COMMENT

REUBEN WU

Decarbonizing the world economy will require renewable energy generation from vast solar farms, such as this one in Nevada.

Three years to safeguard our climate

Christiana Figueres and colleagues set out a six-point plan for turning the tide of the world's carbon dioxide by 2020.

In the past three years, global emissions of carbon dioxide from the burning of fossil fuels have levelled after rising for decades. This is a sign that policies and investments in climate mitigation are starting to pay off. The United States, China and other nations are replacing coal with natural gas and boosting renewable energy sources. There is almost unanimous international agreement that the risks of abandoning the planet to climate change are too great to ignore.

The technology-driven transition to low-carbon energy is well under way, a trend that made the 2015 Paris climate agreement possible. But there is still a long way to go to decarbonize the world economy. The political winds are blustery. President Donald Trump has announced that the United States will withdraw from the Paris agreement when it is legally able to do so, in November 2020.

The year 2020 is crucially important for another reason, one that has more to do with physics than politics. When it comes to climate, timing is everything. According to an April report[1] (prepared by Carbon Tracker in London, the Climate Action Tracker consortium, the Potsdam Institute for Climate Impact Research in Germany and Yale University in New Haven, Connecticut), should emissions continue to rise beyond 2020, or even remain level, the temperature goals set in Paris become almost unattainable. The UN Sustainable Development Goals that were agreed in 2015 would also be at grave risk.

That's why we launched Mission 2020 — a collaborative campaign to raise ambition and action across key sectors to bend the greenhouse-gas emissions curve downwards by 2020 (www.mission2020.global).

As 20 leaders of the world's largest economies gather on 7–8 July at the G20 summit in Hamburg, Germany, we call on them to highlight the importance of the 2020 climate turning point for greenhouse-gas emissions, and to demonstrate what they and others are doing to meet this challenge. Lowering emissions globally is a monumental task, but research tells us that it is necessary, desirable and achievable.

After roughly 1°C of global warming driven by human activity, ice sheets in Greenland ▶

and Antarctica are already losing mass at an increasing rate. Summer sea ice is disappearing in the Arctic and coral reefs are dying from heat stress — entire ecosystems are starting to collapse. The social impacts of climate change from intensified heatwaves, droughts and sea-level rise are inexorable and affect the poorest and weakest first.

The magnitude of the challenge can be grasped by computing a budget for CO_2 emissions — the maximum amount of the gas that can be released before the temperature limit is breached. After subtracting past emissions, humanity is left with a 'carbon credit' of between 150 and 1,050 gigatonnes (Gt; one Gt is 1×10^9 tonnes) of CO_2 to meet the Paris target of 1.5 °C or well below 2 °C (see go.nature.com/2rytztf). The wide range reflects different ways of calculating the budgets using the most recent figures.

At the current emission rate of 41 Gt of CO_2 per year, the lower limit of this range would be crossed in 4 years, and the midpoint of 600 Gt of CO_2 would be passed in 15 years. If the current rate of annual emissions stays at this level, we would have to drop them almost immediately to zero once we exhaust the budget. Such a 'jump to distress' is in no one's interest. A more gradual descent would allow the global economy time to adapt smoothly.

HARNESS MOMENTUM

The good news is that it is still possible to meet the Paris temperature goals if emissions begin to fall by 2020 (see 'Carbon crunch').

Greenhouse-gas emissions are already decoupling from production and consumption. For the past three years, worldwide CO_2 emissions from fossil fuels have stayed flat, while the global economy and the gross domestic product (GDP) of major developed and developing nations have grown by at least 3.1% per year (see go.nature.com/2rthjje). This is only the fourth occasion in the past 40 years on which emission levels have stagnated or fallen. The previous three instances — in the early 1980s, 1992 and 2009 — were associated with global economic predicaments, but the current one is not[2].

