MEETING THE 1.5°C CLIMATE AMBITION

MOVING FROM INCREMENTAL TO EXPONENTIAL ACTION
Meeting the 1.5°C Climate Ambition has been developed for the UN Climate Action Summit in September 2019. It is part of the 2030 Exponential Roadmap 1.5, which outlines sectoral pathways to halve greenhouse gas emissions by 2030 in order to reach net-zero greenhouse gas emissions by 2050.

The roadmap has been developed by a consortium of research institutes and networks, NGOs and businesses and builds on the 2018 Exponential Climate Action Roadmap 1.0, published for the Global Climate Action Summit (GCAS).
"The next few years are probably the most important in our history."

Debra Roberts
Co-Chair of IPCC Working Group II

CONTENTS

06 FOREWORD
10 MEETING THE 1.5°C AMBITION
16 A new worldview: our planet on the edge
20 The goal: net zero by 2050
22 The pathway: halve greenhouse gas emissions every decade
30 Scaling the solutions
38 CONCLUSIONS
41 Roadmap delivery and impact
We need a vision for a world free from fossil fuels and a pathway to achieve it. As co-chair of the United Nations Climate Action Summit’s ambition advisory group I welcome this report because it provides just that.

Our history is defined by momentous societal transformations: the industrial revolution, the women’s vote, civil rights, the end of apartheid in South Africa and the Green Revolution. Major leaps forward are driven by disruption from a combination of social movements, government policies, market confidence, new technologies and science.

These five forces are aligning once more. We are at the beginning of the mother of all transformations to stabilize Earth’s temperature at 1.5°C. The Fridays For Future movement and Extinction Rebellion have exploded onto the scene in the last twelve months and are changing how we talk about climate. More countries are discussing climate emergency declarations, and goals to reach net zero by 2050 or earlier. Businesses are calling for stronger legislation and investors are demanding climate-risk disclosure. Now zero-carbon technologies outcompete fossil fuels and this is killing old tech. And finally, science is highlighting the colossal risks of inaction, and the equally huge opportunities from a fast transformation. This will deliver energy and food security, cleaner cities, less pollution, healthier diets and economic growth.
Meeting the 1.5°C Climate Ambition is part of the second Exponential Roadmap. Together they articulate how far we have come and how far we need to go. Step by step, they chart how the world can move from incremental to exponential action – doubling the number of companies, cities and countries acting on climate, then doubling again and again. These are the exponential strategies now needed to cut emissions 50% by 2030 or earlier, then doing it again by 2040 and again by 2050. This is the Carbon Law pathway and you will be hearing a lot about it in these pages.

Along this journey we also need to store more carbon by protecting forests and peatlands and planting more trees on a truly unprecedented scale. We will need to turn agriculture from a source of carbon to a giant store, but this will enhance soils and improve crop yields. And we will need to protect Earth’s remaining wildernesses – the oceans and land that safely store half of our carbon dioxide emissions and shelter our biodiversity. This report highlights how:

- About 56% of potential emissions in 2030 could be reduced relatively easily with economically attractive solutions that can scale rapidly. This jumps to 64% if we use promising technologies that are unproven at scale.
- The energy sector has recently reached a tipping point where wind and solar outcompete fossil fuels in most regions of the world. The end may well be nigh for coal. Oil and gas will not be far behind. Expect the unexpected.
- We should not assume energy demand must keep rising. Energy demand can be reduced a phenomenal 40% while still providing the same quality of life and services as today. What’s more, people in developing economies can access the same opportunities.
- And finally, nature-based climate solutions – planting trees and protecting peatlands – have the potential to become vast stores of carbon.

Solutions are scaling fast. More people are demanding healthier diets with lower carbon footprints. Major vehicle manufacturers have announced plans to phase out fossil fuels from light vehicles and investors are gaining confidence in alternatives to fossil fuels. But progress must accelerate and governments must drive it. First by declaring a goal of net zero emissions by 2050 at the latest. Then adopting a Carbon Law pathway to reach the goal.

All this points to the potential for the 2020s to see the fastest economic transition in history. This is the future we all want.

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Manuel Pulgar-Vidal
Leader of WWF’s global climate and energy practice

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MEETING THE 1.5°C AMBITION

Climate change is now affecting people on all continents and the impacts are becoming more severe. Scientific evidence shows that humanity is taking grave risks with the stability of Earth’s climate system if global average surface temperature continues rising alongside ecological destruction. Reducing this risk means societies working together to stabilise temperature rise at around 1.5°C. This translates to halving greenhouse gas emissions every decade from now on to approach net-zero emissions by 2050.

Achieving a 1.5°C planet will require the fastest economic transition in history. This transformation is both necessary and achievable. The journey has already begun. Here we chart the actions needed immediately and in the next decade to accelerate the transformation towards a safe operating space for humanity.
Meeting the 1.5°C Ambition began in 2015 when 197 nations forged the Paris Agreement and the Sustainable Development Goals (SDGs). The Paris Agreement created a global consensus to limit Earth’s temperature rise to “well below 2°C” and “in pace with efforts to limit the temperature increase to 1.5°C above pre-industrial levels,” in order to safeguard world development and human wellbeing.

