[19]. Here she describes how we create a good life on the planet Earth in balance with climate and the environment for everything living. The model of the doughnut economy is able to describe the best way of living while considering climate, environment and social conditions for humans. The illustration below shows the state of humanity and the planet in the doughnut economy concept. The illustration shows how we have overshot the planetary boundaries and the basic social foundation is in shortfall.



[19] Kate Raworth: *Doughnut Economics: seven ways to think like a 21st century economist*, 2017.

The model has two circles, which describe two dimensions: the planetary boundaries and the social foundation. Both dimensions need to be assessed and balanced when making important choices for development.

The outer circle describes the planetary boundaries according to the ecological ceiling under which the existence of the planet and its systems operate. The nine planetary boundaries are suggested by scientists led by Johan Rockström and Will Steffen. The nine planetary boundaries are:

1. **Climate Change**. When greenhouse gases such as carbon dioxide, methane and nitrous oxide are released into the air, they enter the atmosphere and amplify Earth's natural greenhouse effect. This means that more heat is trapped in the atmosphere. This results in global warming, and its effects include rising temperatures, more frequent extremes of weather, and sea level rise.
2. **Ocean acidification.** About a quarter of human-emitted carbon dioxide ends up being dissolved in the oceans, where it forms carbon dioxide and lowers the pH of surface water. The acidity reduces the presence of carbonate ions, which are an important building block for the formation of shells and skeletons in many marine animals. The lack of an ingredient makes it difficult for organisms such as corals, shellfish and plankton to grow and survive, endangering the marine ecosystem and food chain.
3. **Chemical pollution and the release of novel entities**. When toxic compounds such as organic pollutants and heavy metals are released into the biosphere, they can last a very long time and possibly have irreversible effects. When they accumulate in living tissues, such as birds and mammals, they lower fertility and cause genetic damage, endangering ecosystems both on land and in the oceans.
4. **Nitrogen and phosphorus loading.** Reactive nitrogen and phosphorus are used a lot in agricultural fertilisers but only a small proportion is taken up by crops. The excess runs off into rivers, lakes and oceans. Here it causes algae blooms that make the water turn green. The algae blooms can be toxic, and they kill off life in the waters by starving it of oxygen.
5. **Freshwater withdrawals.** Water is essential for all life and is widely used by agriculture, industry and households. Excessive withdrawals of water can impair or dry up lakes, rivers and aquifers. This damages the ecosystems and alters the hydrological cycle and climate.
6. **Land conversion.** Conversion of land for human use and economic activity e.g. turning forests and wetlands into cities, farmland and roads diminish wildlife. This process removes the habitat for wildlife and undermines the cycles of water, nitrogen and phosphorus.
7. **Biodiversity loss.** Human economic activity causes reduction in number and variety of species. The ecosystems of the earth become more vulnerable. Abrupt and irreversible changes to ecosystems reduce their resilience. The capacity of the planet for sustaining life and providing ecosystem services is disturbed and lowered.
8. **Air pollution.** The emission of aerosols (small particles) such as dust, smoke and pollutant gases has a negative impact on the health of species. These micro-particles also interact with water vapour and hence they can affect precipitation and cloud formation. This means that regional rainfall patterns can be altered, and the timing and location of monsoon rains can shift.
9. **Ozone layer depletion.** Some economic activity emits gas that damages our ozone layer. CFCs (chlorofluorocarbons can when released enters the stratosphere and disturbs the ozone layer. This layer protects the Earth from harmful UV radiation, so the depletion may result in skin cancer in different species.