Emissions from the United States fell the most: by 3% last year, while its GDP grew by 1.6%. In China, CO_2 emissions fell by 1% in 2016, and its economy expanded by 6.7% (ref. 2). Although it is too early to tell whether this plateau will presage a fall, the signs are encouraging.

In 2016, two-thirds of China's 5.4% extra demand for electricity was supplied by carbon-free energy resources, mostly hydropower and wind[2]. In the European Union, wind and solar made up more than three-quarters of new energy capacity installed; coal demand was reduced by 10% (ref. 3). In the United States, almost two-thirds of the electricity-generating capacity installed by utility companies was based on renewables (see go.nature.com/2skv20g).

The International Energy Agency (IEA) has predicted that, by 2020, renewable sources could deliver 26–27% of the world's electricity needs, compared with 23.7% of electric power at the end of 2015. But that underestimates the pace of change in energy systems.

Growth in electric vehicles alone could displace 2 million barrels of oil per day by 2025, according to a February report[4]. It suggests that, by 2050, this could reach 25 million barrels of oil per day — a stark contrast to expectations from the fossil-fuel industry that demand for oil will rise. And solar power alone could supply 29% of global electricity generation by 2050. This would remove the need for coal and leave natural gas with only a 1% market share. However, the oil firm ExxonMobil predicts that all renewables will supply just 11% of global power generation by 2040 (ref. 4).

THE FOSSIL-FREE ECONOMY IS ALREADY PROFITABLE.

Investors, meanwhile, are growing wary of carbon risks. BlackRock and Vanguard, the two largest fund managers, voted — along with many others — against ExxonMobil management at its annual general meeting on 31 May and instructed the company to report on the profit impact of global measures to keep climate change below 2 °C. Earlier this month, Norway's US$960-billion sovereign-wealth fund declared that it will ask the banks in which it has invested to disclose how their lending contributes to global greenhouse-gas emissions.

Last year, the installed capacity of renewable energy set a new record of 161 gigawatts; in 2015, investment levels reached $286 billion worldwide, more than 6 times that in 2004. Over half of that investment, $156 billion, was for projects in developing and emerging economies[5].

There is a strong headwind against the low-carbon transition in some places, which may impede progress. For example, the Financial CHOICE Act — a bill passed by the US House of Representatives on 8 June — would make it nearly impossible for investors to challenge companies on climate-risk disclosure through shareholder proposal processes, as at ExxonMobil. However, as the UN Secretary General, António Guterres, said in New York last month: "The sustainability train has left the station." The fossil-free economy is already profitable[6] and creating jobs (www.clean200.org). A report this year by the International Renewable Energy Agency and the IEA shows that efforts to stop climate change could boost the global economy by $19 trillion[7]. The IEA has also said that implementing the Paris agreement will unlock $13.5 trillion or more before 2050.

Recent geopolitical events, too, have galvanized activity in support of the Paris agreement. For example, the #WeAreStillIn campaign — involving more than 1,000 governors, mayors, businesses, investors and universities from across the United States — has declared that it will ensure the nation remains a leader in reducing carbon emissions.

SIX MILESTONES

To prioritize actions, we've identified milestones in six sectors. Developed with knowledge leaders, these were reviewed and refined in collaboration with analysts at Yale University, the Climate Action Tracker consortium, Carbon Tracker, the low-carbon coalition We Mean Business, the Partnership on Sustainable, Low Carbon Transport (SLoCaT), advisory firm SYSTEMIQ, the New Climate Economy project and Conservation International.

These goals may be idealistic at best, unrealistic at worst. However, we are in the age of exponential transformation and think that such a focus will unleash ingenuity. By 2020, here's where the world needs to be:

Energy. Renewables make up at least 30% of the world's electricity supply — up from 23.7% in 2015 (ref. 8). No coal-fired power plants are approved beyond 2020, and all existing ones are being retired.

Infrastructure. Cities and states have initiated action plans to fully decarbonize buildings and infrastructures by 2050, with funding of $300 billion annually. Cities are upgrading at least 3% of their building stock to zero- or near-zero emissions structures each year[9].