In 2015, nations invited scientists to assess the impacts of 1.5°C global warming and provide pathways to achieve this goal. In 2018, after two years of intense effort, the Intergovernmental Panel on Climate Change (IPCC) concluded that a 1.2°C world would be substantially better for societies than 2°C. The assessment also concluded that stabilizing temperature at around 1.5°C is feasible, the cost would be affordable and that achieving it brings many other substantial benefits for the economy, ecosystems and human wellbeing.

The cost of weak action setting course for a planet over 3°C warmer – which is the current trajectory – will be catastrophic for many societies. Based on the findings of the report we conclude that we face a planetary crisis: the need to act is urgent and failure to act in time and at scale brings existential risks.

The IPCC 1.5°C Special Report and other recent research firmly conclude that stabilising temperature at 1.5°C above pre-industrial levels is essential and will require an extraordinary transformation of lifestyles, behaviours, norms and values in our society.

Three levers are essential for large-scale systems change:

1. A new worldview. We face unprecedented planetary risks where exponential action is necessary to stabilise Earth’s climate.

2. A goal. We need to reach net zero greenhouse gas emissions by 2050 to stabilise global average temperature at 1.5°C above pre-industrial levels. This can and should be achieved equitably and without compromising other Sustainable Development Goals.

3. A just pathway. We must aim to cut global greenhouse gas emissions in half by 2030 – or sooner – then halve them again by 2040 and reach net zero by 2050 – a pathway called the Carbon Law.

Countries have already committed to meeting Nationally Determined Contributions (NDCs) under the Paris Agreement, but these must be significantly enhanced to meet a 1.5°C goal. The NDCs are far too weak to meet even the 2°C target. Immediate and ambitious targets for countries, cities and companies, backed up with actions, are now essential to cut emissions 50% by 2030 or sooner.

It will take colossal efforts to redirect investment towards clean energy, shift production and consumption towards low-carbon solutions, and forge broad political support to make this transformation a reality. However, the means to achieve these goals already exist.

With ambitious leadership based on the best science the next decade can bring the fastest economic transformation in history. The roadmap presents one among many potential pathways. Reality will unfold with many twists and turns. Whichever path societies take will require exponential action to transform our global economy if we are to increase prosperity and well-being for the most people globally.

The Exponential Roadmap focuses on the actions needed to reach the short-term goal of peaking emissions as soon as possible and halving emissions by 2050. The presented solutions, which must be implemented in parallel, are based on academic research and expert assessment of their potential to scale exponentially and create virtuous cycles, like those in the technology industry, where improvements in performance and price drive higher value.

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The roadmap necessarily focuses on mitigation. Unavoidable climate change will require adaptation and resilience building but this is not the focus of this report.

Figure 1. Global fossil-fuel and cement emissions 1960–2018

After a three-year hiatus with stable global emissions, CO₂ emissions grew by 1.6% in 2017 followed by 2.7% in 2018.3 The continued increase in emissions remains uncertain but still strong growth appears likely because the persistent expansion of natural gas use and coal and oil projects feed the global economy, according to the Global Carbon Project. Data: Global Carbon Project (2019).
The dramatic fall in costs of wind and solar energy in the last decade has reached a tipping point where prices increasingly are lower than many fossil-fuel alternatives. Source: Irena Renewable Cost Database.5

Figure 2. Price drop in solar and wind power since 2010

The number of parties that have signed the UN’s Paris Agreement on climate change.

197

The number of countries that have ratified the agreement.

185

The probability of exceeding 2°C based on what countries are actually doing.7

90%

The probability of exceeding 2°C based on what countries are promising to do.7

97%

The number of countries with national laws consistent with their emissions reduction pledges.

16

The number of countries with legislation or proposed legislation to reach net zero emissions by 2050*.8

8

The growth in carbon dioxide emissions from fossil fuels and cement in 2018.4

2.7%

The years left until emissions need to peak for the world to stand a much better chance of reaching the 1.5°C target.

0
A NEW WORLDVIEW: 
OUR PLANET ON THE EDGE

In January 2019, Swedish student Greta Thunberg told world leaders at the World Economic Forum "I want you to act as if you would in a crisis. I want you to act as if our house is on fire. Because it is. Every child's birthright, and our common heritage is a stable, resilient planet. This birthright is now at risk.

From the unparalleled heat waves across the northern hemisphere in 2018 and 2019 to Cape Town’s “Day Zero” water crisis, to an unprecedented cyclone in Mozambique that created an “inland ocean” overnight, climate-related natural disasters are now assailing our planet.