If these boundaries are exceeded, the environment and the climate of the Earth will be negatively impacted. The outer circle is based on research from Stockholm Resilience Centre[20]. Unfortunately, we human have already exceeded three of the boundaries: climate change, biodiversity loss and the biogeochemical flow boundary. The overshoot of the planetary boundaries is gauged via a set of indicators and data as seen in the table below[21]:

[20] https://www.stockholmresilience.org/research/planetary-boundaries/the-nine-planetary-boundaries.html.
[21] The table is from. Schoenmaker, Dirk: A Framework for Sustainable Finance, 2018. www.cepr.org. https://www.researchgate.net/publication/323764756_A_Framework_for_Sustainable_Finance

Table 1: The ecological ceiling and its indicators of overshoot

Earth system pressure	Control variable	Planetary boundary	Current value and trend
Climate change	Atmospheric carbon dioxide concentration; parts per million (ppm)	At most 350 ppm	399 ppm and rising (worsening)
Biosphere loss	Genetic diversity: rate of species extinction per million species per year	At most 10	Around 100-1,000 and rising (worsening)
	Functional diversity: biodiversity intactness index (BII)	Maintain BII at 90%	84% applied to southern Africa only
Land-system change	Area of forested land as a proportion of forest-covered land prior to human alteration	At least 75%	62% and falling (worsening)
Freshwater use	Blue water consumption; cubic kilometres per year	At most 4,000 km^3	Around 2,600 km^3 and rising (intensifying)
Biochemical flows	Phosphorus applied to land as fertiliser; millions of tons per year	At most 6.2 million tons	Around 14 million tons and rising (worsening)
	Reactive nitrogen applied to land as fertiliser; millions of tons per year	At most 62 million tons	Around 150 million tons and rising (worsening)
Ocean acidification	Average saturation of aragonite (calcium carbonate) at the ocean surface, as a percentage of pre-industrial levels	At least 80%	Around 84% and falling (intensifying)
Air pollution	Aerosol optical depth (AOD); much regional variation, no global level yet defined	–	–
Ozon layer depletion	Concentration of ozon in the stratosphere; in Dobson Units (DU)	At least 275 DU	283 DU and rising (improving)
Novel entities (e.g. chemical pollution)	No global control variable yet defined	–	–

Source: Steffen *et al* (2015).

The inner circle describes the social foundation, and it covers all the conditions, which create well-being for humanity. This sets out the basics of life that all humans should enjoy. These are both basic needs such as food, drink, and shelter but also derived needs, which create a good life such as education, equality and influence. The inner circle consists of 12 social dimensions inspired by the social priorities in the UN SDGs.

1. Health
2. Food
3. Water

4. Energy
5. Networks
6. Housing
7. Gender equality
8. Social equity
9. Political Voice
10. Peace and justice
11. Income and work
12. Education

We can measure the signs of deficiency and shortfall as:

1. **Food security.** The share of the population who is undernourished (11 % in 2014-2016, FAO).
2. **Health.** The share of the population which lives in countries where child mortality for children below 5 is higher than 25 per 1,000 live born (46 % in 2015, World Bank); and the share of the population who lives in countries where life expectancy at birth is below 70 (39 % in 2013, World Bank).
3. **Education.** The share of the adult population above 15 who are illiterate (15 % in 2013, UNESCO); and in the share of children between 12 – 15 years that are not in school (17 % in 2013, UNESCO).
4. **Income and work.** The share of the population which lives below the international poverty level (below $ 1, 9 per day)(13 % in 2012, The World Bank); and the share of youth (15-24 years) who cannot find work (9 % in 2014, ILO).
5. **Peace and justice.** The share of the population living in countries scoring 50 or less out of 100 in the Corruption Perceptions Index (85 % in 2014, Transparency International); and the share of the population living in countries with a homicide rate of 10 or more per 10,000 (13 % in 2008-2013, UNODC).
6. **Political voice.** The share of the population living in countries scoring 0.5 or less out of 1.0 in the Voice and Accountability Index (52 % in 2013, World Bank).
7. **Social equity.** The share of the population living in countries with a Palma ratio of 2 or more (the ratio of the income share of the top 10 % of people to that of the bottom 40 %), (39 % in 1995-2012, World Bank).
8. **Gender equality.** Representation gap between women and men in national parliaments (56 % in 2014, World Bank); worldwide earnings gap between women and men (23 % in 2009, ILO).
9. **Housing.** The proportion of the global urban population living in slum housing in developing countries (24 % in 2012, UN).
10. **Networks.** The share of the population stating that they are without someone to count on for help in times of trouble (24 % in 2015, Gallup); The population without access to the internet (57 % in 2015, ITU).
11. **Energy.** The share of the population lacking access to electricity (17 % in 2013, OECD/IEA); and population lacking access to clean cooking facilities (38 % in 2013, OECD/IEA).
12. **Water and sanitation.** The share of the population without access to an improved drinking water source (9 % in 2015, WHO/UNICEF); and the share of the population without access to improved sanitation (32 % in 2015, WHO/UNICEF).