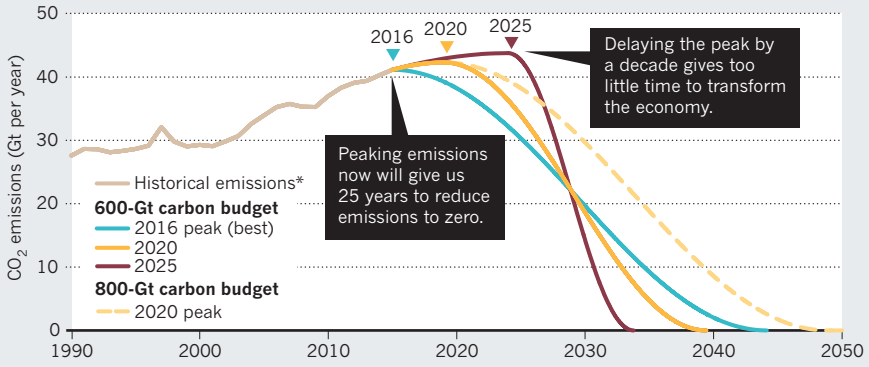
Transport. Electric vehicles make up at least 15% of new car sales globally, a major increase from the almost 1% market share that battery-powered and plug-in hybrid vehicles now claim. Also required are commitments for a doubling of mass-transit utilization in cities, a 20% increase in fuel efficiencies for heavy-duty vehicles and a 20% decrease in greenhouse-gas emissions from aviation per kilometre travelled.

Land. Land-use policies are enacted that reduce forest destruction and shift to reforestation and afforestation efforts. Current net emissions from deforestation and land-use changes form about 12% of the global total. If these can be cut to zero next decade, and afforestation and reforestation can instead be used to create a carbon sink by 2030, it will help to push total net global emissions to zero, while supporting water

SOURCES: STEFAN RAHMSTORF/GLOBAL CARBON PROJECT; HTTP://GO.NATURE.COM/2RCPCRU

CARBON CRUNCH

There is a mean budget of around 600 gigatonnes (Gt) of carbon dioxide left to emit before the planet warms dangerously, by more than 1.5–2°C. Stretching the budget to 800 Gt buys another 10 years, but at a greater risk of exceeding the temperature limit.



*Data from The Global Carbon Project.

supplies and other benefits. Sustainable agricultural practices can reduce emissions and increase CO_2 sequestration in healthy, well-managed soils.

Industry. Heavy industry is developing and publishing plans for increasing efficiencies and cutting emissions, with a goal of halving emissions well before 2050. Carbon-intensive industries — such as iron and steel, cement, chemicals, and oil and gas — currently emit more than one-fifth of the world's CO_2, excluding their electricity and heat demands.

Finance. The financial sector has rethought how it deploys capital and is mobilizing at least $1 trillion a year for climate action. Most will come from the private sector. Governments, private banks and lenders such as the World Bank need to issue many more 'green bonds' to finance climate-mitigation efforts. This would create an annual market that, by 2020, processes more than 10 times the $81 billion of bonds issued in 2016.

FURTHER, FASTER, TOGETHER

If we delay, the conditions for human prosperity will be severely curtailed. There are three pressing and practical steps to avoid this.

First, use science to guide decisions and set targets. Policies and actions must be based on robust evidence. Uncensored and transparent communication of peer-reviewed science to global decision-makers is crucial. Academic journal articles are not easily read or digested by non-experts, so we need a new kind of communication in which *Nature* meets *Harvard Business Review*. Science associations should provide more media training to young scientists and hold communication boot camps on how to make climate science relevant to corporate boards and investors.