Modern societies arose during a 10,000-year period of remarkable climatic stability on Earth, known as the Holocene. Earth has left the Holocene and entered the Anthropocene where industrialised societies are the prime driver of change to Earth’s life support system. Earth’s temperature has now topped 1°C above pre-industrial temperatures – an unprecedented leap in human history. The impacts are already more severe than most researchers estimated a decade ago. The temperature is rising almost 0.2°C every decade and the rate is accelerating. In October 2018, the Intergovernmental Panel on Climate Change (IPCC) concluded that the impacts of a warmer world are – and will be – significantly worse than previous estimates. In a 2°C world we can expect increased water stress, food security challenges, summer sea ice regularly disappearing in the Arctic and near-total loss of existing warm-water corals, impacting livelihoods. Limiting warming to 1.5°C rather than 2°C could result in 420 million fewer people being exposed to severe heatwaves.

“I want you to act as you would in a crisis. I want you to act as if our house is on fire. Because it is.”

Greta Thunberg
World Economic Forum, Davos 2019
Hothouse Earth

In 2018, researchers warned that going beyond 2°C—which is very likely based on current emissions trajectories—could potentially trigger natural processes to drive unmitigable warming and push the planet towards a ‘Hothouse Earth’ state about 4°C above preindustrial temperatures. 8 If temperatures rise much further than today, major ice sheets are likely to destabilise (there is evidence this may be underway), causing sea levels to eventually rise 20 metres or more, bringing constant flood risks to coastal cities from Miami to Mumbai. Food security will be severely threatened and many parts of the planet will become uninhabitable due to the extreme heat. Earth has not been this warm in over three million years.

This risk arises due to tipping points in the Earth system. These relate to, for example, the dieback of boreal forests and Amazon rainforest or permafrost melting, both of which store vast quantities of carbon. If these tipping points are crossed it could lead to the release of additional carbon into the atmosphere, making climate stabilisation significantly more challenging. The problems are compounded through, because research also indicates that crossing one tipping point can create a domino effect making it more likely other tipping points are crossed. Due to these complex feedbacks, a ‘Hothouse Earth’ scenario is plausible even if greenhouse gas emissions from human sources are reduced significantly more challenging. The problems are compounded through, because research also indicates that crossing one tipping point can create a domino effect making it more likely other tipping points are crossed. Due to these complex feedbacks, a ‘Hothouse Earth’ scenario is plausible even if greenhouse gas emissions from human sources are reduced significantly.

Figure 3. Earth’s tipping points

Map of the locations of potential large-scale tipping points, the estimated temperature ranges of the tipping points and potential interactions between tipping points. Crossing one tipping point can increase the risk of crossing another (IPCC 2018; Steffen et al.)

Existential threats

Climate change threatens people’s lives and livelihoods, and the most vulnerable are disproportionately affected. For communities on low-lying Pacific islands, as well as people living in towns and cities along exposed, low-lying coastlines, warming can create a domino effect making it more likely other tipping points are crossed. Due to these complex feedbacks, a ‘Hothouse Earth’ scenario is plausible even if greenhouse gas emissions from human sources are reduced significantly more challenging. The problems are compounded through, because research also indicates that crossing one tipping point can create a domino effect making it more likely other tipping points are crossed. Due to these complex feedbacks, a ‘Hothouse Earth’ scenario is plausible even if greenhouse gas emissions from human sources are reduced significantly.

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THE GOAL: NET ZERO BY 2050

There may still be time to stabilise Earth’s temperature at around 1.5°C without recourse to very large-scale and high-risk geoengineering deployment. But the window is closing rapidly. Limiting temperature rise to 1.5°C will require unprecedented action in four areas: Global greenhouse gas emissions must be drastically reduced, peaking now and reaching net zero by 2050 at the latest. Farming and other land use must move to become stores of carbon rather than emitting greenhouse gases. We need large-scale reforestation and forest, wetland and peatland management to protect the resilience of vital Earth systems. Finally, we must develop and scale robust solutions for storing carbon safely.

The IPCC 1.5 report concludes that this is achievable: “These systems transitions are unprecedented in terms of scale, but not necessarily in terms of speed, and imply deep and rapid emissions reductions across all sectors.” Wealthier nations, with large historic emissions, have a responsibility to set tougher targets. Norway has set a target of net zero by 2030; Finland has set 2035 and Sweden 2045 to reach net zero for emissions within their jurisdictions. It should be noted though that these targets often include purchase of carbon credits.