This inner circle is based on the UN goals for sustainable development, the SDGs.

Between these two sets of boundaries lies a doughnut-shaped space that is both ecologically safe and socially just: a space in which humanity can thrive.

If the concept of the doughnut economy should live as more than just another radical idea, it needs to be developed into transformative actions. The Doughnut Economics Action Lab (DEAL)[22] provides various tools and suggestions to explore the Doughnut and its use in the work of individual organisations, companies and networks[23].

Individual actions

The SDGs emphasize that everybody has a responsibility in order to create a transformation of the world. Both individuals, communities, governments, civil society and businesses need to be mobilised. We know that social norms frame human behaviour however recent findings tell us that social norms as determinants for people's behaviour can change faster than commonly assumed. We need to change our norms, so they cause less harm to the planet and to people.

The following lists some of the values, skills (capabilities) and components of the agency that are supportive of the needed transformation towards sustainable development based on various references in the 'Human Development Report 2020'[24]. The list in the box is far from complete, there are likely to be other values, skills and aspects of agency that are specifically relevant to a particular partnership.

Example Values, Skills and Agency supportive of Sustainable Development

Values *"the principles that help you to decide what is right and wrong, and how to act in various situations"*	**Skills/Capabilities** *"an ability to do an activity or job well, especially because you have practised it"* *"the ability to do something"*	**Agency** *"the ability to take action, or to choose what action to take"* [36]
Values to do with **Stewardship of nature**: what it means to maintain or (re-) create a healthy ecosystem for nature and people, including: • Love for the beauty of nature (enjoyment, feeling and emotions) • Utility of nature • Environmental justice ('the rights of	Skills to do with seeing **Connections and Complexity**, for instance, the ability to: • Place specific phenomena in a wider context (systemic analysis) Skills to do with **Innovation**, for example, the ability to: • Apply critical	Being able to pursue **Quality of Life** through: • Health and health care • Education and lifelong learning • Work • Leisure Being **able to make choices**, particularly at a personal and

[22] https://doughnuteconomics.org/.
[23] See https://doughnuteconomics.org/tools-and-stories.
[24] Human Development Report 2020 | UNDP HDR.

nature') Values to do with **Living well**: what it means for people to live well, so they can lead fulfilling lives, including: • Human dignity (respect for self and others) • Equity (fairness, justice, equality) • Human rights • Identity and belonging • Collaboration • Compassion and solidarity • Valuing experiences and learning	thought • Think outside the box to explore solutions to problems • Plan and adjust plans at short notice when required	communal level in addressing challenges and seizing opportunities — including through: • Participation in political and environmental decision-making • Lobbying for or protesting against (proposed) decisions or actions • Consumption • Collective actions of social or cultural movements, grassroots and interest organisations

People do not act in a vacuum; our behaviour is shaped by factors influenced by the community, social norms, economic circumstances, technology as well as institutions. In other words, there are strong incentives for what we choose to buy as consumers, what companies produce and sell and how governments influence these matters.

Here is a list of suggestions for individual actions for children and youth[25]. Some of the suggestions have to do with the goals for sustainable development and some are great for having a better life. Research has shown that having a good life has a lot to do with a meaningful job, good health, and family relations and less to do with pursuing extrinsic values.