Those in power must also stand up for science. French President Emmanuel Macron's Make Our Planet Great Again campaign is a compelling example. He has spoken out to a global audience in support of climate scientists, and invited researchers to move to France to help accelerate action and deliver on the Paris agreement. To encourage others to speak, scientists should forge connections with leaders from policy, business and civil society. The Arctic Basecamp at Davos in January, for instance, brought scientists into high-level discussions on global risk at the World Economic Forum's annual meeting in Switzerland.

Second, existing solutions must be scaled up rapidly. With no time to wait, all countries should adopt plans for achieving 100% renewable electricity production, while ensuring that markets can be designed to enable renewable-energy expansion.

Third, encourage optimism. Recent political events have thrown the future of our world into sharp focus. But as before Paris, we must remember that impossible is not a fact, it's an attitude. It is crucial that success stories are shared. Demonstrating where countries and businesses have over-achieved on their targets will raise the bar for others. More-ambitious targets become easier to set.

The upcoming G20 meeting in Hamburg is the perfect moment for heads of state to integrate the six milestones into their discussions on how to ensure a resilient, prosperous, inclusive and interconnected global economy. This would pave the way for a year of raised ambition in 2018, when nations take stock of progress and revise national commitments under the Paris agreement.

The G20 is due to adopt the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures, on how the global finance system will manage the risk of climate change. It requires financial institutions to design, disclose and implement a transition strategy with a view to full decarbonization of operations, value chains and portfolios by 2050. National governments and financial regulators must enact these recommendations swiftly.

Cities and provincial governments must help to drive the ambition of national governments on climate change, particularly through smart infrastructure and transport policy. C40 Cities, a network of megacities committed to addressing climate change, has adopted a strategy called Deadline 2020 that aligns its emissions-reductions plans with the Paris agreement. Other cities now have an opportunity to follow suit, for example through the Global Covenant of Mayors for Climate and Energy.

Our co-signatory list, which includes eminent scientists, business leaders, economists, analysts, influencers and representatives of non-governmental organizations, is an example of the strength of radical collaboration across unusual partners, who all share a mission to seize this opportunity to improve people's lives, the planet and the global economy.

There will always be those who hide their heads in the sand and ignore the global risks of climate change. But there are many more of us committed to overcoming this inertia. Let us stay optimistic and act boldly together. ■

Christiana Figueres *is vice-chair of the Global Covenant of Mayors for Climate and Energy, and Convener of Mission 2020.* **Hans Joachim Schellnhuber** *is director of the Potsdam Institute for Climate Impact Research, Germany.* **Gail Whiteman** *is director of the Pentland Centre for Sustainability in Business, Lancaster University, UK.* **Johan Rockström** *is executive director of the Stockholm Resilience Centre, Stockholm University, Sweden.* **Anthony Hobley** *is chief executive of Carbon Tracker, London, UK.* **Stefan Rahmstorf** *is head of Earth system analysis at the Potsdam Institute for Climate Impact Research, Germany.*
e-mail: cfigueres@mission2020.global

1. Mission 2020. *2020: The Climate Turning Point* (Mission 2020, 2017); available at http://go.nature.com/2takuw3
2. International Energy Agency. *World Energy Outlook 2016* (International Energy Agency, 2016).
3. WindEurope. *Wind in Power: 2016 European Statistics* (WindEurope, 2017).
4. Carbon Tracker. *Expect the Unexpected* (Carbon Tracker, 2017).
5. Frankfurt School–UNEP Centre/BNEF. *Global Trends in Renewable Energy Investment 2016* (Frankfurt School, 2016).
6. IRENA. *Renewable Energy and Jobs: Annual Review 2017* (IRENA, 2017).
7. IEA/IRENA. *Perspectives for the Energy Transition* (IEA/IRENA, 2017).
8. REN21. *Renewables 2016: Global Status Report* (REN21, 2016).
9. Climate Action Tracker. *10 Steps* (Climate Action Tracker, 2016); available at http://go.nature.com/2ryh56j

A list of co-signatories accompanies this Comment online (see go.nature.com/2sucret).