A rapid transition to 1.5°C world will bring strong co-benefits in terms of prosperity, health, security and economy. Heatwaves will be less frequent and the number of people at risk of water stress reduces by 50% compared with 2°C. The number of premature deaths is estimated to be lower by 100–200 million people in a 1.5°C world compared with 2°C.1 The economic benefit of a low-carbon future by 2030 is $26 trillion compared with staying on the current high-carbon pathway.2 The UK Committee on Climate Change, for example, estimates the direct cost of achieving net zero emissions by 2050 is just 1–2% of the UK's GDP.3 This estimate does not cover significant avoided costs and indirect benefits. On the flipside, the estimated losses due to stranded assets (worthless pipelines, coal mines and oil wells) rise to $4 trillion if weak policies in the next decade slow down climate progress.4

Greenhouse gas emissions from existing and proposed energy infrastructure – coal-fired power plants under construction or commissioned, for example – represent more than the entire carbon budget remaining to limit warming to 1.5°C with a probability of at least 50%, and perhaps two-thirds of the remaining carbon budget if warming is to be limited to less than 2°C.5

Most computer model scenarios to achieve climate stabilisation at 1.5°C rely on so-called negative emissions technologies (NETs) to remove between 400 and 1000 billion tonnes of carbon dioxide from the atmosphere, or 20–50% of the CO₂ emitted in the last 250 years.6 While the world will likely need to deploy a range of NET solutions, for example Bioenergy and Carbon Capture and Storage (BECCS), these technologies are controversial. They have never been attempted at large scale, they are expensive and carry the risks of serious unintended consequences. At a minimum, BECCS, for example, will require a trade-off between growing energy crops and growing food. It will place huge demands on freshwater and fertilizers and conflict with biodiversity goals. Given the grave risks of over-reliance on untried technologies, these should be deployed as an insurance policy, not the primary solution. But, as the remaining carbon budget dwindles, they will become increasingly necessary.
THE PATHWAY: HALVE GREENHOUSE GAS EMISSIONS EVERY DECADE

The goal of reaching net zero emissions by 2050 translates to an exponential pathway of cutting greenhouse gas emissions in half every decade: 50% by 2030, then 50% again by 2040, then 50% again by 2050. At the same time farming and land use must shift from emitting greenhouse gases to storing them and we need to scale up solutions to store carbon. We call this pathway the “Carbon Law.” The Carbon Law is an exponential trajectory inspired by Moore’s Law in computing where computing power doubles and costs halve every few years.

Reaching net zero emissions by 2050 will not be simple. But solutions already exist in all economic sectors to halve emissions by 2030, as a stepping stone to the ultimate goal. A list of solutions is detailed below, but the key strategies are to markedly improve efficiencies in energy and material usage, reduce demand for energy intensive activities, electrify as much as possible, and produce that electricity from renewable energy sources. The United Nations Environment’s Emissions Gap report estimates that existing, market-ready solutions can cut greenhouse gas emissions by more than 50% by 2030.23

Figure 4. Emissions reduction potential
Sectoral emission reduction potentials that are technically and economically feasible in 2030 based on carbon pricing up to US$100/tCO2e. The assessment shows that global emissions could be reduced by 23 GtCO2e in 2030 compared to the current policy scenario of 59 GtCO2e.18 The assessment also shows that global emissions could be 50% below 2018 levels by 2030 through a mix of existing market-ready solutions and behavioural change. Data: UNEP Emissions Gap Report 2018.

Figure 5. Greenhouse gas emissions
Carbon dioxide is the primary greenhouse gas emitted by human activities. Unlike other greenhouse gases, it affects the climate system for thousands of years. Methane (CH4) is 28–36 times more powerful as a greenhouse gas than carbon dioxide and emissions today last about a decade in the atmosphere. Nitrous oxide (N2O) is more powerful still (265–298 times the warming potential of CO2) and lasts a century in the atmosphere. Fluorinated gases (F-gases) also have a greater warming potential than CO2 and last thousands of years in the atmosphere. Data: Environmental Protection Agency and Project Drawdown.

“We are already at the start of this pathway. In the last decade, the share of wind and solar energy in the energy sector doubled every five years. If doubling continues at this pace fossil fuels will exit the energy sector before 2050.”

Johan Rockström
Director Potsdam Institute of Climate Impact Research
In 2018, 30 solutions to allow emissions to halve by 2030 were published in the first Exponential Roadmap. These solutions synthesized analyses from Project Drawdown, SITRA, and other sources. Now, we have updated them with the most recent data to include new analyses, e.g. low-energy demand scenarios and nature-based solutions. The trajectory for food has been updated to align with conclusions from the EAT Lancet report. All of these solutions are market ready and scalable. While the precise mix of solutions can vary, it's clear that climate solutions need to be implemented in all sectors in parallel and scale exponentially.

Figure 6. Sectoral roadmap to halve emissions by 2030

Proposed trajectories for emissions to peak in 2020 to approximately halve emissions by 2030 y-axis shows the sector’s annual emissions in Gt. Each trajectory shows the overall sector emissions and the relative contribution to emissions reductions from existing scalable solutions, e.g. solar photovoltaics or electric vehicles. In addition, Nature-Based Sinks, which provides the possibility to sequester greenhouse gases, is shown on the right. The number in each trajectory indicates emissions in 2020 and 2030 respectively in billions of tonnes (Gt) of CO2 per year for each emitting sector, and the storage potential for nature-based sinks. The proposed global shift to more healthy plant-based food can prevent the increase in emissions caused by e.g. population growth, and reduce emissions from the food sector by 9.1 Gt by 2030. Nature-based solutions can avoid emissions of 25 Gt CO2 by 2050 and new nature-based sinks can store 9.1 Gt CO2 by 2030.