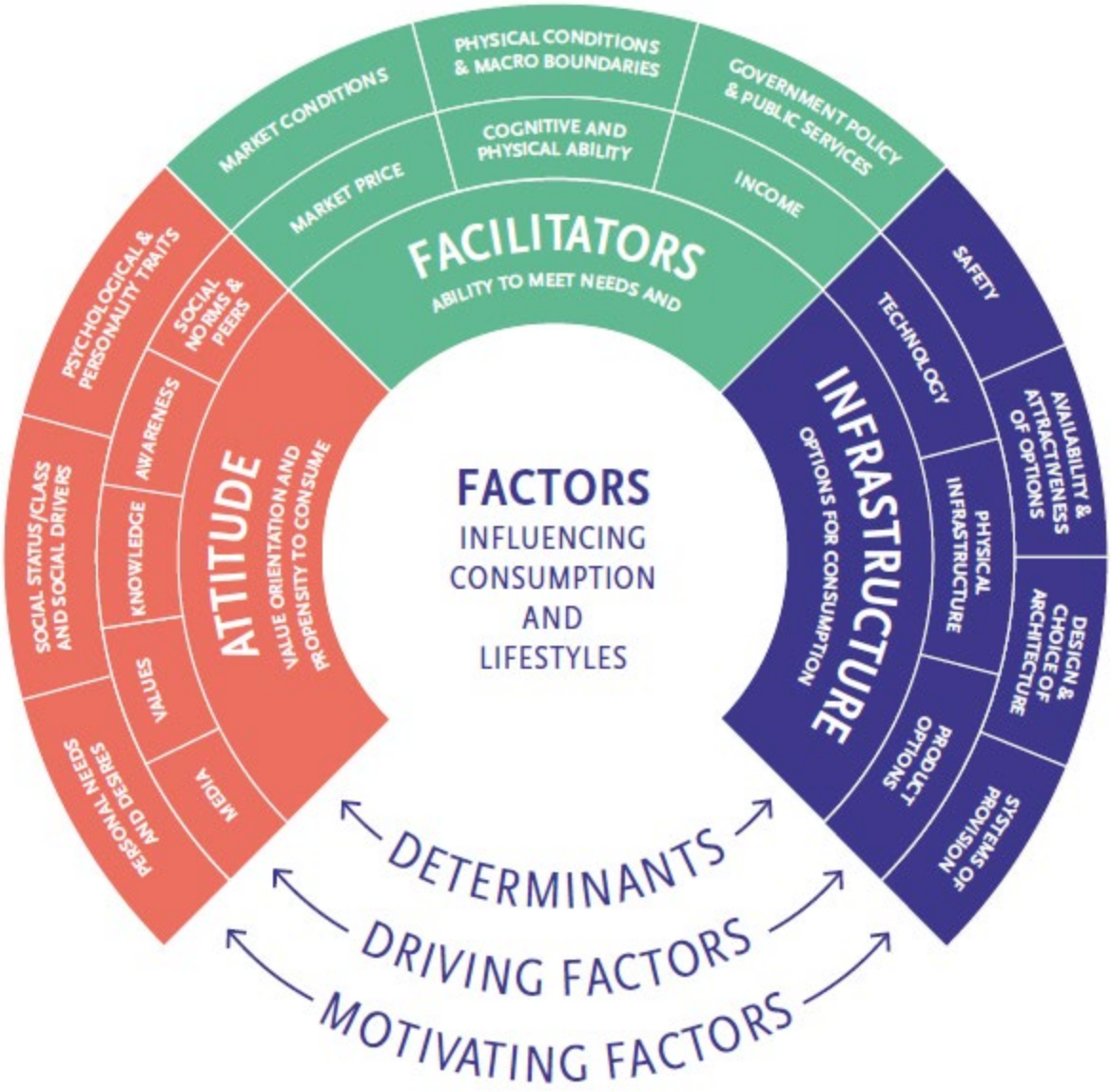
Basic actions	• Stay informed • Invent something • Improve something • Donate what you are not using. Second-hand shops can give new life to your used clothes, books and furniture. • Share ideas with your network
Planet actions	• Plant a tree • Repair something • Recycle as much as possible • Be aware about your ecological footprint and move it (measure it regularly)
Consumption actions	• Reduce your consume • Buy things without packaging • Support companies and shops which work with sustainability • Do not use plastic bags. Bring your own bag and container when you shop • Buy locally produced goods and avoid transportation • Buy smart, plan meals, and use shopping lists. You avoid the power of publicity and are not seduced to buy more than you need • Buy only sustainable fish and shellfish • Do not waste water. Be aware how you use water • Take shorter showers and avoid bathing in a tub because it needs much more water • If you have a dishwasher do not rinse the plates and utensils first • Save electricity by using electricity-saving sockets/power strips • Turn out the light when you are not using it • Save the heat • Save the a/c • Replace old machines with new more energy-efficient ones • Air dry hair and clothes instead of using a machine • Fill up the washing machine completely • Do not preheat the oven when you are baking • Unplug your charger when you are not using it otherwise it continues to use power • Buy new products from companies which recycle and who treat their employees well