The grey bar to the left shows the relative contribution of emitting sectors for the assumed 2020 baseline emissions of 51 billions tonnes of CO2, i.e. it is including food and nature-based emission sources but excluding nature-based sinks. The Energy Supply trajectory addresses both the energy sector’s own emissions and the relative contribution to emissions reductions from existing scalable solutions, e.g. solar photovoltaics or electric vehicles. In addition, Nature-Based Sinks, which provides the possibility to sequester greenhouse gases, is shown on the right. The number in each trajectory indicates emissions in 2020 and 2030 respectively in billions of tonnes (Gt) of CO2 per year for each emitting sector, and the storage potential for nature-based sinks. The proposed global shift to more healthy plant-based food can prevent the increase in emissions caused by e.g. population growth, and reduce emissions from the food sector by 9.1 Gt by 2030. Nature-based solutions can avoid emissions of 25 Gt CO2 by 2050 and new nature-based sinks can store 9.1 Gt CO2 by 2030.

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Difficult to decarbonize sectors

Some economic sectors are more difficult to decarbonize than others, including aviation, shipping, long-distance transport, cement and steel production. These account for about 27% of global CO₂ emissions from all fossil fuel and industrial sources (~9.2 Gt CO₂).20 Investments in R&D in the 2020s will be essential to ensure market-ready solutions exist to halve global emissions a second time from 2030. However, reducing demand for these products will also play a critical role in sustaining a Carbon Law pathway. (See page 27: Seven strategies central to the ‘low energy demand’ scenario).

Some major companies are taking substantial strides to tackle these hard-to-reach sectors. For example, truck company Scania has published a roadmap to become net zero by 2050. The world’s largest shipping company, Maersk, has committed to becoming 100% carbon neutral by 2050. And cement company Dalmia aims to be carbon negative by 2040. In Sweden, the steel industry is planning to have the first commercial scale zero-emissions steel plant, using hydrogen fuel, operational by the early 2030s. Since 2017, Oslo has required that municipal construction projects are fossil free and a commissioned study showed that almost all construction site emissions could be eliminated in the city by 2025.

The UK’s Committee on Climate Change estimates that reducing greenhouse gas emissions by 96% by 2050 is feasible but reducing emissions in certain hard-to-reach sectors – from aviation and shipping to manufacturing and industrial processes – will likely require significant scaling up of electrification, hydrogen, carbon capture and storage, and other low-carbon solutions.

Dramatically reducing energy demand

In recent years, researchers and policymakers have overwhelmingly focused on how to decarbonise the energy supply in order to meet climate goals. In contrast, the recent ‘low energy demand’ study showed how reducing energy demand can deliver a 1.5°C climate while supporting global health, education, poverty, employment and food security goals.23

In the ‘low energy demand’ scenario, global consumption of energy is 40% lower in 2050 than it is today. Seven strategies are at the heart of this energy demand transformation (pages 28–29). Each strategy is founded on examples of best practice from pioneering countries, cities, neighbourhoods, consumers, service providers, and research organisations around the world:

- Countries like Chile, Japan and France which have used standards and codes to continually ratchet up the energy and material efficiency of buildings and consumer goods.
- Cities like Vienna, Montreal and Sydney which have integrated shared mobility providers into their municipal transport infrastructures.
- Neighbourhoods like Pecan Street, Brooklyn and North Portland which have provided living labs for new peer-to-peer business models for electricity trading, tool sharing, and product exchange.
- Consumers who have reduced meat consumption, or who are no longer interested in car ownership or even driving.
- Service providers like Nest and Phillips which have developed smarter, lower-energy systems for heating and lighting homes.
- Research organisations like the International Transport Forum which have shown how flexible on-demand ‘taxi-buses’ can deliver urban mobility needs with less than half the CO₂ emissions and close to zero congestion.

Digitalisation and electrification are common themes of the ‘low energy demand’ scenarios as they support the efficient provision of useful services like mobility and thermal comfort. They are also enablers of the emerging shift in consumer culture away from owning things and towards accessing services. This shift has already happened in how we consume media, and is now starting to reshape how we use and consume transport services, consumer goods, and building space. The ubiquitous smartphone is the multi-functional device which – if it continues to displace the need for dozens of single-purpose devices (from radios and TVs to music systems and cameras) – could deliver 100-fold reductions in power consumption when in use or 30-fold reductions when on standby.23

Figure 7. Hard to decarbonize sectors

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<tr>
<th>Sectors</th>
<th>CO₂ Emissions</th>
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</thead>
<tbody>
<tr>
<td>Long-Distance Road Transport</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>Medium-Distance Road Transport</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Short-Distance Light Road Transport</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Short-Distance Med/Heavy Road Transport</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Combined Heat &amp; Electricity</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Industrial Processes</td>
<td>10%</td>
<td></td>
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<tr>
<td>Residential, Commercial</td>
<td>10%</td>
<td></td>
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<tr>
<td>Non-Electric</td>
<td>5%</td>
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The central insight of the low energy demand scenario is that dramatically downsizing the global energy system by scaling up tried and tested solutions brings the decarbonisation challenge well within the reach of available low-carbon energy technologies. If renewables continue to grow at their current double-digit annual rates to 2030, and then at 5-10% per year to 2050, the low energy demand scenario removes any need to rely on carbon capture and storage as well as negative emission technologies. The energy supply diversifies rather than relentlessly expands, and fossil fuels are phased out.

**SEVEN STRATEGIES CENTRAL TO THE ‘LOW ENERGY DEMAND’ SCENARIO**

1. **Electrify** energy end-use including vehicles and heat pumps to improve end-use efficiency.
2. **Digitalise** energy-using products and services to optimise infrastructure and resource use.
3. **Converge** onto fewer numbers of multi-functional goods to improve service quality and convenience.
4. **Shift** from ownership to usership to reduce material needs.
5. **Utilise** consumer goods, vehicles and physical infrastructures at higher rates to accelerate the introduction of improved alternatives.
6. **Innovate** business models offering low-energy services to appeal to consumers while making sense commercially.
7. **Tighten** efficiency standards continually upwards to deliver cost, performance, health and other benefits.
Setting more ambitious country targets

The IPCC 1.5°C report has sparked a first wave of action among nations to legislate for targets to reach “net zero” as soon as possible, and at the latest by 2050. Progress is promising, but must spread to other countries rapidly.

- Eleven countries in the European Union are now discussing a 1.5°C target for their economies.
- Norway, Finland, Sweden and the UK have now agreed targets to reach net-zero emissions by 2030, 2035, 2040 and 2050 respectively. Developing countries like Costa Rica and Fiji have declared they will be carbon neutral by 2050.
- In 2018, Portugal’s CO2 emissions fell 9% and Ireland’s dropped 7%, while their economies grew.
- In 2019, the UK and Ireland declared climate emergencies. In 2018, Ireland announced plans to divest its national investment fund from fossil-fuels – the first nation to make this commitment. Emissions have peaked and are now decreasing in 49 countries (accounting for 36% of global greenhouse gas emissions). In 18 developed countries (representing 28% of global emissions), CO2 emissions declined at an average rate of 2.4% per year between 2005 and 2015. These sustained declines in CO2 emissions are associated with concerted policy efforts to support renewable energy and switch away from carbon-intensive fuels, improve energy efficiency and reduce energy demand.

These positive examples do come with caveats. These modest declines occurred during the global financial crisis when economies slumped and the rise in emissions slowed globally. Most of the progress to date has been made in the energy sector. Other economic sectors – food, transport, buildings and industry – have not been sufficiently addressed, so transforming these sectors would result in significantly faster emissions declines. Moreover, country legislation to reach net-zero by 2050 often allows purchase of carbon credits. Ultimately, this creative accounting must go: countries must actually legislate for targets to reach “net zero” as soon as possible, and at the latest by 2050. Progress is promising, but must spread to other countries rapidly.

This is a critical moment in international policy. In 2020, nations are required to raise their climate ambition and declare this through enhanced Nationally Determined Contributions (NDCs) under the Paris agreement. Such pledges must reach “net zero” by 2050 and pathways in line with Carbon Law. This greater ambition must be combined with coherent policy to accelerate the pace of change to ignite and accelerate rapid system transformation. Policies that support low-carbon solutions while discouraging carbon-intensive processes and lifestyles.

Policies that support a rapid transition to a 1.5°C world include:

- Remove fossil-fuel subsidies and revise agricultural subsidies.
- Establish a price for carbon at a sufficient price level, and apply it globally.
- Ensure that national decision-making; budgets, tax systems and technology strategies are aligned with a 1.5°C world.
- Develop sector-wide roadmaps in energy, transport, buildings, food, agriculture and industry to halve carbon emissions by 2030 and reach net zero by 2050.
- Legislate for higher standards on emissions, efficiency and performance across all industries and accelerate the next generation zero-carbon solutions.
- Set stop dates for fossil fuel extraction and use.
- Connect technology strategies to climate strategies, allowing for mutual reinforcement.
- Adopt and accelerate circular, digital and sharing economies, directed towards decarbonisation.
- Incentivise a shift in behaviour towards healthy diets, cycling and public transport.
- Promote nature-based solutions including the creation of carbon sinks and enhance biodiversity.
- Ensure climate policies are fair - protecting vulnerable communities without violating planetary boundaries.
- Ensure climate policies are fair - protecting vulnerable communities without violating planetary boundaries.

“We need to step up ambition quite radically. We are not talking about a small incremental approach.”

Luis Alfonso de Alba
United Nations Secretary General’s envoy on climate change
Leadership and movements
Cities, companies and citizens have a critical role to drive momentum to accelerate the solutions required to follow the Carbon Law pathway. Cities and companies have direct control over about 35% of greenhouse gas emissions. Policymakers can work with these groups to nurture engagement with climate action. In the last 12 months there has been a step-change in public action on climate, as well as city, company and investor momentum. But this needs to expand further and faster to reach the critical mass with the high climate ambition required.