[25] See also *The Lazy Person's guide to Saving the World,* https://www.un.org/sustainabledevelopment/takeaction/

	• Use matches and not lighters that uses fuel and plastic • Use fewer napkins when you eat street food • Buy second-hand clothes • Do not buy products which are the result of trade with wild and endangered animals • Ask for sustainable food options in restaurants and shops • Bring your own bag when you shop
Transport actions	• Use a bicycle, walk or take the bus. Drive less car
SDG actions	• Learn more about the SDGs. The more you know the more you can inspire others the bigger the chance that we will achieve the goals • Use technology to talk about the SDGs. Make a hackathon, a movie, a new company or something else. New Technology and inventions are important to achieve the goals • Share your knowledge about the SDGs with others, so that you can make up changes together • Find partners who are equally interested in achieving sustainable development, reducing inequality and climate change like you
Friendly actions	• Do acts of random kindness to people • Make others participate in your actions and great ideas • Help others in doing their homework • Promote peaceful and non-violent culture • Be there for everybody and have understanding for everybody. Some of your neighbours are probably refugees or immigrants with a difficult past • Report online trolls if you see someone bullying others • Hug a tree and kiss a frog. Enjoy creating relations to non-human species
Organisational actions	• Spend time in an organization that works with one or more of the SDGs • Donate money to an organization that works with one or more of the SDGs • Volunteer for collecting garbage and waste from beaches.
Food actions	• Avoid food waste! Take your leftovers home. Prepare only the food that you are going to eat • Eat less meat, poultry and fish - especially red meat. Support better agricultural production forms • Begin to compost at home – it is recycling of nutrients • Freeze fresh food and leftovers if you cannot eat it all. It saves food and money • Buy “funny” fruit and vegetables – lots of fruits and vegetables are thrown out because their size, shape or the color is not “right”

	• Support that surplus food from local shops can be donated to places that can use it e.g. drop-in centres for people who are having a hard time
Health actions	• Live healthily and have a good life. Eat with balance and get enough exercise • Do not smoke or drink too much • Get your vaccines • Learn how to avoid diseases such as HIV/aids, malaria and tuberculosis • Use a shovel and not a machine for removing the snow
Political actions	• Speak up and demand that national government engage in SDGs • Demand that politicians write laws that give equal access to health insurance for all • Talk about how women are paid 10-30 % less wages than men • Speak up about injustice in the workplace when you hear about it • Talk about climate change, so more children and youths know about it • Talk about the need to keep the ocean free of garbage • Demand that your local authorities make sure that you can dispose of your electronic devices in a good way. Electronic waste is traded illegally and is polluting the environment • Participate in the democracy in your school or local community • Know your rights and speak up about it, so that more know about them • Check how your food, smartphone, clothes, shoes, plastic are made • Use your political rights
Equality actions	• Be aware on language and behavior which discriminates against gender, ethnicity, body size, race, age, class, caste • Share positive stories about equality • Discuss acceptance of girls and women. They are more closely watched in regards to behavior, opinions, sexuality and their life in general • Talk about people who do not have access to toilets, so that the taboo can be broken. Much too many have to do the needy outdoors and this endangers health • Learn more about workplaces nationally and internationally. Learn how the companies work. Discuss it with friends
Home actions	• Limit your garbage. Make an effort to reduce how much waste you produce • Use a water bottle and a recyclable coffee cup • Do not use plastic straws • Print less. Write down digitally or in a notebook • Avoid receiving bank statements. Pay bills online or via the mobile.

Figure 5: Factors influencing sustainable lifestyles



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