Citizen movements
In early 2019, fuelled by growing anger and frustration at those in power reneging on their promises and responsibilities to tackle climate disruption, schoolchildren walked out of school to strike in cities around the world. The students describe climate change as an emergency and have demanded policymakers set stronger targets. The root cause of the school strikes is intergenerational inequity – the costs of stabilising Earth’s climate will be borne by the next generation if deep cuts are not made immediately. For the first time, we now have a voice for future generations.

The movement is having a noticeable impact and has the potential to be a significant tipping point in social attitudes to climate action. The secretary general of OPEC, Mohammed Barkindo, has said that the growing mass mobilisation against oil is beginning to “dictate policies and corporate decisions, including investment in the industry”.24

Research shows schoolchildren strongly influence parental attitudes25 indicating that the new movement may begin to challenge existing societal norms. Moreover, the school strikes reflect a perceptible shift in worldviews. According to a recent 26-nation survey by the Pew Research Centre, people around the world agree that climate change poses a severe risk to their countries. In 13 of those countries, people listed climate change as the top international threat, above Islamic terrorism, cyberattacks and Russia.26

Cities
Cities are concentrations of human ingenuity, and for the 1.5°C revolution they must be engaged. 70 cities now receive over 90% of their energy from renewable sources.27 Indeed, on their own, cities and other subnational entities have the power to reduce greenhouse gas emissions by about one third by 2030, according to one scenario.19

Many cities are using their political might to work together to drive up ambition.

- 9138 cities (representing 19% of the global population) have made climate commitments to the Global Covenant of Mayors.
- 23 cities, including nine African cities, have already set net zero targets for 2050 or sooner.

“The youth are sending a clear and unmistakable message: This is an emergency.”
Patricia Espinosa
Executive Secretary, United Nations Framework Convention on Climate Change
At least 230 cities have set a 100% renewable goal in at least one sector. 

More than 200 cities representing 62 million people in Europe have demanded the European Union adopts a net zero by 2050 policy. 

221 cities have accepted WWF’s One Planet City Challenge in 2019 signalling their commitment to being assessed against a 1.5°C target. 

19 major cities including London, New York, Tokyo and Stockholm have committed to make new buildings net zero carbon by 2030 (C40). 

Companies

Businesses are also beginning to act. Over 600 major companies have committed to science-based targets aligned with the Paris Agreement. At least 27 large companies (with revenues in excess of $1 billion) have committed to net zero emissions by 2050 at the latest. Ikea, Unilever and Telia Company plan to reach net zero emissions by 2030 and Verizon by 2035. 

However, only 10% of the Fortune 500 companies have set targets aligned with the Paris Agreement, and far fewer have set targets aligned with a 1.5°C world. Initiatives to halve emissions through the value chain, in line with the Carbon Law - must scale rapidly and encourage companies of all sizes to reach their full potential, not the bare minimum. 

But the role of the business sector goes much further than reducing the direct emissions. The business proposition as such has an even stronger impact and businesses must make sure they align with a 1.5°C world. This goes hand in hand with new, exponential business opportunities as markets shift. 

Finance

The G20’s Task Force on Climate-Related Financial Disclosures (TCFD) has asked companies to disclose their exposure to climate risk. 160 companies overseeing $86 trillion in assets support the initiative and another initiative, Climate Action 100+, includes 360 investors with more than USD $34 trillion in assets under management and aims to ensure the world’s largest corporate greenhouse gas emitters take necessary action on climate change. Since the fossil-fuel divestment movement began in 2013, over 500 organizations with assets worth about $10 trillion have committed to divest from fossil fuels.

More significantly, 34 central banks have joined forces to ensure a smooth transition to a low-carbon economy through the Network for Greening the Financial System (NGFS). This network, including the Banks of England and the Banque de France, represents half of global greenhouse gas emissions. In 2019, it provided a series of recommendations for all central banks to avoid a climate-driven “Minsky moment”, the term for an abrupt collapse in asset prices.
Exponential Technologies

From digitalisation to robotics and synthetic biology, a technological revolution is underway and artificial intelligence, cloud computing, 5G and the Internet of Things (IoT) are poised to create further disruption in the next decade.

The digital revolution may be the biggest wildcard in the economic transformation. It can influence whether we end up on a 1.5°C planet or a world 3-4°C warmer - Hothouse Earth. Reaching net zero emissions by 2050 will require rapid transitions across all economic sectors and a shift towards sustainable consumption, increasingly mediated by technology. This means the digital revolution is an essential tool to support societal goals. 28, 29

Exponential technological development can considerably reduce energy consumption and material waste in all sectors, while supporting global health, sustainability and economic goals. It can also enable rapid transformation through new disruptive business models.

When it comes to applying the Carbon Law, the digital sector has the potential to directly reduce fossil-fuel emissions 15% by 203030 and indirectly support a further reduction of 35% through influence of consumer and business decisions and systems transformation.

For example:

- Solar, wind, storage and smart grid technology supported by digital solutions, will enable electrification, decentralisation and greening of the energy system.
- Energy usage in buildings can be brought down by increased space utilization through new digitally enabled sharing models.
- Mobility as a service, electrification, and autonomous vehicles connected to another one can tap the value of unused vehicles.
- Digitalisation can improve delivery by optimising shipments, routes and traffic systems.
- Artificial Intelligence can be applied to design products for re-purpose, sharing, re-use and recycling as the new default.
- Deforestation can now be predicted and detected through digital solutions which helps take proactive action, and to monitor and improve agriculture, reforestation and peatland restoration.
- Through the use of Internet of Things, AI, 5G and digital twin technology, the need for more roads and physical infrastructure can be dramatically reduced through optimizing existing infrastructure.

Supporting societal goals

While digitalisation and emerging technologies can contribute to reducing greenhouse gas emissions, many online platforms could be better utilised for the benefits of society. Platforms such as social media, search and eCommerce now influence the behaviour of about four billion consumers and producers every day – over half the population of the planet.

As well as influencing consumer behaviour – advertising revenue is now predominantly about online presence – these platforms now increasingly influence the flow of information in the world. This is influencing democratic processes by enabling disinformation campaigns and algorithmic propaganda – but also offers opportunities to accelerate the climate movement.

While some of the leading technology companies have ambitious internal sustainability targets, the conversation about how they use their influence to support the rest of society is less well developed. Given the power of digital platforms, it is time for a new social contract between them and society. Specifically for these companies, this means starting with a strong commitment to using technology for the good of society, promising to make low-carbon solutions the default, enabling shifts to low-carbon consumption, and promoting fact-based worldviews.

To avoid unintended consequences from technology, the potential impacts of early-stage innovations should be assessed and learnt from. Innovations with high positive climate-impact potential must be strongly supported in the coming decade.31

"Preventing irreversible climate disruption is the race of our lives, and for our lives. It is a race that we can and must win.”

António Guterres
UN Secretary-General
CONCLUSIONS

Slow policy progress over 30 years means that incremental decarbonization is no longer an option. Only decisive and rapid action can reduce the risk of catastrophic climate change, and simultaneously improve the quality of life for millions of people. Without decisive action to drive the fastest and fairest economic transition in history, this generation of leaders is handing the next generation an increasingly destabilized climate and Earth system. Indeed, decisions made today about infrastructure investments in energy systems, roads, railways, ships, aircraft and buildings will influence whether global warming can be stabilised around 1.5°C or not this century.

Ten years ago a global goal to reach net-zero emissions by 2050 seemed politically unlikely. Now, the latest science clearly shows this goal is necessary, achievable and desirable – a 1.5°C planet will provide the greatest good for the most people. And countries are starting to adopt goals and
Halving emissions every decade using proven measures across society and the economy can deliver on this goal. Achieving it will substantially reduce risks of catastrophic climatic impacts, but not eliminate these risks entirely. The technologies and solutions needed to cut emissions rapidly are available, can scale quickly and are affordable. They must be accelerated by strong policy, climate leadership, exponential technology and finance. The economic transition will bring significant benefits from reduced pollution to improved health and economic growth. Indeed, the transformation is the biggest economic opportunity of this generation.

Reaching the 2050 goal of net zero emissions globally will help ensure the continuation of the conditions that have allowed human civilisation to flourish over the past 10,000 years. This is every child’s birthright.

“\[quote\]It always seems impossible until it’s done\[quote\]”

Nelson Mandela

ROADMAP DELIVERY AND IMPACT

Meeting the 1.5°C Climate Ambition is published along with the Exponential Roadmap 1.5 report and released at the UN Climate Action Summit in New York, September 2019. The Exponential Roadmap 1.5 follows directly from the Exponential Climate Action Roadmap 1.0 report, which was launched at the opening plenary of the Global Climate Action Summit (GCAS) in September 2018 by Johan Rockström and Christiana Figueres.

It was the first major international report fully aligned with the requirements of the IPCC 1.5 degree-report, which stated that the world must halve emissions by 2030 and has achieved strong impact. The roadmap also provided the foundation for two declarations: the Step-Up Declaration signed by 20 front-running companies, including Ericsson, Salesforce, Cisco, Uber, and HP, to accelerate action, and the Speedwell Declaration led by New Energy Nexus and WWF and signed by 327 CEOs of tech start-ups committed to rapid action.

The Exponential Roadmap 1.5 provides an update to the first roadmap, based on new data and research as well as quantifying the scale of growth in climate leadership required from cities, companies, nations and citizen initiatives. It provides a comprehensive summary of proven solutions that deliver emissions, energy and material savings while driving prosperity. And it highlights how these solutions can be accelerated with policy, climate leadership, and technology.


LET’S HALVE GLOBAL EMISSIONS BY 2030